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PROJECT MANUAL

VOLUME 3: DIVISIONS 21 – 33

Binghamton City School District 2024 Capital Project

- Theodore Roosevelt Elementary School

03-02-00-01-0-010-014



CSArch Project # 215-2402

The design of this project conforms to applicable provisions of the New York State Uniform Fire Prevention and Building Code the New York State Energy Conservation Construction Code and the Manual of Planning Standards of the New York State Education Department

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PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract including all General Conditions, Supplementary Conditions, Division 1 specification sections as well as Information to Bidders requirements that are included in the project documents, apply to the work of this Contract.

1.2 ALLOWANCES, ALTERNATES AND UNIT PRICES

- A. Refer to Division 1 specifications for allowances, alternates and unit prices required as part of this Contract.

1.3 INTENT

- A. The intent of the drawings and these specifications is to provide all systems complete and operative. Whether indicated on the drawings and/or included in the specification or not, provide all materials, equipment and labor usually furnished with such systems.

1.4 DEFINITIONS

- A. Provide: Furnish, install and connect.
- B. Furnish: Supply material only.
- C. EXR: Existing to remain.

1.5 SCOPE OF WORK

- A. Drawings and specifications are complementary and must be so interpreted to determine the full scope of work under this section. Wherever any material, article, operation or method is either specified or shown on the drawings, this Contractor is required to provide each item and perform each prescribed operation according to the designated quality, qualification or condition, furnishing all necessary labor equipment and incidentals.
- B. Specifically included, without limiting the generality of drawings and specifications are:
 - 1. Delegated Fire Protection Design including PE Stamped Shop Drawings & Hydraulic Calculations.
 - 2. Valves where indicated.
 - 3. Backflow preventer.

4. Connection to existing water mains.
5. Excavation and backfill for piping.
6. Sprinkler system.
7. Automatic Fire Pump.
8. Standpipe system.
9. Tests: This contractor shall furnish materials, equipment and labor and shall perform all work of testing of the plumbing systems as outlined hereinafter. Testing procedure shall include installation tests and operating tests.

1.6 CONTINUITY OF UTILITY SERVICES

- A. It is of paramount importance that each utility service operate continuously and without interruption. Whenever this contractor plans to make changes or alterations to any existing utility service, such plans shall result in no or minimum service interruption or inconvenience to Owner. This contractor shall plan and schedule any change or alteration to an existing utility service with Architect and Owner. Such planning, timing, and/or scheduling shall be approved by both these parties.

1.7 CODES AND STANDARDS

- A. All materials, equipment, and installations by this contract shall be in accordance with the latest editions of the following applicable requirements:
 1. 2020 New York State Building Code, including all applicable amendments supplements to the following:
 - a) 2018 International Building Code
 - b) 2018 International Existing Building Code
 - c) 2018 International Fire Code
 - d) 2018 International Plumbing Code
 - e) 2018 International Mechanical Code
 - f) 2018 International Fuel Gas Code
 2. 2020 Supplement to the New York State Energy Conservation Construction Code including all applicable amendments to the following:
 - a) 2018 International Energy Conservation Code
 - b) 2013 ASHRAE 90.1
 3. 2020 Uniform Code Supplement (May 12, 2020)
 4. Local Utility Standards.
 5. Local Municipal and/or City Standards.
 6. Conform to requirements of Owner's insurance carriers.
 7. All requirements of the National Fire Protection Association (NFPA).

1.8 SUBMITTALS AND SUBMISSION REQUIREMENTS

- A. All submittals shall be in accordance with Division 1 requirements, the following requirements listed below, and also as indicated in each specification section. All submittals not complying with the listing above will be returned to the contractor without being reviewed. Rejection by Architect or Engineer of any items submitted shall require resubmittal of acceptable items.
1. Within (30) days after receiving signed contract or notice to proceed, submit to Architect for review complete descriptive dimensional data and ratings for equipment and materials proposed to be furnished and installed. Submit (8) copies of data unless otherwise specified by the architect.
 2. Prior to the start of any work this contractor shall submit for approval dimensional shop drawings & hydraulic calculations bearing the stamp of a NY Licensed PE.
 3. All materials submitted shall clearly state the job name and specification section(s) that it applies to.
 4. Any package containing more than one piece of equipment or material shall also contain a schedule clearly listing all items in submittal. Schedule page(s) shall also indicate project name and building name.
 5. All submittals must be clearly marked using nomenclature used in this specification for proper item identification, schedule of usage's, model numbers, construction materials, performance, data, etc.
 6. Projects involving multiple buildings must have the submittals separated by building. Submittals in which buildings are combined will not be accepted. (Exception: When specifically approved by engineer, basic materials may be submitted once.)
 7. The contractor shall verify and insure that dimensions and elevations of equipment and structures to be used conform to the space allocated for the equipment on the drawings, and complies with existing conditions.
 8. Submittals traced or copied from contract drawings are not acceptable and will be returned without review.

9. In the event material and/or equipment is installed prior to obtaining approval of shop drawings, and in the sole opinion of the Owner's Agent, this material and/or equipment does not meet the specifications, the Contractor shall be liable for the removal and the replacement at no additional cost to the contract.
- B. Samples: When requested by Engineer, provide samples of both specified equipment and proposed substitutions for review by the Owner's Agent. Such equipment shall be delivered to a location designated, or erected at the job site as directed. When neither is physically possible, arrange for the Owner's Agent to visit an acceptable site where the proposed equipment can be inspected.
- C. Substitutions:
 1. Submittals for equipment or materials other than as specified shall be accepted for review by the Owner's agent.
 2. Approval of substitute equipment shall be based on functional, physical and aesthetic compatibility to the equipment specified as determined by the Owner's agent and approved by the engineer.
 3. Where substitute equipment is approved, the contractor shall be responsible for, and bear the cost of any necessary changes by his trade or other trades to make the system complete and operable.
 4. Contractor is fully responsible for providing coordination between all trades affected by equipment substitution.
 5. When requested, contractor shall submit layout drawings indicating new dimensions and arrangements of substituted equipment. Layout drawings shall indicate all revisions necessary for all services affected by substitution.

1.9 CUTTING AND PATCHING

- A. This contractor shall bear the cost of all cutting and patching required by and for the installation of this work. This contractor shall perform all cutting and patching unless otherwise indicated on drawings or if directed by the Architect.
- B. Patching of fire rated floors, walls, partitions, etc. shall be made using new materials equal to the fire rating of the existing.

- C. Should changes, omissions or errors in this contract's work require cutting, patching or making alterations in any portion of new construction, such work will be performed by GC at this Contractor's expense.
- D. Cutting shall be done in a manner which will not adversely affect the strength of the building. Holes and openings shall be neatly cut so as to provide a finished appearance and shall be patched around the edge where required for a finished appearance. Provide temporary bracing, shoring, etc. as required.
- E. Patching shall be structurally sound and match the existing materials and finish of adjacent materials. Patching is required in finished areas, wherever existing work is removed, at the sides of openings, etc.
- F. At the completion of the work, all evidence of alteration will be as inconspicuous as possible.

1.10 SUBSTANTIAL COMPLETION REQUEST FOR PUNCH LIST

- A. Contractor shall submit a letter in email form stating that the work is substantially complete and ready for Punch List review by Engineer.
- B. Contractor shall note which areas are substantially complete by Building (if multiple buildings) and by Area according to the Key Plan.
- C. Contractor shall list all items that are known to be incomplete at time of submission.
- D. If the request is for a partial Punch List, Contractor shall also include a list of room numbers/room tags.
- E. When letter is received by the Engineer, site review(s) will be coordinated with the Construction Manager, Clerk, Architect.

1.11 FIELD INSPECTION

- A. As there are various conditions at the site which do not show on the accompanying drawings, or which are at variance with the conditions indicated on the drawings, it is important that each bidder visit the site and acquaint himself with existing conditions, and take these conditions into consideration when preparing his proposal. Each bidder shall obtain information or make any measurement desired. Lack of knowledge relative to existing conditions will not be allowed as a basis for extra compensation.

- B. This contractor and his subcontractors shall inspect existing equipment to remain prior to any of his new work in order to determine that all equipment is in good operating condition. If equipment is found to be lacking components, is inoperable, damaged, etc., contractor shall provide immediate written notice to the Owner. The Owner or his representative shall determine if any additional work is necessary and the method by which any work shall be performed.

1.12 INSTRUCTION SERVICES AND MANUALS

A. Instructions:

1. Provide competent personnel to remain at the jobsite for necessary time to instruct the Owner's personnel in proper operation and maintenance of installation made by this contractor.
2. This contractor shall be responsible for notifying and instructing Owner's personnel on all equipment operations, maintenance requirements, etc. Furnish operating training session(s) for equipment listed.
3. The Owner shall be responsible for establishing an operating and maintenance program for all equipment listed.

B. Training Session: A training session shall be held for each system and/or item listed below:

Item	Description	Training Hours For Each Bldg
1.	Sprinkler Heads and Spares	1/2
2.	Tamper (Supervisory Valves)	1/2
3.	Flow Switches	1/2
4.	Fire Hose Cabinets	1
5.	Fire Pump and Controller	8
6.	Jockey Pump and Controller	1/2

C. The instruction shall include the following types of information:

1. System overview
2. Major component designation
3. System operation procedures
4. Maintenance scheduling and procedures
5. Provide a list of spare components each system would normally required.

D. Services: Provide services required, for all equipment specified under this contract, for a period of (1) year after written acceptance by the Owner.

- E. Manuals: Submit (3) sets of Operation and Maintenance manuals. Each set shall contain the manufacturers' data, operating instruction parts catalog and maintenance procedures for each piece of equipment. Include normal maintenance servicing schedule to be performed by the Owner.

- 1. For projects containing multiple buildings, manuals shall be submitted separately for each building.

1.13 PERMITS, CERTIFICATES AND FEES

- A. This Contractor shall obtain and pay for permits, certificates, fees etc. listed below. Costs for permits, fees etc. shall be included in the Base Bid amount.
 - 1. All required applications and permits to begin work.
 - 2. Certificate of inspection including Third Party Agent.
 - 3. All municipal connection charges.
 - 4. All local utility charges (gas etc.).
 - 5. Fees and charges shall be obtained directly from the respective authority having jurisdiction.

1.14 REMOVAL, DISPOSAL AND HAZARDOUS MATERIALS

- A. All removed equipment shall be removed from the site and properly disposed of.
- B. All hazardous materials must be disposed of in compliance with ENCON and all other regulatory agencies.
- C. The Owner may wish to keep certain equipment, therefore, check with Owner before removals to determine what may be salvageable.

1.15 GUARANTEE

- A. Contractor shall guarantee all work furnished through this contract including work performed by sub-contractors, for a period of (1) year (unless otherwise noted), from the date of final acceptance. Contractor agrees to repair or replace any defective work or materials at no additional cost to the Owner. Contractor shall also pay for any damage to other work resulting from repairs to defects. Contractor shall furnish written guarantees to the Owner's agent in accordance with the general conditions.

1.16 INSTALLATION

- A. This contractor shall coordinate scheduling and installation of work with other contractors, sub-contractors and other trades. The contractor is also required to coordinate all work with owner supplied materials, direct contracts, and normal building operations, if any.
- B. All finished work shall be neat and workmanlike. All work of a special nature shall be performed by skilled and qualified workmen who can present credentials showing experience in said trade. New systems shall be delivered to Owner complete in perfect working order, tested and balanced in full accordance with plans and specifications. Existing systems shall function in same manner as before this work was performed. Any malfunctions which arise in existing systems as a result of demolition or alteration of parts of such systems shall be corrected.
- C. Layout of equipment, accessories and piping systems in plan is generally diagrammatic unless specifically dimensioned or detailed. Check project drawings and existing site conditions before installing work for interference's as governed by structural or other conditions. Owner reserves the right to make reasonable changes in location of equipment, accessories or piping systems prior to "roughing-in" without involving additional expense. Exact dimensions shown upon plans will be subject to verification and confirmation of exact conditions at site at time of construction. "Plus or minus" dimensions are shown upon drawing as a guide only. Exact surrounding conditions are governed by final equipment selection and/or other like details.
- D. Furnish all new equipment and materials as described herein. Any material, operation, method or device mentioned, listed or noted within this specification, if not specifically mentioned as furnished or installed by others, shall be furnished and installed by this contractor.

1.17 TESTING AND INSPECTION

- A. Inspections required for any ordinances, regulations, instructions, laws, rules, standards and practices that require any work to be inspected or tested shall be performed. Contractor shall give Owner, Architect and Engineer timely notice of readiness of work for inspection or testing and the date fixed for said inspection or testing.
- B. Third-Party Agency must inspect completed installation and present Owner with Certificate of Inspection showing approval.

- C. Required local or municipal inspection processed and present Owner with certificate indicating approval of such governing bodies.
- D. Contractor shall submit a written report to Architect, copy to Engineer, on results of each inspection or test on system or equipment supplied. Report shall contain all pertinent information, recommendations, approvals, additional work required, etc.
- E. Tests:
 - 1. After installations are completed and before insulation is applied, walls are closed, or trenches backfilled, all portions of the installation shall be tested in accordance with the procedures described herein.
 - 2. Interior domestic water piping shall be tested at 125 psi pressure. Contractor shall fill piping at the beginning of working day and maintain pressure for two hours with no pressure loss. If no leaks are found, the piping shall be allowed to remain under pressure overnight and then be inspected the next morning. No insulation shall be applied to the piping until the test is complete.

1.18 RECORD DOCUMENTS

- A. PE Stamped shop drawings & hydraulic calculations are to be provided by this contractor prior to the start of work.
- B. When required by general conditions or other Division 1 Section this Contractor shall prepare and turn over to Owner's agent record As-built documents. As-built drawings will include actual equipment location layout, service connections, ductwork and piping layouts, valve locations, etc.
- C. In all projects, contractor shall provide record drawings of all underground equipment and service runs. As-built drawings for underground work will include dimensions to actual locations finish grade elevations, and actual invert to underground structures equipment and service runs.

1.19 IDENTIFICATION AND NAMEPLATES

- A. Provide engraved plastic labels screwed to equipment furnished under this contract including control panels, starters, switches, panels, etc. Labels shall have black background, white letters; minimum letter height 3/8" high, self adhesive labels or punch tape type labels are not acceptable.

1.20 PENETRATIONS THRU FIRE RATED CONSTRUCTION

- A. All penetrations by this contract through rated construction shall be sealed fire safe by a UL listed approved method.
- B. All piping penetrations through walls, floors, etc. shall be sleeved.
- C. All piping penetrations through fire rated partitions, walls, floors, etc. shall be installed as follows; penetration shall be oversized 1/2" to 3/4" maximum. This contractor shall pack with fireproofing insulation, type FS cerablanket. Outside of penetrations (exposed surfaces around pipes and ductwork) shall be caulked and sealed with flame stop V, as manufactured by Flame Stop, Inc.; or an approved equal. Flame stop sealant shall be troweled smooth for finishing as required.

1.21 CONFINED SPACES

- A. All work in pipe tunnels, mechanical pits, well manholes, etc. shall be performed by skilled tradesman and laborers with current certification for working in confined space. Contractor shall bear all costs to provide all safety equipment, ventilation, etc. as required by State and Federal Regulations and shall obtain all necessary permits for such work.
- B. Contractor shall submit copy of current certifications and photo I.D. of all tradesman and laborers who will be working in confined spaces on this project.

1.22 COORDINATION DRAWINGS

- A. Before construction work commences, Contractors for all trades shall submit Coordination Drawings at not less than 1/4" = 1'-0" scale. Coordination Drawings are required throughout all areas for all trades. These drawings shall identify and show resolutions of trade conflicts. Mechanical Equipment Rooms shall be drawn early in the Coordination Drawing process, simultaneous with all other congested areas. Prepare Coordination Drawings as follows:
 - 1. HVAC Contractor will prepare the base plan Coordination Drawings showing all ductwork and all pertinent piping and equipment. The drawings shall be coordinated with cable tray, lighting fixtures, sprinklers, air diffusers, other ceiling mounted items, ceiling heights, structural work, maintenance clearances, electric code clearance, reflected ceiling plans, and other contract requirements. Reposition proposed locations of work after coordination drawing review by the Owner and the Architect. Provide adjustments to exact size, location and offsets of ducts, pipes, conduit, etc., to achieve reasonable appearance objectives. Provide these adjustments as part of Base Bid Contracts. Minor revisions need not be

redrawn.

2. HVAC Contractor will provide prints and CAD drawings and submit the base plan to all major trades' Contractors.
3. Electrical, Plumbing and Fire Protection Contractors will draft location of piping and equipment on the base plan, indicating areas of conflict and suggested resolutions.

END OF SECTION 210010

SECTION 210300 – DELEGATED DESIGN FIRE PROTECTION-SPRINKLER STANDPIPE SYSTEM

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract including the General and Supplementary Conditions and Division 1 Specifications Sections, apply to the work of this section.
- B. Entire sprinkler system shall be designed to be in compliance with NFPA 13 and shall be approved by the Owners Insurance Underwriter prior to installation.

1.2 SUBMITTALS

- A. All items specified in this section.
- B. Prior to purchasing any equipment or materials, a list of their manufacturers shall be submitted.
- C. Scale drawings indicating invert and sleeve locations, stamped by a Professional Engineer.
- D. Scale drawings showing all piping with sizes, elevations and appropriate indication of coordination with other trades, dimensioned location of each sprinkler head, all pipe sizes & hydraulic calculations bearing the stamp of a NY Licensed PE.
- E. Catalog information, factory assembly drawings and field installation drawings as required for a complete explanation and description of all items of equipment.
- F. Documents Will Not Be Accepted for Review Unless:
 - 1. They include complete information pertaining to appurtenances and accessories.
 - 2. They are submitted as a package where they pertain to related items.
 - 3. They are properly marked with service or function identification as related to the project, where they consist of catalog sheets displaying other items which are not acceptable.
 - 4. They bear the stamp of a NY PE.

1.3 NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) STANDARDS

- A. Applicable Publications: The following publications form a part of this specification.
 - 1. Sprinkler System – NFPA 13 2016, NFPA 14 2016, and NFPA 20 2016.
- B. The drawings and information included in this specification are given as a guide only, and they, therefore, do not relieve this Contractor from providing all work and equipment necessary to complete the installation according to the requirements. The number and spacing of sprinkler heads, spacing and size of pipe, location and number of valves, methods of draining lines, alarm valves and all other details and work shall be as required by the ISO, Owner's Underwriters', NFPA, local authorities and all other governing authorities.
- C. In general, sprinklers are to be arranged for coverage in accordance with NFPA #13 for The hazard classification, shown on the plans and hydraulically designed with a uniform density. Variation in discharge from individual sprinklers shall not exceed 15%.

1.4 LAYOUT

- A. This is a delegated design of an NFPA 13,14 & 20 compliant system.
- B. Sprinkler heads shall be installed symmetrically, centered in ceiling tiles and coordinated with ceiling light fixtures, diffusers, ductwork, etc.

1.5 FIELD INSPECTION

- A. As there are various conditions at the site which do not show on the accompanying drawings, or which are at variance with the conditions indicated on the drawings, it is important that each bidder visit the site and acquaint himself with existing conditions, and take these conditions into consideration when preparing his proposal. Each bidder shall obtain information or make any measurement desired. Lack of knowledge relative to existing conditions will not be allowed as a basis for extra compensation.
- B. This contractor and his subcontractors shall inspect existing equipment to remain prior to any of his new work in order to determine that all equipment is in good operating condition. If equipment is found to be lacking components, is inoperable, damaged, etc., contractor shall provide immediate written notice to the Owner. The Owner or his representative shall determine if any additional work is necessary and the method by which any work shall be performed.

1.6 CODES, PERMITS AND INSPECTIONS

- A. All work shall meet or exceed the latest requirements of all national, state, county, municipal and other authorities exercising jurisdiction over construction work at the project.
- B. All required permits and inspection certificates shall be obtained, paid for, and made available by the contractor at the completion of the work.
- C. Any portion of the work which is not subject to the approval of an authority having jurisdiction, shall be governed by the applicable sections of the overall National Fire Code, as published by the NFPA.
- D. Installation procedures, methods, and conditions shall comply with the latest requirements of the Federal Occupational Safety and Health Act (OSHA).

1.7 GUARANTEES AND CERTIFICATES

- A. All work shall be guaranteed to be free from leaks or defects. Any defective materials or workmanship as well as damage to the work of all trades resulting from the same shall be replaced or repaired as directed for the duration of stipulated guarantee periods.
- B. The duration of guarantee period following the date of acceptance of the work, shall be (1) one year.
- C. The date of acceptance shall be the date of the final payment for the work or the date of a formal notice of acceptance, whichever is earlier.
- D. Non-durable replaceable items do not require replacement after the date of acceptance. If received in writing, requests to have earlier acceptance dates established for these items will be honored.
- E. Certification shall be submitted attesting to the fact that specified performance criteria are met by all items of equipment.

1.8 EXISTING UNDERGROUND UTILITIES

- A. Underground utilities are shown on the drawing to the extent to which they are known, however, contractors are cautioned that there may be more services than shown and locations may vary from those shown.

- B. Excavations shall be made carefully so as to avoid damage to existing work. Should any work be damaged, it shall be satisfactorily repaired immediately by the contractor causing the damage.
- C. Exposed underground work shall be protected by the contractor.

1.9 RECORD DOCUMENTS

- A. When required by general conditions or other Division 1 Section this Contractor shall prepare and turn over to Owner's agent record As-built documents. As-built drawings will include actual equipment location layout, service connections, ductwork and piping layouts, valve locations, etc.
- B. In all projects, contractor shall provide record drawings of all underground equipment and service runs. As-built drawings for underground work will include dimensions to actual locations finish grade elevations, and actual invert to underground structures equipment and service runs.

PART 2 – PRODUCTS

2.1 PIPING & EQUIPMENT/SPRINKLER & ALARM EQUIPMENT

- A. Products of The Viking Corp., Reliable Sprinkler Corp, Grinnell Co., Inc. or other "equal" manufacturer selected from "List of Approved Equipment and Materials" published by Factory Mutual and shall bear UL approval stamp or label, where applicable. Piping and equipment shall also be listed by a testing agency.

2.2 PIPE, FITTINGS, HANGERS & ESCUTCHEONS

- A. Pipe: All piping material shall be Black Iron according to ASTM A-120 with 1", 1-1/4", 1-1/2", 2", 6" and above being Schedule 40 and 2-1/2" thru 5" being Schedule 10 ASTM A135. As manufactured by Wheatland Tube and US Steel.
- B. Fittings: Pipe 1" thru 2" threaded malleable iron Class 150, ANSI B1603. Pipe 2-1/2" thru 6" threaded malleable iron or Victaulic Quick Vic Rigid Coupling Style 107 for grooved end pipe with ductile iron housing enamel coated and grade EHP-EDPM.
- C. Hangers: All hangers shall and installation shall be in accordance with the requirements of Section NFPA 13 section 3-15. Provide longitudinal and lateral sway bracing. Provide welded flanges on riser at each floor AWS D10.9; Level AR-3.

- D. Escutcheon Plates: At pipe penetrations through wall (Where piping is exposed) provide heavy gauge chrome escutcheons with springs, snap/split retro fit.

2.3 VALVE SEALS, SIGNS, TAGS & CHARTS

- A. Seals: Provide brass cross-link chain, all brass padlock, with keys, copper wire and approved seal, for each manually operated shut-off valve required to be sealed in open position.
- B. Signs: Provide identification signs of standard design, fasten securely at designated locations as per requirements of insuring agency. This shall include "When bell rings...", hydraulic calculation signs, and Inspectors test.
- C. Tags: Provide brass tags about 2" in diameter; stamp with designating numbers, secure 12 gauge copper wire to spindle of all control valves.
- D. Charts: The Contractor shall provide two (2) copies of approved sprinkler system diagram and valve charts giving designating number, function, location of each valve, mounted in painted, glazed frames, hung where directed.

2.4 SPRINKLER HEADS

- A. Provide approved automatic spray sprinkler heads, Reliable Sprinkler Corporation; or equal.
- B. Provide heads and type as scheduled on the plans.
- C. Provide stock of six (6) extra sprinkler heads of each type with cabinet, two (2) sprinkler wrenches in accordance with NFPA Pamphlet No. 13.
- D. Style and finish of sprinkler heads must be selected and approved by the Architect. Submit one (1) sample of each head.

2.5 TEMPORARY PLUGGING

- A. At times when pipe laying is not actually in progress, the open ends of the pipes shall close temporarily with pipe plugs or by other means. If water is in the trench when work is resumed, the trench shall be dewatered and the plugs shall not be removed until all danger of water entering the pipe is past.

2.6 CLEANING LINES

- A. At the conclusion of the work, the Contractor shall thoroughly clean all new pipes by flushing with water or other means to remove dirt, stones, pieces of wood, etc. which may have entered during the construction period. If, after this cleaning, any obstructions remain, they shall be removed to the satisfaction of the Engineer and/or Water District. Pipes shall be flushed at a rate of 2.5' per second for a duration suitable to the Engineer and/or the Water District. The rates of flow required to produce 2.5' per second flushing velocity in different sizes of pipe are as shown in the following table:

Pipe Size (Inches)	Flow Required to Produce 2.5 FPS Velocity (Gallons per Minute)	Hydrant Opening Required At 40 PSI Residual
4	100	One - 2-1/2"
6	220	One - 2-1/2"
8	390	One - 2-1/2"
12	880	One - 2-1/2"

2.7 SYSTEM TESTING REQUIREMENTS

- A. Testing shall be done within 72 hours of conclusion of installation.
- B. Hydrostatic acceptance tests, consisting of a pressure test and a leakage test, shall be performed on all sections of all water systems installed after the trench has been backfilled. Hydrostatic presumptive tests may be performed when the system is partially backfilled to simply check the work, but acceptance of the system shall be based on hydrostatic test runs on the finished system after it is completely backfilled. All hydrostatic tests shall be performed in accordance with Section 4 of ANSI/AWWA C600-82.
- C. All testing shall be in accordance with NFPA13, 14, 20 and all applicable sections & shall include the following:
1. All hose connection and fire department connection threads shall be tested to verify their compatibility with threads used by the local fire department.
 2. All new systems, including yard piping and fire department connection piping, shall be tested hydrostatically at not less than 200 PSI (13.8 BAR) or 50 PSI (3.5 Bar) in excess of the system working pressure, whichever is great for 2 hours.
 3. An air pressure leakage test at 40 PSI (2.8 BAR) shall be conducted for 24 hours.

4. Piping between the fire department connection and the check valve in the inlet pipe shall be tested hydrostatically in the same manner as the balance of the system.
5. The standpipe system shall be tested to verify system demand.
6. This test shall be conducted by flowing water simultaneously from the outlet(s) indicated in the approved hydraulic calculations of each standpipe as required.
7. The backflow prevention assembly shall be forward flow tested to ensure proper operation.
8. Each pressure-regulating device shall be tested to verify that the installation is correct, that the device is operating, and that the inlet and outlet pressures and flow at the device are in accordance with the design.
9. The main drain valve shall be opened and shall remain open until the system pressure stabilizes.
10. Automatic dry and semiautomatic systems shall be tested by initiating a flow of water from the hydraulically most remote hose connection.
11. Where pumps are part of the water supply for a standpipe system, testing shall be conducted while the pumps are operating.
12. All piping and attached appurtenances subjected to system working pressure shall be hydrostatically tested at 200 PSI (13.8 BAR) and shall maintain that pressure without loss for 2 hours.
13. In addition to the standard hydrostatic test, an air pressure leakage test at 40 PSI (2.7 BAR) shall be conducted for 24 hours. Any leakage that results in a loss of pressure in excess of 1-1/2 PSI (0.1 BAR) for the 24 hours shall be corrected.
14. A working test of the dry pipe valve shall be made by opening the inspector's test connection.
15. Each pressure-reducing valve shall be tested upon completion of installation to ensure proper operation under flow and no-flow conditions.
16. The backflow prevention assembly shall be forward flow tested to ensure proper operation.

17. The installing contractor shall identify a hydraulically designed sprinkler system with a permanently marked weatherproof metal or rigid plastic sign secured with corrosion resistant wire, chain, or other approved means. Such signs shall be placed at the alarm valve dry pipe valve preaction valve, or deluge valve supply in the corresponding hydraulically designed area.
18. The installing contractor shall provide a general information sign used to determine system design basis and information relevant to the inspection, testing, and maintenance requirements by NFPA 25.
19. Suction piping shall be flushed at a flow rate not less than 2,350 gpm, or at the hydraulically calculated water demand rate of the system, whichever is greater.
20. Flushing shall occur prior to hydrostatic test.
21. Where the maximum flow available from the water supply cannot provide the flow rate of 2,350 GPM, the flushing flow rate shall be equal to or greater than 150 percent of rated flow of the connected fire pump.
22. Where the maximum flow available from the water supply cannot provide a flow of 150 percent of rated flow of the pump, the flushing flow rate shall be greater of 100 percent or rated flow of the connected fire pump or the maximum flow demand of the fire protection system.
23. Suction and discharge piping shall be hydrostatically tested at not less than 200 PSI (13.8 BAR) pressure or at 50 PSI (3.4 BAR) in excess of the maximum pressure to be maintained in the system, whichever is greater.
24. The pressure required in note 23 shall be maintained for 2 hours.
25. The installing contractor shall furnish a certificate for flushing and hydrostatic test prior to the start of the fire pump field acceptance test.
26. The pump manufacturer and the controller manufactures, or their factory authorized representatives, shall be present for the field acceptance test.
27. The fire pump shall perform at minimum, rated, and peak loads with objectionable overheating of any component.
28. Where the maximum flow available from the water supply cannot provide a flow of 150 percent of the rated flow of the pump, the fire pump shall be operated at the greater of 100 percent rated flow or the maximum

flow demand of the fire protection system(s) maximum allowable discharge to determine acceptance.

29. The quantity of water discharge from the fire pump assembly shall be determined and stabilized.
 30. For electric motors operating at rated voltage and frequency, the ampere demand on each phase shall not exceed the product of the full-load ampere rating times the allowable service factor as stamped on the motor nameplate.
 31. For electric motors operating under varying voltage, the product of the actual voltage and current demand on each phase shall not exceed the product of the rated voltage and rated full-load current times the allowable service factor.
 32. The voltage at the motor contactor output lugs shall not vary more than 5 percent below or 10 percent above rated (nameplate) voltage during the test.
- D. The contractor shall submit suage reports to the Engineer & Owner of all tests as described above and/or required by NFPA.
- E. All water for tests shall be furnished and disposed of by the Contractor at his own expense. Source and/or quality of the water which the Contractor proposed to use in testing the lines shall be acceptable to the Water District.

System Testing Checklist					
	Code Referenced	Code Section	Test Description	Test Information	Form Used
1	NFPA 14-2016	11.3.1-11.3.1.1	Hose Threads	Verify Compatibility with threads used by local FD	Contractors Material and Test Certificate for Above Ground Piping
2	NFPA 14-2016	11.4.1-11.4.5	Hydrostatic Test	50 PSI over system working pressure for 2 hours	Contractors Material and Test Certificate for Above Ground Piping
3	NFPA 14-2016	11.4.5.1-11.4.5.2	Air Pressure Leakage Test	Pneumatic test at 40 PSI for 24 hours	Contractors Material and Test Certificate for Above Ground Piping
4	NFPA 14-2016	11.4.6	Fire Dept. Connection	Piping between check valve and FDC to be Hydrostatic and	Contractors Material and Test Certificate for Above Ground Piping
5	NFPA 14-2016	11.5.1-11.5.2.1	Flow Test	Flow water simultaneously from required hose putlets	Contractors Material and Test Certificate for Above Ground Piping
6	NFPA 14-2016	11.5.3.1-11.5.4	Backflow Preventer	Forward test BFP to ensure operation	Contractors Material and Test Certificate for Above Ground Piping
7	NFPA 14-2016	11.5.5-11.5.5.2	Pressure regulating devices	Test operation, inlet/outlet pressures	Contractors Material and Test Certificate for Above Ground Piping
8	NFPA 14-2016	11.5.6-11.5.6.3	Main Drain Flow Test	Open drain until pressure stabilizes	Contractors Material and Test Certificate for Above Ground Piping
9	NFPA 14-2016	11.5.7-11.5.8	Dry Pipe System Testing	Flow water from most remote hose connection	Contractors Material and Test Certificate for Above Ground Piping

System Tested: Fire Protection Sprinklers					
	Code Referenced	Code Section	Test Description	Test Information	Form Used
1	NFPA 13-2016	25.2.1.1- 25.2.1.10	Hydrostatic Test	Hydrostatic test at 200 PSI for 2 hours	Contractors Material and Test Certificate for Above Ground Piping
2	NFPA 13-2016	25.2.2.1- 25.2.3.1	Dry Pipe System Testing	Pneumatic test at 40 PSI for 24 hours	Contractors Material and Test Certificate for Above Ground Piping
3	NFPA 13-2016	25.2.4.1- 25.2.4.4	Pressure Regulating Devices	Test operation, inlet/outlet pressures	Contractors Material and Test Certificate for Above Ground Piping
4	NFPA 13-2016	25.2.5.1- 25.2.5.2	Backflow Preventer	Forward test BFP to ensure operation	Contractors Material and Test Certificate for Above Ground Piping
5	NFPA 13-2016	25.5.1-25.5.2	Hydraulic Information	Post Sign Detailing Hydraulic Design Info.	N/A
6	NFPA 13-2016	25.6.1- 25.6.1.2	General Infor. Sign	Post Sign Detailing All Info Listed	N/A

2.8 STERILIZATION

- A. All pipes and fittings connected to and forming a portion of a potable water supply shall be sterilized and flushed in a manner acceptable to the Engineer and/or Water District. Sterilization shall be accomplished after the pipe has passed the pressure and leakage tests.
- B. Sterilization shall be performed in accordance with ANSI/AWWA C601-81 (excluding section 5.1 covering the tablet method).
- C. Sterilization shall be accomplished by applying a chlorine solution that will give a 50 ppm chlorine residual throughout the main being disinfected. The chlorine solution shall remain in the water mains for a minimum period of (24) hours. At the termination of this period, the chlorine residual shall be a minimum of 25 ppm. If the residual is less than 25 ppm, the entire procedure shall be repeated. The chlorine solution shall be thoroughly flushed out prior to placing the new section of the main in service. The chlorine solution shall be disposed of in a manner that will in no detrimental way affect fish, plant or animal life.
- D. After the water mains have been flushed with potable water to the satisfaction of the Engineer and/or Water District, samples of water from the mains shall be taken for bacteriological analysis.
- E. The number of samples and their collection point shall be reviewed with and be acceptable to the Superintendent of Water District. The testing laboratory that will so the bacteriological analysis shall be the responsibility of this contractor. The water samples shall test bacteriologically safe before the water mains are placed in service. Certification of testing is required.

2.9 SPRINKLER DRAINS AND TEST CONNECTION

- A. Provide all necessary drain valves, drain risers, capped nozzles, auxiliary piping, etc., as required to drain the system risers and mains and all trapped portions of the system. Drain valves which are not connected to drain pipes leading to floor drains shall be hose type. Provide inspectors test connections at end of system in accordance with NFPA #13.
- B. Note: Sprinkler contractor shall furnish and install all switches. Electrical contractor shall split system zone wire and tie to existing fire alarm system.

2.10 TESTS

- A. Subject sprinkler system to tests required by and in presence of representatives of agencies having jurisdiction.

- B. Provide instruments, equipment; pay expense incurred in making tests; obtain approvals, certificate.
- C. Where evidence of stoppage appears in piping or equipment, disconnect, clean, repair, reconnect obstructed parts; also bear cost of cutting, patching adjoining work necessitated by such cleaning, repairing.

PART 3 – EXECUTION

3.1 INTERIOR PIPING

- A. Run slightly off level to low points, provide drain valve.
- B. All water piping shall maintain electrical continuity with wedges and or straps.

END OF SECTION 210300

SECTION 210310 – FIRE PROTECTION PIPING AND VALVES

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.02 DESCRIPTION OF WORK

- A. Extent of piping and valves required by this section is indicated on drawings and/or specified in other Division-22 sections.
- B. Types of pipes and pipe fittings specified in this section include the following:
 - 1. Steel Pipes.
 - 2. Copper Tube.
 - 3. Plastic Pipes.
 - 4. Grooved Piping Products.
 - 5. Miscellaneous Piping Materials/Products.
- C. Types of valves specified in this section include the following:
 - 1. Gate Valves.
 - 2. Globe Valves.
 - 3. Drain Valves.
 - 4. Ball Valves.
 - 5. Butterfly Valves.
 - 6. Check Valves.
 - 7. Swing Check.
- D. Piping and Valves furnished as part of factory-fabricated equipment are specified as part of the equipment assembly in other Division-22 sections.

1.03 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in manufacture of piping and valves, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

- B. Installer's Qualifications: Firm with at least 3 years of successful installation experience on projects with fire protection work similar to that required for project.
- C. Codes and Standards:
 - 1. UL Compliance: Provide fire protection products in accordance with UL standards; provide UL label on each product.
 - 2. FM Compliance: Provide fire protection products and installations in accordance with FM standards; provide FM label on each product.
 - 3. Welding: Qualify welding procedures, welders and operators in accordance with ASME B31.1, or ASME B31.9, as applicable, for shop and project site welding of piping work.
 - a. Certify welding of piping work using Standard Procedure Specifications by, and welders tested under supervision of, National Certified Pipe Welding Bureau (NCPWB).
- D. Valve Types: Provide valves of same type by same manufacturer.
- E. Valve Identification: Provide valves with manufacturer's name (or trademark) and pressure rating clearly marked on valve body.

1.04 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data, including installation instructions for each type of pipe and valve. Include pressure drop curve or chart for each type and size of valve. Submit pipe schedule showing manufacturer, pipe or tube weight, fitting type and joint type for each piping system. Submit valve schedule showing manufacturer's figure number, size, location, and valve features for each required valve.
- B. Shop Drawings: Submit manufacturer's assembly-type (exploded view) shop drawings for each type of valve, indicating dimensions, weights, materials, and methods of assembly of components.
- C. Welding Certifications: Submit reports as required for piping work.
- D. Maintenance Data: Submit maintenance data and spare parts lists for each type of valve. Include this data, product data, and shop drawings in Maintenance Manual; in accordance with requirements of Division I.

PART 2 – PRODUCTS

2.1 BASIC PIPES AND PIPE FITTINGS

- A. General: Provide pipes and pipe fittings complying with Division-22 Basic Materials and Methods section "Pipes and Pipe Fittings", accordance with the following listing:
- B. Black Steel Pipe: ASTM A53, Schedule 40 for less than 8"; ASTM A53, Schedule 30 for 8" and larger; threaded joints, with : (Class 125 cast-iron threaded fittings or Class 150 malleable iron threaded fittings.)
- C. Class 250 cast-iron threaded fittings or Class 300 malleable iron threaded fittings.
- D. Class 125 cast-iron threaded fittings for 2" and smaller; Class 150 malleable iron threaded fittings for 6" and smaller.
- E. Black Steel Pipe: ASTM A53, Schedule 40 for less than 8"; ASTM A53, Schedule 30 for 8" and larger; mechanical grooved pipe couplings and fittings; cut-grooved type.
- F. Black Steel Pipe: ASTM A53, Schedule 10 for 5" and smaller; 0.134" wall thickness for 6"; and 0.188" wall thickness for 8" and 10"; wrought-steel butt welding fittings, welded joints.
- G. Black Steel Pipe: ASTM A53, Schedule 10 for 5" and smaller; 0.134" wall thickness for 6"; and 0.188" wall thickness for 8" and 10"; mechanical grooved pipe couplings and fittings; roll- groove or mechanical locking type.
- H. Copper Tube: ASTM B88, Type L, hard-drawn temper; wrought)copper fittings; solder joints.
- I. Chlorinated Polyvinyl Chloride Pipe (CPVC): ASTM F 442; Schedule 13.5 for 3" and smaller; CPVC socket and threaded fittings: ASTM F437, F438 and F439; solvent welded joints, CPVC solvent cement: ASTM F493.
- J. Polybutylene Pipe (PB): ASTM D 2662, Schedule 11; socket fusion fittings: ASTM D 3309; thermal fusion joints: ASTM D 2657.

2.2 GROOVED PIPING PRODUCTS

- A. General: As Installer's option, mechanical grooved pipe couplings and fittings may be used for sprinkler piping systems in lieu of welded, flanged, or threaded methods, and may also be used as unions, seismic joints, flexible connections, expansion joints, expansion compensators, or vibration reducers.
- B. Coupling Housings: Malleable iron conforming to ASTM A 47.
- C. Coupling Housings: Ductile iron conforming to ASTM A 536.
- D. Coupling Housings Description: Grooved mechanical type, which engages grooved or shouldered pipe ends, encasing an elastomeric gasket which bridges pipe ends to create a seal. Cast in two or more parts, secure together during assembly with nuts and bolts. Permit degree of contraction and expansion as specified in manufacturer's latest published literature.
- E. Gaskets: Mechanical grooved coupling design, pressure responsive so that internal pressure serves to increase seal's tightness, constructed of elastomers having properties as designated by ASTM D 2000.
 - 1. Water Services: EDPM Grade E, with green color code identification.
- F. Bolts and Nuts: Heat-treated carbon steel, ASTM A 183, minimum tensile 110,000 psi.
 - 1. Exposed Locations: Tamper resistant nuts.
- G. Branch Stub-Ins: Upper housing with full locating collar for rigid positioning engaging machine-cut hole in pipe, encasing elastomeric gasket conforming to pipe outside diameter around hole, and lower housing with positioning lugs, secured together during assembly with nuts and bolts.
- H. Fittings: Grooved or shouldered end design to accept grooved mechanical couplings.
 - 1. Malleable Iron: ASTM A 47.
 - 2. Ductile Iron: ASTM A 536.
 - 3. Fabricated Steel: ASTM A 53, Type F for 3/4" to 1½"; Type E or S, Grade B for 2" to 20".
 - 4. Steel: ASTM A 234.

- I. Flanges: Conform to Class 125 cast iron and Class 150 steel bolt hole alignment.
 - 1. Malleable Iron: ASTM A 47.
 - 2. Ductile Iron: ASTM A 536.
- J. Grooves: Conform to the following:
 - 1. Standard Steel: Square cut.
 - 2. Lightweight Steel: Roll grooved.
 - 3. Cast Iron: Radius cut grooved, AWWA C606.
- K. Available Manufacturers: Subject to compliance with requirements, manufacturers offering grooved piping products which may be incorporated in the work include, but are not limited to, the following:
- L. Manufacturer: Subject to compliance with requirements, provide grooved piping products of one of the following:
 - 1. ITT Grinnell Corp.
 - 2. Stockham Valves & Fittings, Inc.
 - 3. Victaulic Co. of America.

2.3 MISCELLANEOUS PIPING MATERIAL/PRODUCTS

- A. Welding Materials: Except as otherwise indicated, provide welding materials as determined by Installer to comply with installation requirements. Comply with Section II, Part C, ASME Boiler and Pressure Vessel Code for welding materials.
- B. Soldering Materials: Except as otherwise indicated, provide soldering materials as determined by Installer to comply with installation requirements.
- C. Tin-Antimony Solder: ASTM B 32, Grade 95TA.
- D. Dielectric Flanges: Assembly having insulating material isolating joined dissimilar metals, to prevent galvanic action and stop corrosion.
 - 1. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150 or 300 psig minimum pressure to suit system pressures.
 - 2. Dielectric-Flange Insulation Kits: Field-assembled, companion- flange assembly, full-face or ring type. Components include neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
 - a. Provide separate companion flanges and steel bolts and nuts for

150- or 300-psig minimum working pressure to suit system pressures.

2.4 BASIC VALVES

- A. General: Provide valves complying with Division-15 Basic Materials and Methods section "Valves", in accordance with the following listing:
- B. Sectional: Gate valves or butterfly valves; UL-listed.
- C. Check: Swing check valves; UL-listed.

2.5 SPECIAL VALVES

- A. General: Provide valves, UL listed, in accordance with the following listing. Provide sizes and types which mate and match piping and equipment connections.
- B. Detector Check Valves: Provide cast-iron body detector check valve, bronze fitted, with tapped bosses on each side for by-pass meter, air vent, and cover-mounted eyebolt.
- C. Available Manufacturers: Subject to compliance with requirements, manufacturers offering valves which may be incorporated in the work include; but are not limited to, the following:
- D. Manufacturer: Subject to compliance with requirements, provide valves of one of the following:
 - 1. Allen (W.D.) Mfg. Co.; Div. of J.W. Moon, Inc.
 - 2. Croker-Standard Div.; Fire-End & Croker Corp.
 - 3. Elkhart Brass Mfg. Co., Inc.
 - 4. Grinnell Fire Protection Systems Co., Inc.
 - 5. Grunau Sprinkler Mfr. Co., Inc.
 - 6. Guardian Fire Equipment, Inc.
 - 7. NIBCO
 - 8. Seco Mfg., Inc.
 - 9. Stockham Valves and Fittings.
 - 10. Western Fire Equipment Co.; Div. of Premier Industrial.

2.6 BASIC METERS AND GAGES

- A. General: Provide meters and gages complying with Division-15 section "Meters and Gages", in accordance with the following listing:
 - 1. Pressure gages, 0-300 psi range.

2.7 FIRE PROTECTION SPECIALTIES

- A. General: Provide fire protection specialties, UL-listed, in accordance with the following listing. Provide sizes and types which mate and match piping and equipment connections.
- B. Backflow Preventer: Provide double check valve assembly consisting of shut-off valves on inlet and outlet, valve type to be OS & Y and shall include test cocks at three locations. Construct in accordance with ASSE Standard 1015.
- C. Available Manufacturers: Subject to compliance with requirements, manufacturers offering fire protection specialties which may be incorporated in the work include; but are not limited to, the following:
- D. Manufacturer: Subject to compliance with requirements, provide fire protection backflow preventers of one of the following:
 - 1. Cla-Val Co.
 - 2. Conbraco Industries, Inc.
 - 3. Febco.
 - 4. Hersey Products, Inc.
 - 5. Watts Regulator Co.
 - 6. Zurn Industries Inc. Wilkins Regulator Div.

PART 3 – EXECUTION

3.1 INSPECTION

- A. General: Examine areas and conditions under which fire protection materials and products are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF BASIC IDENTIFICATION

- A. General: Install mechanical identification in accordance with Division-22 Basic Materials and Methods section "Plumbing Identification".

- B. Install fire protection signs on piping in accordance with NFPA 13 and NFPA 14 requirements.

3.3 INSTALLATION OF PIPES AND PIPE FITTINGS

- A. General: Install pipes and pipe fittings in accordance with Division-22 Basic Materials and Methods section "Pipes and Pipe Fittings".
- B. Comply with requirements of NFPA 13 and NFPA 14 for installation of fire protection piping materials. Install piping products where indicated, in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that piping systems comply with requirements and serve intended purposes.
- C. Coordinate with other work, including plumbing piping, as necessary to interface components of fire protection piping properly with other work.
- D. Install dielectric flanges and/or unions to effectively isolate dissimilar metals, prevent galvanic action, and stop corrosion.

3.4 INSTALLATION OF VALVES

- A. Install valves in accordance with Division-22 Basic Materials and Methods section "Valves".

3.5 INSTALLATION OF FIRE PROTECTION SPECIALTIES

- A. Install backflow preventers at a minimum of 30" above floor. Install a drain line from the drain outlet on backflow preventer to a floor drain.

3.6 ADJUSTING AND CLEANING

- A. Cleaning and Inspecting: Clean and inspect fire protection systems in accordance with requirements of Division-22 Basic Materials and Methods section "Pipes and Pipe Fittings".

END OF SECTION 210310

SECTION 210330 – WET PIPE SPRINKLER SYSTEMS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section specifies wet-pipe sprinkler systems for buildings and structures.
- B. Products specified in this Section with installation not in Contract include sprinkler cabinets with spare sprinklers and sprinkler wrenches. Deliver to the Owner's maintenance personnel.
- C. Products installed but not specified in this Section include water meters that will be furnished by the utility company to the site and ready for installation. This is the name and address of the utility company:
- D. Related Sections: The following Sections contain requirements that relate to this Section:
 - 1. Division 2 Section "Water Systems" for water supply piping from water source to inside of building.
 - 2. Division 7 Section "Firestopping" for fire barrier sealers.
 - 3. Division 10 Section "Fire Extinguishers, Cabinets, and Accessories" for fire extinguishers and cabinets.
 - 4. Division 22 Section "Fire Pumps."
 - 5. Division 22 Section "Plumbing Piping" for water supply when Work of this Section connects to water distribution system inside building.
 - 6. Division 22 Section "Water Distribution Piping" for water supply when Work of this Section connects to water distribution system inside building.
 - 7. Division 26 Section "Fire Alarm Systems" for alarm devices not specified in this Section.

1.3 DEFINITIONS

- A. Pipe sizes used in this Section are nominal pipe size (NPS) specified in inches. Tube sizes are standard tube size specified in inches. Equivalent or approximate SI (metric) sizes are indicated in millimeters (mm) in parentheses.
- B. Working plans as used in this Section refer to documents (including drawings and calculations) prepared pursuant to requirements in NFPA 13 for obtaining approval of authority having jurisdiction.
- C. Other definitions for fire protection systems are included in referenced NFPA standards.

1.4 SYSTEM DESCRIPTION

- A. Wet-Pipe Sprinkler System: System with automatic sprinklers attached to piping system containing water and connected to water supply so that water discharges immediately from sprinklers when they are opened by fire.
- B. Sprinkler System Protection Limits: All spaces within areas indicated. Include closets, toilet and locker room areas, each landing of each stair, and special applications areas.
 - 1. Exception: Areas with other fire extinguishing systems and areas indicated to be without sprinkler protection.
 - 2. Exception: Light-hazard occupancy, dwelling unit bathrooms 55 sq. ft. (5.1 sq. m) and less and closets 24 sq. ft. (2.2 sq. m) and less, that also comply with other NFPA 13 requirements.
- C. Flow Data:
 - 1. Test Hydrant: Northwest Corner of Existing Hospital adjacent to FDC
 - 2. Static Pressure: 118
 - 3. Flow (GPM): 1445
 - 4. Residual Pressure: 75
 - 5. Most recent test: August, 2023
- D. Contractor to perform flow test to verify above flow data. Coordinate flow test with local water department, owner or authority having jurisdiction. Use new flow test data as basis for Hydraulic Calculations.

1.5 SYSTEM PERFORMANCE REQUIREMENTS

- A. Design and obtain approval from authority having jurisdiction for fire protection systems specified.
- B. Minimum Pipe Sizes: Not smaller than sizes indicated for connection to water supply piping, standpipes, and branches from standpipes to sprinklers.
- C. Conduct fire hydrant flow tests as required to obtain hydraulic data needed to prepare design for hydraulically calculated systems.
- D. Hydraulically design sprinkler systems according to:
 - 1. Sprinkler System Occupancy Hazard Classifications: As follows:
 - a. Office and Public Areas: Light hazard.
 - b. Storage Areas: Ordinary hazard.
 - c. Equipment Rooms: Ordinary hazard.
 - d. Service Areas: Ordinary hazard.
 - 2. Minimum Density Requirements for Automatic Sprinkler System Hydraulic Design: As follows:
 - a. Light Hazard Occupancy: 0.10 GPM over 1500 sq. ft. (6.3 mL/s over 140 sq. m) area.
 - b. Ordinary Hazard, Group 1 Occupancy: 0.15 GPM over 1500 sq. ft. (9.5 mL/s over 140 sq. m) area.
 - c. Ordinary Hazard, Group 2 Occupancy: 0.20 GPM over 1500 sq. ft. (12.6 mL/s over 140 sq. m) area.
 - d. Extra Hazard, Group 1 Occupancy: 0.30 GPM over 2500 sq. ft. (18.9 mL/s over 233 sq. m) area.
 - e. Extra Hazard, Group 2 Occupancy: 0.40 GPM over 2500 sq. ft. (25.2 mL/s over 233 sq. m) area.
 - f. Special Occupancy Hazard: As determined by authority having jurisdiction.
 - 3. Maximum Sprinkler Spacing: As follows:
 - a. Light Hazard Occupancy (unobstructed, or noncombustible obstructed construction): 225 sq. ft./sprinkler.
 - b. Light Hazard Occupancy (obstructed combustible construction): 168 sq. ft./sprinkler.
 - c. Ordinary Hazard: 130 sq. ft./sprinkler.
 - d. Other Areas: According to NFPA 13.

- E. Components and Installation: Capable of producing piping systems with the following minimum working pressure ratings except where indicated otherwise.

1. Sprinkler Systems: 175 psig (1200 kPa).

1.6 SUBMITTALS

- A. Product data for fire protection system components. Include the following:
1. Provide shop drawings & hydraulic calculations bearing the stamp of a NY Licensed, PE.
 2. Water meters.
 3. Backflow preventers.
 4. Valves.
 5. Specialty valves, accessories, and devices.
 6. Alarm devices. Include electrical data.
 7. Fire department connections. Include type of fire department connection; number, size, type, and arrangement of inlets; size and direction of outlet; and finish.
 8. Excess pressure pumps. Include electrical data.
 9. Sprinklers, escutcheons, and guards. Include sprinkler flow characteristics, mounting, finish, and other data.
- B. Sprinkler system drawings identified as "working plans," prepared according to NFPA 13 & 14. Submit required number of sets to authority having jurisdiction for review, comment, and approval. Include system hydraulic calculations. All documents must bear the stamp of NY Licensed Professions Engineer.
- C. Licensed engineer's sprinkler system drawings specified in "Quality Assurance" Article to authority having jurisdiction. Include system hydraulic calculations where applicable.
- D. Sprinkler system drawings, identified as "working plans" and prepared according to NFPA 13, that have been approved by authority having jurisdiction. Include system hydraulic calculations where applicable.
- E. Licensed engineer's installation report specified in "Field Quality Control" Article.
- F. Test reports and certificates as described in NFPA 13. Include "(Sub)Contractor's Material & Test Certificate for Aboveground Piping" and "(Sub)Contractor's Material & Test Certificate for Underground Piping."

- G. Maintenance data for each type of fire protection specialty specified, for inclusion in "Operating and Maintenance Manual" specified in Division 1 Section "Project Closeout."
- H. 2 copies of NFPA 13A "Recommended Practice for the Inspection, Testing and Maintenance of Sprinkler Systems." Deliver to Owner's maintenance personnel.
- I. 2 copies of NFPA 25 "Standard for Inspection, Testing and Maintenance of Water Based Fire Protection Systems." Deliver to Owner's maintenance personnel.

1.7 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Firms whose equipment, specialties, and accessories are listed by product name and manufacturer in UL Fire Protection Equipment Directory and FM Approval Guide and that conform to other requirements indicated.
- B. Listing/Approval Stamp, Label, or Other Marking: On equipment, specialties, and accessories made to specified standards.
- C. Listing and Labeling: Equipment, specialties, and accessories that are listed and labeled.
 - 1. The Terms "Listed" and "Labeled": As defined in "National Electrical Code," Article 100.
 - 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.
- D. Comply with requirements of authority having jurisdiction for submittals, approvals, materials, hose threads, installation, inspections, and testing.
- E. Comply with requirements of Owner's insurance underwriter for submittals, approvals, materials, installation, inspections, and testing.
- F. Licensed Engineer: Submit design drawings, design calculations, and installation inspection reports. Include seal and signature of registered engineer licensed in jurisdiction where Project is located, certifying compliance with specifications.
- G. Installer's Qualifications: Firms qualified to install and alter fire protection piping, equipment, specialties, and accessories, and repair and service equipment. A qualified firm is one that is experienced (minimum of 5 previous projects similar in size and scope to this Project) in such work, familiar with precautions required, and in compliance with the requirements of the authority having jurisdiction.

Submit evidence of qualifications to the Architect upon request. Refer to Division 1 Section "Reference Standards and Definitions" for definition of "Installer."

- H. NFPA Standards: Equipment, specialties, accessories, installation, and testing complying with the following:
1. NFPA 13 "Standard for the Installation of Sprinkler Systems."
 2. NFPA 13R "Standard for the Installation of Sprinkler Systems in Residential Occupancies up to and Including Four Stories in Height."
 3. NFPA 26 "Recommended Practice for the Supervision of Valves Controlling Water Supplies for Fire Protection."
 4. NFPA 70 "National Electrical Code."
 5. NFPA 231 "Standard for General Storage."
 6. NFPA 231C "Standard for Rack Storage of Materials."

PART 2- PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Specialty Valves and Water Motor Alarm Devices:
 - a. ASCOA Fire Systems, Figgie International Co.
 - b. Central Sprinkler Corp.
 - c. Firematic Sprinkler Devices, Inc.
 - d. Gem Sprinkler Co. Div., Grinnell Corp.
 - e. Globe Fire Sprinkler Corp.
 - f. Reliable Automatic Sprinkler Co., Inc.
 - g. Star Sprinkler Corp.
 - h. Viking Corp.
 2. Detector Check Valves:
 - a. Ames Co., Inc.
 - b. Cla-Val Co.
 - c. Hersey Products, Inc., Grinnell Corp.
 - d. Kennedy Valve Div., McWane, Inc.
 - e. Viking Corp.
 - f. Watts Regulator Co.

3. Water Meters:
 - a. Badger Meter, Inc.
 - b. Hersey Products, Inc., Grinnell Corp.
 - c. Kent Meters, Inc.
 - d. Neptune Water Div., Schlumberger Industries, Inc.
 - e. Sensus Technologies, Inc., BTR Co.
4. Backflow Preventers:
 - a. Ames Co., Inc.
 - b. Cla-Val Co.
 - c. Conbraco Industries, Inc.
 - d. Febco.
 - e. Hersey Products, Inc., Grinnell Corp.
 - f. Watts Regulator Co.
 - g. Wilkins Regulator Div., Zurn Industries, Inc.
5. Waterflow Indicators and Supervisory Switches:
 - a. Gamewell Co.
 - b. Gem Sprinkler Co. Div., Grinnell Corp.
 - c. Potter Electric Signal Co.
 - d. Reliable Automatic Sprinkler Co., Inc.
 - e. System Sensor Div., Pittway Corp.
 - f. Victaulic Company of America.
 - g. Watts Regulator Co.
6. Fire Department Connections:
 - a. Badger-Powhatan, Figgie International Co.
 - b. Croker Div., Fire-End and Croker Corp.
 - c. Elkhart Brass Mfg. Co., Inc.
 - d. Firematic Sprinkler Devices, Inc.
 - e. Gem Sprinkler Co. Div., Grinnell Corp.
 - f. Guardian Fire Equipment, Inc.
 - g. Potter-Roemer Div., Smith Industries, Inc.
 - h. Reliable Automatic Sprinkler Co., Inc.
 - i. Sierra Fire Equipment Co.
7. Excess Pressure Pumps:
 - a. Gamewell Co.
8. Sprinklers:
 - a. ASCOA Fire Systems, Figgie International Co.
 - b. Central Sprinkler Corp.
 - c. Firematic Sprinkler Devices, Inc.
 - d. Gem Sprinkler Co. Div., Grinnell Corp.

- e. Globe Fire Sprinkler Corp.
 - f. Reliable Automatic Sprinkler Co., Inc.
 - g. Star Sprinkler Corp.
 - h. Viking Corp.
9. Hose Valves and Racks and Hose:
- a. Badger-Powhatan, Figgie International Co.
 - b. Croker Div., Fire-End and Croker Corp.
 - c. Elkhart Brass Mfg. Co., Inc.
 - d. Guardian Fire Equipment, Inc.
 - e. Potter-Roemer Div., Smith Industries, Inc.
 - f. Sierra Fire Equipment Co.
10. Indicator Posts and Indicator Post Gate Valves:
- a. Clow Valve Co. Div., McWane, Inc.
 - b. Gem Sprinkler Co. Div., Grinnell Corp.
 - c. Kennedy Valve Div., McWane, Inc.
 - d. Nibco, Inc.
 - e. Stockham Valves and Fittings, Inc.
 - f. Waterous Co.
11. Indicator Valves:
- a. Gem Sprinkler Co. Div., Grinnell Corp.
 - b. Grinnell Supply Sales Co., Grinnell Corp.
 - c. Kennedy Valve Div., McWane, Inc.
 - d. Milwaukee Valve Co., Inc.
 - e. Nibco, Inc.
 - f. Sprink-Line by Sprink, Inc.
 - g. Victaulic Company of America.
12. Fire Protection Service Gate and Check Valves:
- a. Gem Sprinkler Co. Div., Grinnell Corp.
 - b. Kennedy Valve Div., McWane, Inc.
 - c. Nibco, Inc.
 - d. Stockham Valves and Fittings, Inc.
 - e. Victaulic Company of America.
13. Grooved Couplings for Steel Piping:
- a. Grinnell Supply Sales Co., Grinnell Corp.
 - b. Gustin-Bacon Div., Tyler Pipe Subsid., Tyler Corp.
 - c. Sprink-Line by Sprink, Inc.
 - d. Stockham Valves and Fittings, Inc.
 - e. Victaulic Company of America.

14. Grooved Couplings for AWWA Ductile-Iron Piping:
 - a. Gustin-Bacon Div., Tyler Pipe Subsid., Tyler Corp.
 - b. Victaulic Company of America.
15. Grooved Couplings for Copper Tubing: Victaulic Company of America.
16. Press-Seal Fittings for Steel Piping: Victaulic Company of America.
17. Mechanically Formed Outlet Procedure: T-Drill Industries, Inc.

2.2 PIPES AND TUBES

- A. Refer to Part 3 Article "Sprinkler System Piping Applications" for identification of systems where pipe and fitting materials specified below are used.
- B. Ductile-Iron Pipe: AWWA C115, ductile-iron barrel with iron-alloy threaded flanges, 250-psig (1725 kPa) minimum working pressure rating, and AWWA C104 cement-mortar lining. Option: Pipe may be AWWA pattern, cut-grooved for grooved-coupling joints.
- C. Steel Pipe: ASTM A 53, Schedule 40 in sizes 6 inches (150 mm) and smaller and Schedule 30 in sizes 8 inches (200 mm) and larger, black and galvanized, plain and threaded ends, for welded, threaded, cut-groove, and rolled-groove joints
- D. Steel Pipe: ASTM A 135, Schedule 10 through 5-inch (125 mm) sizes and NFPA 13 specified wall thickness for 6-inch (150 mm) through 10-inch (250 mm) sizes, with plain ends, black and galvanized, for rolled-groove and welded joints.
- E. Steel Pipe: ASTM A 135, threadable lightwall, black and galvanized, for threaded joints.
- F. Steel Pipe: ASTM A 135 or ASTM A 795, Schedule 5, plain ends and black finish, for use with press-seal or rolled-groove fittings.
- G. Steel Pipe: ASTM A 795, black and galvanized, for joints listed and for use with fittings for plain-end steel pipe.
 1. Type: Standard-weight pipe, Schedules 30 and 40, for cut-groove, rolled-groove, threaded, and welding joints.
 2. Type: Lightweight pipe, Schedule 10, for rolled-groove and welding joints.
 3. Type: Extra-lightweight pipe, thickness less than Schedule 10, for rolled-groove and welding joints.

- H. Copper Tube: ASTM B 88, Types L and M (ASTM B 88M, Types B and C), water tube, drawn temper.
- I. Chlorinated Polyvinyl Chloride (CPVC) Plastic Pipe: ASTM F 442, UL-listed, 175-psig (1200 kPa) rating, made in NPS for sprinkler service. Include "Listed" and "CPVC Sprinkler Pipe" marks on pipe.

2.3 PIPE AND TUBE FITTINGS

- A. Cast-Iron Threaded Flanges: ASME B16.1, Class 250, raised ground face, bolt holes spot faced.
- B. Ductile-Iron and Gray-Iron Flanged Fittings: AWWA C110, 250-psig (1725 kPa) minimum pressure rating, with AWWA C104 cement-mortar lining.
- C. Cast-Iron Threaded Fittings: ASME B16.4, Class 250, standard pattern, with threads according to ASME B1.20.1.
- D. Malleable-Iron Threaded Fittings: ASME B16.3, Class 300, standard pattern, with threads according to ASME B1.20.1.
- E. Grooved-End Fittings for Ductile-Iron Pipe: ASTM A 536 ductile-iron or ASTM A 47 malleable-iron, AWWA pipe-size, designed to accept AWWA C606 grooved couplings. Include cement lining or Food and Drug Administration (FDA)-approved interior coating.
- F. Steel Fittings: ASTM A 234/A 234M, seamless or welded; ASME B16.9, butt welding; or ASME B16.11, socket-welding type for welded joints.
- G. Steel Flanges and Flanged Fittings: ASME B16.5.
- H. Grooved-End Fittings for Steel Pipe: UL-listed and FM-approved, ASTM A 536, Grade 65-45-12 ductile iron or ASTM A 47 Grade 32510 malleable iron, with grooves or shoulders designed to accept grooved couplings.
- I. Steel Press-Seal Fittings: UL 213, FM-approved, 175-psig (1200 kPa) pressure rating, for use with Schedule 5, plain-end, steel pipe and fitting manufacturer's pressure sealing tools. Fittings include carbon-steel housing, butylene O-rings, and pipe stop.
- J. Wrought-Copper Fittings: ASME B16.22, streamlined pattern.
- K. Cast-Bronze Flanges: ASME B16.24, Class 300, raised ground face, bolt holes spot faced.

- L. Grooved-End Fittings for Copper Tube: UL-listed, ASTM B 75 (ASTM B 75M), copper tube and ASTM B 584 bronze castings, designed for grooved-end couplings.
- M. Mechanically Formed Outlets for Copper Tube: Manufacturer's UL-listed, standard, written procedure for forming "T"-branch outlets.
- N. Chlorinated Polyvinyl Chloride (CPVC) Plastic Pipe Fittings: ASTM F 438 for 3/4 inch (20 mm) to 1-1/2 inches (40 mm) and ASTM F 439 for 2 inches (50 mm) to 3 inches (80 mm), UL listed, 175-psig (1200 kPa) rating, made in NPS for sprinkler service. Include "Listed" and "CPVC Sprinkler Fitting" marks on fittings.
- O. Polybutylene (PB) Plastic Pipe Fittings: ASTM D 3309, UL-listed, 175-psig (1200 kPa) rating, socket-fusion type, made in copper tube sizes for sprinkler pipe service. Include "Listed" and "PB Sprinkler Fitting" marks on fittings.

2.4 JOINING MATERIALS

- A. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for joining materials not included in this Section.
- B. Flanged Joints for Ductile-Iron Pipe and Ductile-Iron or Cast-Iron Fittings: AWWA C115 ductile-iron or gray-iron pipe flanges, rubber gaskets, and high-strength steel bolts and nuts.
- C. Brazing Filler Metals: AWS A5.8, Classification BCuP-3 or BCuP-4.
- D. Couplings for Grooved-End Steel Pipe and Grooved-End Ferrous Fittings: UL 213, AWWA C606, ASTM A 536 ductile-iron or ASTM A 47 malleable-iron housing, with enamel finish. Include synthetic-rubber gasket with central-cavity, pressure-responsive design; ASTM A 183 carbon-steel bolts and nuts; and locking pin, toggle, or lugs to secure grooved pipe and fittings.
- E. Couplings for Grooved-End Ductile-Iron Pipe and Fittings: UL 213, AWWA C606, ASTM A 536 ductile-iron housing, with enamel finish. Include synthetic-rubber gasket with central-cavity, pressure-responsive design, and ASTM A 183 carbon-steel bolts and nuts to secure grooved pipe and fittings.
- F. Couplings for Grooved-End Copper Tube and Grooved-End Copper Fittings: UL 213, ASTM A 536 ductile-iron or ASTM A 47 malleable-iron housing, with copper-colored enamel finish. Include synthetic-rubber gasket with central-cavity, pressure-responsive design, and ASTM A 183 carbon-steel bolts and nuts.

- G. CPVC Cement: Primer and solvent cement made by pipe and fitting manufacturer for joining sprinkler piping.

2.5 GENERAL-DUTY VALVES

- A. Refer to Division 22 Section "Valves" for general-duty gate, ball, butterfly, globe, and check valves.

2.6 FIRE PROTECTION SERVICE VALVES

- A. General: UL-listed and FM-approved, with 175-psig (1200 kPa) non-shock minimum working pressure rating.
- B. Gate Valves, 2 Inches (50 mm) and Smaller: UL 262, cast-bronze, threaded ends, solid wedge, outside screw and yoke, rising stem.
- C. Indicating Valves, 2-1/2 Inches (65 mm) and Smaller: Butterfly or ball type, bronze body with threaded ends, and integral indicating device.
 - 1. Indicator: Visual.
 - 2. Indicator: Electrical 115 volts a.c., prewired, single-circuit, supervisory switch.
 - 3. Indicator: Electrical 115 volts a.c., prewired, 2-circuit, supervisory switch.
- D. Gate Valves, 2-1/2 Inches (65 mm) and Larger: UL 262, iron body, bronze mounted, taper wedge, outside screw and yoke, rising stem. Include replaceable, bronze, wedge facing rings and flanged ends.
- E. Gate Valves, 2-1/2 Inches (65 mm) and Larger for Use with Indicator Posts: UL 262, iron body, bronze mounted, solid wedge disc, non-rising stem with operating nut and flanged ends.
- F. Indicator Posts: UL 789, wall type, cast-iron body, with windows for target plates that indicate valve position, extension rod and coupling, locking device, and red enamel finish.
 - 1. Operation: Operating wrench.
 - 2. Operation: Hand wheel.
- G. Swing Check Valves, 2-1/2 Inches (65 mm) and Larger: UL 312, cast-iron body and bolted cap, with bronze disc or cast-iron disc with bronze disc ring and flanged ends.

- H. Butterfly Check Valves, 4 Inches (100 mm) and Larger: UL 312, split-clapper style, cast-iron body with rubber seal, bronze alloy discs, stainless-steel spring and hinge pin.

2.7 SPECIALTY VALVES

- A. Alarm Check Valves: UL 193, 175-psig (1200 kPa) working pressure, designed for horizontal or vertical installation, with cast-iron, flanged inlet and outlet, bronze grooved seat with O-ring seals, and single-hinge pin and latch design. Include trim sets for bypass, drain, electric sprinkler alarm switch, pressure gages, precision retarding chamber, and fill line attachment with strainer.
 - 1. Drip Cup Assembly: Pipe drain without valves, and separate from main drain piping.
 - 2. Drip Cup Assembly: Pipe drain with check valve to main drain piping.
 - 3. Option: Grooved-end connections for use with grooved-end piping.
- B. Alarm Check Valves: UL 193, 175-psig (1200 kPa) working pressure, designed for horizontal or vertical installation, with cast-iron flanged inlet and outlet, bronze grooved seat with O-ring seals, and single-hinge pin and latch design. Provide trim sets for bypass, drain, electric sprinkler alarm switch, pressure gages, drip cup assembly piped without valves separate from main drain line, and fill line attachment with strainer.
- C. Pressure-Regulating Valves: UL 1468, 400-psig (2760 kPa) minimum rating, brass, pressure-regulating type. Include female NPS inlet and outlet and adjustable setting feature. Size 1-1/2 inches (40 mm) or 2-1/2 inches (65 mm), and straight or 90 degree angle (1.57 rad) pattern design as indicated.
- D. Ball Drip Valves: UL 1726, automatic drain valve, 3/4-inch (20 mm) size, spring-loaded, ball check device with threaded ends.
- E. Detector Check Valves: UL 213, galvanized cast-iron body, bolted cover with air bleed device for access to internal parts, and flanged ends; designed for 175-psig (1200 kPa) working pressure. Include 1-piece bronze disc with bronze bushings, pivot, and replaceable seat. Include threaded bypass taps in the inlet and outlet for bypass meter connection. Set valve to allow minimal water flow through bypass meter when major water flow is required.
 - 1. Water Meter: AWWA C700, disc type, of size and end connections at least one-fourth those of detector check valve. Include meter, bypass piping, gate valves, check valve, and connections to detector check valve.

2.8 WATER METERS

- A. General: Register in gallons (L), except where registration in cu. ft. (cu. m) is indicated.
- B. Water Meters: AWWA C701, turbine type.
- C. Water Meters: AWWA C702, compound type.
- D. Water Meters: AWWA C703, fire service type.
- E. Water Meters: AWWA C704, propeller type.

2.9 BACKFLOW PREVENTERS

- A. General: ASSE standard backflow preventers, of size indicated for maximum flow rate indicated and maximum pressure loss indicated.
 - 1. Working Pressure: 300 psig (1035 kPa) minimum except where indicated otherwise.
 - 2. Bronze, cast-iron, steel, or stainless-steel body with flanged ends.
 - 3. Interior Lining: FDA-approved epoxy coating, for backflow preventers having cast-iron or steel body.
 - 4. Interior Components: Corrosion-resistant materials.
 - 5. Strainer on inlet, where strainer is indicated.
- B. Reduced-Pressure-Principle Backflow Preventer: ASSE 1013, consisting of OS&Y gate valves on inlet and outlet and strainer on inlet. Include test cocks and pressure-differential relief valve with ASME A112.1.2 air-gap fitting located between 2 positive-seating check valves for continuous pressure application.
 - 1. Pressure Loss: 12 psig (83 kPa) maximum, through middle third of flow range.
- C. Double-Check Backflow Prevention Assemblies: ASSE 1015, consisting of shutoff valves on inlet and outlet and strainer on inlet. Include test cocks with 2 positive-seating check valves for continuous pressure application.
 - 1. Pressure Loss: 5 psig (35 kPa) maximum, through middle third of flow range.

- D. Reduced-Pressure Detector Assembly Backflow Preventers: UL 312 and ASSE 1047, consisting of OS&Y gate valves on inlet and outlet, and strainer on inlet. Include pressure-differential relief valve having ASME A112.1.2 air-gap fitting located between 2 positive-seating check valves, test cocks, and bypass with displacement-type water meter, valves, and reduced-pressure backflow preventer, for continuous pressure application.
 - 1. Pressure Loss: 12 psig (83 kPa) maximum, through middle third of flow range.
- E. Double-Check Detector Assembly Backflow Preventers: UL 312 and ASSE 1048, consisting of OS&Y gate valves on inlet and outlet and strainer on inlet. Include 2 positive-seating check valves and test cocks, and bypass with displacement-type water meter, valves, and double-check backflow preventer, for continuous pressure application.
 - 1. Pressure Loss: 5 psig (35 kPa) maximum, through middle third of flow range.

2.10 EXCESS PRESSURE PUMPS

- A. Description: UL-listed, factory-fabricated, positive-displacement, gear-type pump assembly. Include controls, wet-pipe kit, switches, pipe fittings, valves, mounting brackets, and connections for power, hydraulic piping, and wiring from alarm devices. Characteristics are:
 - 1. Pump and Motor: Directly connected.
 - 2. Motor Control: By differential pressure switch.
 - 3. Lights: To indicate sprinkler system operating condition:
 - a. White Light: Pressure is normal.
 - b. Red Light: Pressure is low.
 - 4. Pump Capacity: Approximately 1 GPM (63 mL/s).
 - 5. Pump Discharge Head: Approximately 130 psig (900 kPa), and limited to 175 psig (1200 kPa) maximum.
 - 6. Motor: 1/4 horsepower, 115 volts a.c., 60 Hz (187 W, 115 volts a.c., 60 Hz).

2.11 SPRINKLERS

- A. Automatic Sprinklers: With heat-responsive element conforming to:
 - 1. UL 199, for applications except residential.
 - 2. UL 1626, for residential applications.
 - 3. UL 1767, for early-suppression, fast-response applications.

- B. Sprinkler types and categories are as indicated and as required by application. Furnish automatic sprinklers with nominal 1/2-inch (12.7 mm) orifice for "Ordinary" temperature classification rating except where otherwise indicated and required by application.
- C. Sprinkler types, features, and options include:
1. Coated, painted, or plated sprinklers.
 2. Concealed ceiling sprinklers, including cover plate.
 3. Extended coverage sprinklers.
 4. Flow-control sprinklers.
 5. Flush ceiling sprinklers, including escutcheon.
 6. Pendent sprinklers.
 7. Pendent, dry-type sprinklers.
 8. Quick-response sprinklers.
 9. Recessed sprinklers, including escutcheon.
 10. Sidewall sprinklers.
 11. Sidewall, dry-type sprinklers.
 12. Upright sprinklers.
- D. Flush Pendent Heads: Two-piece design with flush mounting body, concealed drop-down deflector, and exposed quick response fusible link. Exposed surfaces of sprinkler and escutcheon to be furnished with factory-applied white finish. Furnish automatic sprinklers with nominal 1/2-inch orifice for 165° F temperature classification rating except where otherwise indicated and required by application.
- E. Horizontal Sidewall Heads: Glass bulb or fusible link type, with deflector configured to distribute water primarily to the front of the sprinkler. Chrome plated finish in areas exposed to view; rough bronze finish in areas not exposed to view. Heads shall be wax-coated where installed exposed to acids, chemicals, or other corrosive fumes. Unless otherwise indicated, provide heads with nominal 1/2" discharge orifice, for "Ordinary" temperature classification.
- F. Pendent Heads: Two-piece design with flush mounting body and exposed glass bulb or fusible link. Exposed surfaces of sprinkler (cover, link, and escutcheon) to be furnished with factory-applied white finish. Unless otherwise indicated, provide heads with nominal 1/2" discharge orifice for "Ordinary" temperature classification.

- G. Standard Upright Heads: Glass bulb or Fusible link type with deflector configured to distribute water laterally and downward. Chrome plated finish in areas exposed to view; rough bronze finish in areas not exposed to view. Unless otherwise indicated, provide heads with nominal 1/2" discharge orifice for "Ordinary" temperature classification.
- H. Dry Type Sprinkler Heads: Fusible link type, compression center strut with spring-loaded tube and locking seal. Provide dry pendent heads with deflector configured to distribute water laterally and downward. Chrome plated finish in areas exposed to view. Unless otherwise indicated, provide heads with nominal 1/2" discharge orifice for "Ordinary" temperature classification.
- I. Sprinkler Finishes: Chrome-plated, bronze, and painted.
- J. Special Coatings: Wax, lead, and corrosion-resistant paint.
- K. Sprinkler Escutcheons: Materials, types, and finishes for following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
 - 1. Ceiling Mounting: Chrome-plated steel, 1-piece, flat.
 - 2. Ceiling Mounting: Chrome-plated steel, 2-piece, with 1-inch vertical adjustment.
 - 3. Ceiling Mounting: Plastic, white finish, 1-piece, flat.
 - 4. Sidewall Mounting: Chrome-plated steel, 1-piece, flat.
 - 5. Sidewall Mounting: Plastic, white finish, 1-piece, flat.
- L. Sprinkler Guards: Wire-cage type, including fastening device for attaching to sprinkler.
- M. Sprinkler Cabinets: Finished steel cabinet and hinged cover, with space for minimum of 6 spare sprinklers plus sprinkler wrench, suitable for wall mounting. Include number of sprinklers required by NFPA 13 and 1 wrench for sprinklers. Include separate cabinet with sprinklers and wrench for each style sprinkler on Project.

2.12 SPECIALTY SPRINKLER FITTINGS

- A. Specialty Fittings: UL-listed and FM-approved, made of steel, ductile iron, or other materials compatible with system materials and applications where used.
- B. Press-Seal Fittings: UL 213, carbon-steel housing with butylene O-rings and pipe stop, for use with plain-end, Schedule 5 steel pipe.

- C. Locking-Lug Fittings: UL 213, ductile-iron body with locking-lug ends, for use with plain-end steel pipe.
- D. Mechanical-"T" Fittings: UL 213, ductile-iron housing with pressure-responsive gasket, bolts, and threaded or locking-lug outlet.
- E. Mechanical-Cross Fittings: UL 213, ductile-iron housing with pressure-responsive gaskets, bolts, and threaded or locking-lug outlets.
- F. Drop-Nipple Fittings: UL 1474, with threaded inlet, threaded outlet, and seals; adjustable.
- G. Sprinkler Alarm Test Fittings: Ductile-iron housing with 1-1/2-inch (40 mm) inlet and outlet, integral test valves, combination orifice and sight glass, and threaded or locking-lug ends.

2.13 FIRE DEPARTMENT CONNECTIONS

- A. Flush, Wall-Type Fire Department Connections: UL 405, cast-brass body; NH-standard thread inlets according to NFPA 1963 and matching local fire department threads; and threaded NPS outlet. Include lugged cap, gasket, and chain; lugged swivel connection, extension pipe nipples, and clappers for each hose connection inlet; and wall escutcheon plate with marking "AUTO SPKR."
 - 1. Connections: One 2-1/2-inch (65 mm) inlet and 2-1/2-inch (65 mm) outlet.
 - 2. Connections: One 2-1/2-inch (65 mm) inlet and 3-inch (80 mm) outlet.
 - 2. Connections: Two 2-1/2-inch (65 mm) inlets and 4-inch (100 mm) outlet.
 - 3. Connections: Two 2-1/2-inch (65 mm) inlets and 6-inch (150 mm) outlet.
 - 4. Connections: Three 2-1/2-inch (65 mm) inlets and 6-inch (150 mm) outlet.
 - 5. Connections: Four 2-1/2-inch (65 mm) inlets and 6-inch (150 mm) outlet.
 - 6. Connections: Six 2-1/2-inch (65 mm) inlets and 6-inch (150 mm) outlet.
 - 7. Connections: Six 2-1/2-inch (65 mm) inlets and 8-inch (200 mm) outlet.
 - 8. Inlet Alignment: In line, horizontal.
 - 9. Inlet Alignment: In line, vertical.
 - 10. Inlet Alignment: Square.
 - 11. Clapper Type: Drop clappers in body.
 - 12. Clapper Type: Female clapper snoots.
 - 13. Clapper Type: Check snoots.
 - 14. Direction of Outlet: Back.
 - 15. Direction of Outlet: Top.
 - 16. Direction of Outlet: Bottom.
 - 17. Direction of Outlet: End.

18. Escutcheon Plate: Round.
 19. Escutcheon Plate: Square.
 20. Escutcheon Plate: Rectangular.
 21. Finish: Polished chrome plated.
 22. Finish: Rough chrome plated.
 23. Finish: Polished brass.
- B. Exposed, Wall-Type Fire Department Connections: UL 405, cast-brass body; NH-standard thread inlets according to NFPA 1963 and matching local fire department threads; and threaded NPS outlet. Include lugged cap, gasket, and chain; lugged swivel connection and drop clappers for each hose connection inlet; and round wall escutcheon plate with marking "AUTO SPKR."
1. Connections: Two 2-1/2-inch (65 mm) inlets and 4-inch (100 mm) outlet.
 2. Connections: Two 2-1/2-inch (65 mm) inlets and 6-inch (150 mm) outlet.
 3. Connections: Three 2-1/2-inch (65 mm) inlets and 6-inch (150 mm) outlet.
 4. Direction of Outlet: Back, straight.
 5. Direction of Outlet: Back, angle.
 6. Finish: Polished chrome plated.
 7. Finish: Rough chrome plated.
 8. Finish: Polished brass.
- C. Exposed, Sidewalk Fire Department Connections: UL 405, cast-brass body; NH-standard thread inlets according to NFPA 1963 and matching local fire department threads; and threaded NPS bottom outlet. Include lugged cap, gasket, and chain; lugged swivel connection and drop clappers for each hose connection inlet; 18-inch (460 mm) high brass sleeve; and round sidewalk escutcheon plate with marking "AUTO SPKR."
1. Connections: Two 2-1/2-inch (65 mm) inlets and 4-inch (100 mm) outlet.
 2. Connections: Two 2-1/2-inch (65 mm) inlets and 6-inch (150 mm) outlet.
 3. Connections: Three 2-1/2-inch (65 mm) inlets and 6-inch (150 mm) outlet.
 4. Connections: Four 2-1/2-inch (65 mm) inlets and 6-inch (150 mm) outlet.
 5. Connections: Six 2-1/2-inch (65 mm) inlets and 6-inch (150 mm) outlet.
 6. Connections: Six 2-1/2-inch (65 mm) inlets and 8-inch (200 mm) outlet.
 7. Inlet Alignment: In line, horizontal.
 8. Inlet Alignment: Square.
 9. Finish, Including Sleeve: Polished chrome plated.
 10. Finish, Including Sleeve: Rough chrome plated.
 10. Finish, Including Sleeve: Polished brass.

2.14 ALARM DEVICES

- A. Alarm Devices: Types and sizes that will match piping and equipment connections.
- B. Water-Motor-Operated Alarms: UL 753, mechanical operation type, 10-inch (250 mm) diameter, cast-aluminum alarm gong, with red enamel factory finish. Include Pelton-wheel-type operator with nylon shaft bearings, and shaft length and sleeve to suit wall thickness and construction; 3/4-inch (20 mm) inlet and 1-inch (25 mm) drain.
- C. Waterflow Indicators: UL 346, electrical-supervision type, vane-type waterflow detector, rated to 250 psig (1725 kPa), and designed for horizontal or vertical installation. Include 2 SPDT (single-pole, double-throw) circuit switches to provide isolated alarm and auxiliary contacts, 7 ampere, 125 volts a.c. (7 A, 125 V a.c.) and 0.25 ampere, 24 volts d.c. (0.25 A, 24 V d.c.); complete with factory-set, field-adjustable retard element to prevent false signals, and tamper-proof cover that sends a signal when cover is removed.
- D. Pressure Switches: UL 753, waterflow switch with retard, electrical-supervision type, SPDT (single-pole, double-throw), normally closed contacts, designed to operate on rising pressure and signal water flow.
- E. Supervisory Switches: UL 753, for valves, electrical-supervision type, SPDT (single-pole, double-throw), normally closed contacts, designed to signal controlled valve in other than full open position.
- F. Supervisory Switches: UL 753, for indicator posts, electrical-supervision type, SPDT (single-pole, double throw), normally closed contacts, designed to signal controlled valve in other than full open position.

2.15 PRESSURE GAGES

- A. Pressure Gages: UL 393, 3-1/2 to 4-1/2 inches (90 to 115 mm) diameter dial, with dial range of 0-250 psig (0-1600 kPa).

PART 3 – EXECUTION

3.1 SPRINKLER SYSTEM PIPING APPLICATIONS

- A. Refer to Part 2 of this Section for detailed specifications on pipe and fittings products listed below. Use pipe, tube, fittings, and joining methods according to the following applications. Piping may be joined with flanges instead of indicated joints. Use grooved-end fittings with grooved couplings that are made by the same manufacturer and that comply with listing when used together for grooved-coupling joints.
 - 1. Option: Mechanical-"T" bolted-branch-outlet fittings, instead of fitting types specified, may be used for branch connections.
 - 2. Option: Specialty sprinkler fittings, including mechanical-"T" fittings, may be used instead of specified fittings downstream of zone valves.
- B. Pipe Between Fire Department Connections and Check Valves: Use galvanized-steel pipe instead of black-steel pipe when steel pipe is specified for applications below. Do not use welded joints.
- C. Sizes 2 Inches (50 mm) and Smaller: ASTM A 53, A 135, or A 795; Schedule 40 steel pipe with threaded ends, cast-iron or malleable-iron threaded fittings, and threaded joints.
- D. Sizes 2 Inches (50 mm) and Smaller: ASTM A 135, threadable, lightwall steel pipe with threaded ends, cast-iron or malleable-iron threaded fittings, and threaded joints.
- E. Sizes 2 Inches (50 mm) and Smaller: ASTM A 135 or A 795, Schedule 10 steel pipe, welding-type fittings, and welded joints.
- F. Sizes 2 Inches (50 mm) and Smaller: ASTM A 53, A 135, or A 795; Schedule 40 steel pipe with cut-groove ends, grooved-end steel pipe fittings, and grooved-coupling joints.
- G. Sizes 2 Inches (50 mm) and Smaller: ASTM A 53, A 135, or A 795; Schedule 40 steel pipe with rolled-groove ends, grooved-end steel pipe fittings, and grooved-coupling joints.
- H. Sizes 2 Inches (50 mm) and Smaller: ASTM A 135 or A 795, Schedule 10 steel pipe with rolled-groove ends, grooved-end steel pipe fittings, and grooved-coupling joints.

- I. Sizes 2 Inches (50 mm) and Smaller: ASTM A 135 or A 795, Schedule 5 steel pipe, steel press-seal fittings, and press-seal joints.
- J. Sizes 2 Inches (50 mm) and Smaller: Type L (Type B) copper tube, wrought-copper fittings, and brazed joints.
 - 1. Fittings Option: Mechanically formed outlets with brazed joints.
- K. Sizes 2 Inches (50 mm) and Smaller: Type M (Type C) copper tube, wrought-copper fittings, and brazed joints.
- L. Sizes 2 Inches (50 mm) and Smaller: Chlorinated polyvinyl chloride (CPVC) plastic pipe and fittings, with solvent-cemented joints and metal-to-plastic transition fittings.
- M. Sizes 2 Inches (50 mm) and Smaller: Polybutylene (PB) plastic pipe and fittings, with socket-fusion joints and metal-to-plastic transition fittings.
- N. Sizes 2-1/2 Inches (65 mm) to 6 Inches (150 mm): ASTM A 53, A 135, or A 795; Schedule 40 steel pipe with threaded ends, cast-iron or malleable-iron threaded fittings, and threaded joints.
- O. Sizes 2-1/2 Inches (65 mm) to 6 Inches (150 mm): ASTM A 53, A 135, or A 795; Schedule 40 steel pipe, welding type steel fittings, and welded joints.
- P. Sizes 2-1/2 Inches (65 mm) to 6 Inches (150 mm): ASTM A 53, A 135, or A 795; Schedule 40 steel pipe with cut-groove ends, grooved-end steel pipe fittings, and grooved-coupling joints.
- Q. Sizes 2-1/2 Inches (65 mm) to 6 Inches (150 mm): ASTM A 53, A 135, or A 795; Schedule 40 steel pipe with rolled-groove ends, grooved-end steel pipe fittings, and grooved-coupling joints.
- R. Sizes 2-1/2 Inches (65 mm) to 6 Inches (150 mm): ASTM A 135 or A 795, Schedule 10 steel pipe with rolled-groove ends, grooved-end steel pipe fittings, and grooved-coupling joints.
- S. Sizes 2-1/2 Inches (65 mm) to 6 Inches (150 mm): Type L (Type B) copper tube with rolled-groove ends, copper tube grooved-end fittings, copper tube grooved couplings and grooved-coupling joints.
 - 1. Fittings and Joining Option to 4 Inches (100 mm): Wrought-copper fittings and brazed joints.

2. Fittings Option to 4 Inches (100 mm): Mechanically formed outlets and brazed joints.
- T. Sizes 8 Inches (200 mm) and Larger: ASTM A 53 or A 795, Schedule 30 steel pipe, welding-type steel fittings, and welded joints.
- U. Sizes 8 Inches (200 mm) and Larger: ASTM A 53 or A 795, Schedule 30 steel pipe with cut-groove ends, steel pipe grooved-end fittings, grooved couplings, and grooved-coupling joints.
- V. Sizes 8 Inches (200 mm) and Larger: ASTM A 53 or A 795, Schedule 30 steel pipe with rolled-groove ends, steel pipe grooved-end fittings, grooved couplings, and grooved-coupling joints.

3.2 VALVE APPLICATIONS

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 1. Shutoff Duty: Use gate, ball, or butterfly valves.
 2. Throttling Duty: Use globe, ball, or butterfly valves.

3.3 JOINT CONSTRUCTION

- A. Refer to Division 22 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.
- B. Grooved-End Pipe and Grooved-End Fitting Joints: Use grooved-end fittings and grooved couplings that are made by the same manufacturer and that are listed for use together. Groove pipe and assemble joints with grooved coupling, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.
 1. Groove Type: Cut.
 2. Groove Type: Rolled.
- C. Grooved-End Copper Tube and Grooved-End Fitting Joints: Use grooved-end fittings and grooved couplings that are made by the same manufacturer and that are listed for use together. Roll-groove tube and assemble joints with grooved coupling, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

- D. Brazed Joints: Use AWS A5.8, BCuP-3, or BCuP-4 filler metals.
- E. Mechanically Formed Outlet Joints: Use UL-listed procedure and follow forming equipment manufacturer's written instructions. Drill pilot hole in tube, form branch for collar, dimple tube to form seating stop, and braze branch tube into formed-collar outlet.
- F. Press-Seal Fitting Joints: Follow manufacturer's written instructions, including use of specific equipment, pressure sealing tool, and accessories made for this procedure.
- G. Locking-Lug Joints: Follow manufacturer's written instructions.
- H. Dissimilar Materials Piping Joints: Make joints using adapters compatible with both piping materials.
- I. Handling of Solvent Cements, Primers, and Cleaners: Comply with procedures in ASTM F 402 for safe handling when joining plastic pipe and fittings with solvent cements.
- J. PB Heat-Fusion Joints: Conform to ASTM D 3309.

3.4 SERVICE ENTRANCE PIPING

- A. Refer to Division 22 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.
- B. Grooved-End Pipe and Grooved-End Fitting Joints: Use grooved-end fittings and grooved couplings that are made by the same manufacturer and that are listed for use together. Groove pipe and assemble joints with grooved coupling, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.
 - 1. Groove Type: Cut.
 - 2. Groove Type: Rolled.
- C. Grooved-End Copper Tube and Grooved-End Fitting Joints: Use grooved-end fittings and grooved couplings that are made by the same manufacturer and that are listed for use together. Roll-groove tube and assemble joints with grooved coupling, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.
- D. Brazed Joints: Use AWS A5.8, BCuP-3, or BCuP-4 filler metals.

- E. Mechanically Formed Outlet Joints: Use UL-listed procedure and follow forming equipment manufacturer's written instructions. Drill pilot hole in tube, form branch for collar, dimple tube to form seating stop, and braze branch tube into formed-collar outlet.
- F. Press-Seal Fitting Joints: Follow manufacturer's written instructions, including use of specific equipment, pressure sealing tool, and accessories made for this procedure.
- G. Locking-Lug Joints: Follow manufacturer's written instructions.
- H. Dissimilar Materials Piping Joints: Make joints using adapters compatible with both piping materials.
- I. Handling of Solvent Cements, Primers, and Cleaners: Comply with procedures in ASTM F 402 for safe handling when joining plastic pipe and fittings with solvent cements.
- J. PB Heat-Fusion Joints: Conform to ASTM D 3309.

3.5 WATER SUPPLY CONNECTION

- A. Connect fire protection piping to water supply piping of size and in location indicated.
- B. Install shutoff valve, check valve, pressure gage, drain, and other accessories indicated at connection to water supply piping.
- C. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water supply piping.

3.6 PIPING INSTALLATIONS

- A. Refer to Division 22 Section "Basic Mechanical Materials and Methods" for basic piping installation.
- B. Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate general location and arrangement of piping. Install piping as indicated, as far as practical. Deviations from approved "working plans" for sprinkler piping require written approval from authority with jurisdiction. File written approval with the Architect prior to deviating from approved "working plans."
- C. Use approved fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

- D. Install unions adjacent to each valve in pipes 2 inches (50 mm) and smaller. Unions are not required on flanged devices or in piping installations using grooved couplings.
- E. Install flanges or flange adapters on valves, apparatus, and equipment having 2-1/2-inch (65 mm) and larger connections.
- F. Install "Inspector's Test Connections" in sprinkler piping, complete with shutoff valve, sized and located according to NFPA 13.
- G. Install sprinkler piping with drains for complete system drainage.
- H. Install sprinkler zone control valves, test assemblies, and drain headers adjacent to standpipes when sprinkler piping is connected to standpipe.
- I. Install ball drip valves to drain piping between fire department connections and check valves, and where indicated. Drain to floor drain or outside building.
- J. Install alarm devices in piping systems.
- K. Hangers and Supports: Comply with NFPA 13.
 - 1. Install hanger and support spacing and locations for steel piping joined with grooved mechanical couplings according to manufacturer's written instructions for rigid systems.
 - 2. Earthquake Protection: Install piping according to NFPA 13 to protect from earthquake damage.
- L. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each riser. Include pressure gages with connection not less than 1/4 inch (7 mm) and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.

3.7 SPECIALTY SPRINKLER FITTING INSTALLATIONS

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

3.8 VALVE INSTALLATIONS

- A. Refer to Division 22 Section "Valves" for installation of general-duty valves. Install fire-protection specialty valves, trim, fittings, controls, and specialties according to NFPA 13, manufacturer's written instructions, and the authority having jurisdiction.
- B. Gate Valves: Install fire-protection service valves supervised-open, located to control sources of water supply except from fire department connections. Where there is more than 1 control valve, provide permanently marked identification signs indicating portion of system controlled by each valve.
- C. Install check valve in each water supply connection. Install backflow preventers instead of check valves in potable water supply sources.
- D. Alarm Check Valves: Install valves in vertical position for proper direction of flow, including bypass check valve and retard chamber drain line connection.
- E. Detector Check Valves: Install for proper direction of flow, located to detect system leakage and unauthorized use of water and to prevent backflow into public water mains. Install bypass with water meter, with gate valves on each side of meter, and check valve downstream from meter.

3.9 WATER METER INSTALLATION

- A. Install water meter according to utility company's written installation instructions and requirements.
- B. Size meter and arrange piping and specialties to comply with utility company's requirements.
- C. Set meter on 3000-psi (20.7 MPa) minimum, portland cement mix concrete pad, as indicated. Refer to Division 3 Section "Cast-In-Place Concrete" for requirements for formwork, reinforcement, and concrete.

3.10 ROUGHING-IN FOR WATER METER

- A. Install roughing-in piping and specialties for water meter installation according to utility company's instructions and requirements.

3.11 BACKFLOW PREVENTER INSTALLATION

- A. Install backflow preventers of type, size, and capacity indicated. Comply with plumbing code and authority with jurisdiction. Install air-gap fitting on units with atmospheric vent connection and pipe relief outlet drain to nearest floor drain. Do not install bypass around backflow preventer.

3.12 SPRINKLER APPLICATIONS

- A. Rooms without Ceilings: Upright sprinklers.
- B. Rooms without Ceilings: Pendent sprinklers.
- C. Rooms without Ceilings: Upright and pendent sprinklers, as indicated.
- D. Rooms with Suspended Ceilings: Pendent sprinklers.
- E. Rooms with Suspended Ceilings: Recessed sprinklers.
- F. Rooms with Suspended Ceilings: Flush sprinklers.
- G. Rooms with Suspended Ceilings: Concealed sprinklers.
- H. Rooms with Suspended Ceilings: Pendent, recessed, flush, and concealed sprinklers, as indicated.
- I. Wall Mounting: Sidewall sprinklers.
- J. Spaces Subject to Freezing: Upright, pendent dry-type, and sidewall dry-type sprinklers.
- K. Special Applications: Use extended-coverage, flow-control, and quick-response sprinklers where indicated.
- L. Sprinkler Finishes: Use sprinklers with following finishes:
 - 1. Upright, Pendent, and Sidewall Sprinklers: Chrome-plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax-coated where exposed to acids, chemicals, or other corrosive fumes.
 - 2. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.

3. Flush Sprinklers: Bright chrome, with painted white escutcheon.
4. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.
5. Residential Sprinklers: Dull chrome.

3.13 SPRINKLER INSTALLATIONS

- A. Install sprinklers in patterns indicated.
- B. Install sprinklers in suspended ceilings in center of acoustical panels and tiles.
- C. Install sprinklers in suspended ceilings in center of narrow dimension of acoustical panels.
- D. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing. Use dry-type sprinklers supplied from heated space.

3.14 EXCESS PRESSURE PUMP INSTALLATION

- A. Install excess pressure pumps, controls, devices, and supports according to manufacturer's written installation instructions for wet-pipe sprinkler system application.
 1. Mounting: Install mounted on wall, where indicated.
 2. Mounting: Install attached to water supply pipe.

3.15 FIRE DEPARTMENT CONNECTION INSTALLATIONS

- A. Install fire department connections of types and features indicated in locations indicated.
- B. Install ball drip valves at each check valve for fire department connection to mains and where indicated. Drain to floor drain or outside building.

3.16 CONNECTIONS

- A. Connect to specialty valves, specialties, fire department connections, and accessories.
- B. Connect water supplies to sprinkler systems. Include backflow preventers.

- C. Connect water supply piping to fire pump system piping. Fire pumps, pressure maintenance pumps, controllers, and accessories are specified in Division 22 Section "Fire Pumps."
- D. Electrical Connections: Power wiring is specified in Division 16.
- E. Connect alarm devices to fire alarm system.
- F. Connect excess pressure pumps to following piping and wiring:
 - 1. Hydraulically to sprinkler system.
 - 2. Hydraulically to pressure gages and controls.
 - 3. To electrical power system.
 - 4. To alarm device accessories for pump.
 - 5. To fire alarm system.

3.17 FIELD QUALITY CONTROL

- A. Perform field acceptance tests of each fire protection system. Flush, test, and inspect sprinkler piping systems according to NFPA 13 Chapter "System Acceptance."
- B. Replace piping system components that do not pass test procedures specified, then retest to demonstrate compliance. Repeat procedure until satisfactory results are obtained.
 - 1. Report test results promptly and in writing to Architect.
 - 2. Report test results promptly and in writing to authority having jurisdiction when required.

3.18 CLEANING

- A. Clean dirt and debris from sprinklers. Replace sprinklers having paint other than factory finish with new sprinklers. Cleaning and reuse of painted sprinklers is prohibited.

3.19 COMMISSIONING

- A. Starting Procedures: Follow manufacturer's written procedures. If no procedures are prescribed by manufacturer, proceed as follows:
 - 1. Verify that specialty valves, trim, fittings, controls, and accessories have been installed correctly and operate correctly.

2. Verify that excess pressure pumps and accessories have been installed correctly and operate correctly.
 3. Verify that specified tests of piping are complete.
 4. Check that damaged sprinklers and sprinklers with paint or coating not specified have been replaced with new, correct type of sprinklers.
 5. Check that sprinklers are correct type, have correct finish and temperature ratings, and have guards where required for applications.
 6. Check that potable water supplies have correct type of backflow preventer.
 7. Check that fire department connections have threads compatible with local fire department equipment and have correct pressure rating.
 8. Fill wet-pipe sprinkler systems with water.
 9. Energize circuits to electrical equipment and devices.
 10. Start and run excess pressure pumps.
 11. Adjust operating controls and pressure settings.
- B. Coordinate with fire alarm system tests. Operate systems as required.
- C. Coordinate with fire pump tests. Operate systems as required.

3.20 DEMONSTRATION

- A. Demonstrate equipment, specialties, and accessories. Review operating and maintenance information.
- B. Schedule demonstration with at least 7 days' advance notice.

END OF SECTION 210330

SECTION 220500 – COMMON PLUMBING REQUIREMENTS

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 and all Division 22 Sections.

1.2 PLANS AND SPECIFICATIONS

- A. All work under this title, on drawings or specified, is subject to the general and special contract conditions for the entire project, and the contractor for this portion of the work is required to refer especially thereto, and to the architectural drawings.
- B. Drawings are diagrammatic and specifications are complementary and must be so interpreted to determine the full scope of work under this heading. Wherever any material, article, operation or method is either specified or shown on the drawings, this contractor is required to provide each item and perform each prescribed operation according to the designate quality, qualification or condition, furnishing all necessary labor, equipment or incidentals.
- C. Wherever the designation "Architect" appears, it shall imply Architect or Engineer. Wherever the term "Contractor" or "PC" appears, it shall imply the Contractor responsible for Division 22, Plumbing Work.

1.3 CONFLICTS

- A. If, in the interpretation of contract documents, it appears that the drawings and specifications are not in agreement, the Contractor is to contact the Engineer. The Engineer shall be the final authority. Addenda supersede the provisions which they amend.
- B. In the absence of a written clarification by the engineer, the Contractor must install his work in accordance with the more stringent condition. Contractor assumes full responsibility for any and all items furnished and installed without the written approval by the Architect or Engineer.

1.4 DIMENSIONS, LAYOUTS AND OBSTACLES

- A. Verify dimensions and elevations from actual field measurements after building construction has sufficiently progressed.
- B. Assume full and final responsibility for the accuracy of any or all work performed under this Division and make repairs and corrections as required or directed at no extra cost to the Owner.
- C. Layouts of piping, and equipment shown on drawings are diagrammatic. Contractor shall verify dimensions and layouts for specific project conditions, field verify any existing conditions, and coordinate with all other trades prior to procurement, fabrication and installation of equipment and material. Existing Conditions shall be field verified by contractor prior to bid submissions. Unknown conditions during construction due to omission of contractor field verification prior to bid shall be resolved by the contractor at no cost to the owner or project. Contractor assumes full responsibility for completeness of installation including coordination of work with other trades.
- D. Make actual installations in accord with design layouts, but with necessary adjustments as determined by trade coordination, actual material and equipment procured, field verifications, and other project conditions in order to provide a fully functional and complete system, save and maintainable in all aspects. Any such required adjustments and deviations shall require specific approval of the Engineer/Architect prior to procurement, fabrication, and installation.
- E. Take particular care to coordinate all piping and equipment under this Division to prevent conflict and remove and relocate work as may be made necessary by such conflict at no extra cost to the Owner or project.
- F. Unless expressly permitted by the Engineer/Architect or shown otherwise on the Drawings, all piping and related items shall be installed so that they are concealed except as permitted by the Engineer/Architect in service rooms noted on the Drawings.
- G. The Owner or Owner's Representative reserves the right to relocate Fixtures and equipment six (6) feet in any direction from locations indicated on plans, before roughing-in, with no change in contract price.

1.5 REVIEW OF PROPOSED EQUIPMENT AND MATERIALS

- A. Submittals:
 - 1. Contractor shall submit a complete list and schedule, including all proposed equipment and materials to the Construction Manager or Owner's Representative and Engineer for review and approval within 10 business days of contract award.

- B. Submit all proposed material, equipment, and fabrication shop drawings to the Engineer for approval prior to procurement, fabrication, and installation.
- C. Substitution Requests:
 - 1. Substitutions are defined as any manufacturer and/or model not indicated in drawings or specifications. Requests for substitutions must be made in writing ten (10) days prior to bid date so that an addendum may reach all contractors.
 - 2. In addition to other contract provisions regarding substitution requests, Contractor must certify by letter that he has checked the proposed substitution products or materials for conformance to applicable codes, standards, and regulations, specifications, and space limitations and assumes full responsibility thereafter.
 - 3. Approval of substitution requests is at the sole discretion of the Engineer and Owner.
 - 4. If substitutions are proposed after the bids are received, the Contractor shall state amount of credit to the Owner for substitution. Substitutions that are considered equal by the Contractor and carried in bid without approval by Engineer shall be the responsibility of the Contractor. The Engineer and/or Owner shall not be made liable or responsible for losses incurred by the Contractor, due to the rejection of said items for installation.
 - 5. Where equipment requiring different arrangement or connections other than as indicated is acceptable, it shall be the responsibility of this Contractor to furnish revised layouts, and install the equipment to operate properly and in harmony with the intent of the drawings and specifications. All changes in the work required by the different arrangement shall be done at no additional cost to the Owner or Project, including but not limited to structural steel modifications. Control and power wiring modifications required by Contractor, imposed modifications, and the additional cost of these modifications, shall be the responsibility of this Contractor.

1.6 PERMITS, CODES AND ORDINANCES

- A. The Contractor shall arrange and pay for all permits, inspections, etc., as required by local utilities or applicable agencies.
- B. All work and material shall be in complete accordance with the ordinances, regulations, codes, etc., of all political entities exercising jurisdictions.

1.7 QUALITY ASSURANCE

- A. Install Plumbing Systems in accordance with applicable industry standards.

- B. All materials within domestic water distribution systems that may come in contact with potable water delivered shall comply with ANSI/NSF Standard 61: Drinking Water System Components – Health Effects.
- C. Install Plumbing Systems in accordance with manufacturer's installation, operations and maintenance instructions.
- D. Prior to putting any potable water fixture currently or potentially used for drinking or cooking purposes, including but not limited to a bubbler, drinking fountain, or faucets, in operation, perform a "first draw" sampling of the water in accordance with 10 NYCRR subpart 67-4. First-draw samples shall be collected from all outlets, as defined in this Subpart. A first-draw sample volume shall be 250 milliliters (mL), collected from a cold water outlet before any water is used. All first-draw samples shall be analyzed by a laboratory approved to perform such analyses by the New York State Department of Health's Environmental Laboratory Approval Program (ELAP). The water shall be motionless in the pipes for a minimum of 8 hours, but not more than 18 hours, before sample collection. The construction manager or owner's representative and owner shall be notified of any sample indicating a lead level of 5 micrograms per liter (equivalent to parts per billion, or ppb). Any potable water fixture connected to any such tested branch piping shall be taken out of service and conspicuous notice shall be made that the fixture is "OUT OF SERVICE".

1.8 COORDINATION WITH OTHER TRADES

- A. Check plumbing work with all other trades.
- B. Anticipate, avoid, and resolve interferences with other trades.
- C. Take particular care to coordinate all piping, ductwork, plumbing and major electrical components above ceiling, to prevent conflict. Remove and relocate work as may be made necessary by such conflict, at no extra cost to the Owner.
- D. Obtain decision for approval from project Engineer for proposed group installation before proceeding, and for clearance in structure and finish of the building.
- E. The Contractor shall coordinate with, receive and install, Owner furnished equipment where indicated.
- F. Coordinate location of controls and instrumentation devices, including but not limited to control valves, thermowells, pressure probes, insertion flow meters, and ultrasonic flow

meters, with Building Automation System (BAS) requirements. Provide installation of controls and instrumentation devices furnished as part of the BAS.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Delivery of Materials: Make provisions for delivery and safe storage of all materials. Check and properly receipt material to be "furnished by others" to contractor, and assume full responsibility for all materials while in storage with full visible identification and information.

1.10 PROJECT CONDITIONS

- A. Coordination: Field verify existing conditions that will determine exact locations, distances, levels, dimensions, elevations, etc. Review all drawings of other trades and report any conflicts to the Architect/Engineer which will affect the project cost. Lack of field verification does not constitute a basis for change orders and additional costs incurred by the owner or project. Contractor assumes full responsibility for completeness of installation including coordination of work with other trades.
- A. Existing facilities shall be considered occupied and functioning during the entire duration of construction. Care shall be taken when working in or around occupied spaces. There will be no interruption in mechanical systems or utilities without written approval from the Owner.

1.11 MISCELLANEOUS SUPPORT

- A. Contractor is responsible for providing all miscellaneous support components necessary for properly supporting Plumbing Systems including hangers, rods, anchors, steel, and bases.

PART 2 - PRODUCTS (not used)

PART 3 - EXECUTION

3.1 COMMON PLUMBING SYSTEMS INSTALLATION REQUIREMENTS

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of Plumbing systems.

- B. Indicated locations and arrangements were used to size systems and address other design considerations. Install systems as indicated unless deviations to layout are approved by Architect and Engineer.
- C. Install systems in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install systems indicated to be exposed and in equipment rooms and service areas at right angles or parallel to building walls.
- E. Install equipment level and plumb, parallel and perpendicular to other building systems and components, unless otherwise indicated.
- F. Install equipment to allow maximum possible headroom unless specific mounting heights are indicated.
- G. Diagonal runs of piping are prohibited unless specifically indicated otherwise.
- H. Install systems above accessible ceilings to allow sufficient space for ceiling panel removal.
- I. Install systems and 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.
- J. Install equipment with all required manufacturer's service clearances maintained.
- K. Install piping at indicated slopes.
- L. Install piping free of sags and bends.
- M. Install fittings for changes in direction and branch connections.
- N. Install systems to allow application of insulation.
- O. Select system components with pressure rating equal to or greater than system operating pressure.
- P. Install escutcheons for penetrations of walls, ceilings, and floors.
- Q. Running piping over electrical equipment and in elevator machine rooms is prohibited.
- R. Running piping into or through interior exit stairways, other than systems serving such stairwells as permitted by the International Building Code, is prohibited.
- S. Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Such Penetrations shall be sealed with firestop materials.

- T. Install Plumbing Systems on required supports and bases meeting maximum allowable spans and sized for the specific loads.
- U. Install controls and instrumentation devices for Plumbing Systems required for system operations and as indicated.

END OF SECTION 220500

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SECTION 220502 – COMMON PLUMBING DEMOLITION REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Description of Work: Provide plumbing removal work as indicated and as required for removal and/or abandonment of systems, equipment and fixtures, etc. made obsolete by this Project, and as required for removal and remodeling by other trades.

1.2 EXISTING CONDITIONS

- A. Existing plumbing systems, equipment and fixtures may not all be shown on the Drawings. Existing conditions, where indicated, are based on preliminary field observations and/or existing conditions documentation made available to the Architect and Engineer and must be verified. Report any discrepancies to the Architect and Engineer before disturbing the existing installation.
- B. Prior to bidding, examine the site to determine all actual observable conditions. Additional work or scope changes due to the Contractor's failure to investigate such existing conditions shall not be grounds for change orders or cause additional costs to the owner and project.

1.3 COORDINATION

- A. Adjoining Areas: It is expected that the Contractor understands that adjoining areas of the building (or project site) must remain in operation and Plumbing Systems and services must remain in operation at all times, unless specifically approved otherwise.
- B. Scheduling: Demolition work and any required shut-downs shall be scheduled in conjunction with all other trades and the owner. Contractor cooperation will be expected under all conditions.
- C. Area Limits: Construction traffic and removal of debris will be limited to specific areas and routes. Confirm with the Construction Manager and Owner.
- D. Coordinate and ensure that all equipment affected by the work is de-energized and electrically disconnected by a qualified and authorized contractor or owner's representative prior to proceeding with demolition.

1.4 ADJACENT MATERIALS

- A. Protection: During execution of removal work, primary consideration shall be given to protecting from damage, building structure, furnishings, finishes and the like, which are not specifically indicated to be removed.
- B. Repairs: Existing items or surfaces to remain, which are damaged as a result of this work shall be refinished, repaired or replaced to the satisfaction of the Owner, at no cost to the Contract.

1.5 TRANSIENT SERVICES

- A. Locate and identify any and all services passing through the project area which serve areas outside the work limits.
- B. Maintain all services to areas outside the work limits unless specifically authorized otherwise in writing by the Engineer or Owner's Representative. When transient services must be interrupted, provide temporary services for affected areas outside the work limits.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Patching: Materials used for patching shall be in conformance with the applicable sections of the Project Manual. Where materials are not specifically described, but required for proper completion of the Work, they shall be as selected by the Contractor, subject to approval of the Architect and Engineer.

PART 3 - EXECUTION

3.1 INSPECTION/VERIFICATION

- A. Inspection: Before commencing work of this Section, carefully inspect the project site and become familiar with existing systems and conditions.
- B. Items to be Salvaged: Verify with the Engineer and Owner's Representative, all systems, materials and equipment which are to be salvaged, and those which must be removed. The Owner reserves the right to salvage any or all existing plumbing materials and equipment at the project site.

3.2 DEMOLITION

- A. General: Remove plumbing equipment, piping, fixtures and related materials within the project work limits, as indicated.
- B. Disconnections: Disconnect all plumbing work located in walls, ceilings or floors scheduled for removal. Disconnect plumbing connections to equipment being removed by other trades.
- C. Protection: Perform all removal work in such a manner so that damage to adjacent items and surfaces is minimized.
- D. Patching: When plumbing materials are removed, patch and finish surfaces to remain to match surrounding surfaces.

3.3 EXISTING PLUMBING WORK TO REMAIN

- A. General: Protect and maintain access to existing systems which must remain. Reinstall existing systems disturbed.
- B. Reconnections: Where systems in adjoining areas or indicated to remain, become disconnected or affected by demolition work, they shall be reconnected as required to restore original operation. Restoration work shall comply with requirements for new work.

3.4 EXISTING PLUMBING WORK TO BE RELOCATED

- A. General: Disconnect, remove, reinstall and reconnect equipment indicated to be relocated and where required to accommodate remodeling or new construction. Extend existing installations as required. Materials and methods used for relocations and extensions shall conform to requirements for new work.

3.5 DISPOSITION OF EXISTING MATERIALS AND EQUIPMENT

- A. Items to Salvage: Material and equipment which is indicated (or directed by Owner) to be salvaged, shall be carefully removed and stored where directed on the site.
- B. Items to Reuse/Relocate: Carefully remove and store on site, all material and equipment indicated to be reused or relocated. Thoroughly clean, and make any necessary minor repairs to such equipment, prior to installation.
- C. Items to Remove: Remove and legally dispose of all other materials and debris resulting from demolition work on a daily basis.

3.6 CLEANING

- A. Remove from the Project Site all dirt, dust and debris resulting from removal operations daily. Refuse shall not be allowed to block or otherwise impair circulation in corridors, stairs, sidewalks, roadways or other traffic areas.

END OF SECTION 220502

SECTION 220513 - COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on alternating-current power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.2 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: Premium 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 ADDITIONAL REQUIREMENTS FOR POLYPHASE MOTORS

- 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: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
 - 1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width-modulated inverters.

2. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
3. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

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.

2.6 ELECTRONICALLY COMMUTATED MOTORS (ECM)

- A. Motors shall be, variable-speed, DC, brushless motors, specifically designed for the voltage, frequency, and phase indicated.
- B. Motors shall be complete with and operated by an integrated controller/inverter that operates the wound stator and senses rotor position to electronically commute the stator.
- C. Motors shall be designed for synchronous rotation.
- D. Rotors shall be permanent magnet type with near zero rotor losses.
- E. Motors shall have built-in soft start and soft speed change ramps.
- F. Motors shall be able to be mounted with shaft in horizontal or vertical orientation.

- G. Motors shall be permanently lubricated with ball bearings.
- H. Motors shall maintain a minimum of 70% efficiency over the entire operating range.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 220513

SECTION 220517 - 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. Sleeve-seal systems.
 - 4. Sleeve-seal fittings.
 - 5. Grout.
 - 6. Silicone sealants.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Advance Products & Systems, Inc.
 - 2. CALPICO, Inc.
 - 3. GPT; an EnPro Industries company.

- B. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop collar.
- C. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, anticorrosion coated or galvanized, with plain ends and integral welded waterstop collar.
- D. Galvanized-Steel Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.
- E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface 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. [Jay R. Smith Mfg. Co.](#)
 - 2. [Zurn Industries, LLC.](#)
- B. Description: Manufactured, Dura-coated or Duco-coated cast-iron sleeve with integral clamping flange for use in waterproof floors and roofs. Include clamping ring, bolts, and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with setscrews.

2.3 SLEEVE-SEAL SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. [Advance Products & Systems, Inc.](#)
 - 2. [CALPICO, Inc.](#)
 - 3. [GPT; an EnPro Industries company.](#)
 - 4. [Metraflex Company \(The\).](#)
 - 5. [Proco Products, Inc.](#)
- B. Description:
 - 1. Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
 - 2. Designed to form a hydrostatic seal of 20 psig minimum.
 - 3. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 4. Pressure Plates: Stainless steel.

5. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.4 SLEEVE-SEAL FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Advance Products & Systems, Inc.
 2. CALPICO, Inc.
 3. GPT; an EnPro Industries company.
 4. Metraflex Company (The).
 5. Proco Products, Inc.
- B. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall.
- C. Plastic or rubber waterstop collar with center opening to match piping OD.

2.5 GROUT

- A. Description: Nonshrink, for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.6 SILICONE SEALANTS

- A. Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant, ASTM C920, Type S, Grade NS, Class 25, Use NT.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Dow Corning Corporation.
 - b. GE Construction Sealants; Momentive Performance Materials Inc.
 - c. Polymeric Systems, Inc.
 - d. Schnee-Morehead, Inc., an ITW company.
 - e. Sherwin-Williams Company (The).

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
 - 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 or silicone sealant, 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.
- E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration Firestopping."

3.2 STACK-SLEEVE-FITTING INSTALLATION

- A. Install stack-sleeve fittings in new slabs as slabs are constructed.
 - 1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 - 2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing.

3. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
 4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 5. Use silicone sealant to seal the space around outside of stack-sleeve fittings.
- B. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials.

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.4 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Use grout or silicone sealant to seal the space around outside of sleeve-seal fittings.

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
- B. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.6 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
1. Exterior Concrete Walls above Grade:
 - a. Piping Smaller Than NPS 6: Sleeve-seal fittings.
 - b. Piping NPS 6 and Larger: Sleeve-seal fittings.
 2. Exterior Concrete Walls below Grade:
 - a. Piping Smaller Than NPS 6: 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: 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: 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: 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.
 4. Concrete Slabs above Grade:
 - a. Piping Smaller Than NPS 6: Stack-sleeve fittings.
 - b. Piping NPS 6 and Larger: Stack-sleeve fittings.
 5. Interior Partitions:
 - a. Piping Smaller Than NPS 6: Steel pipe sleeves.
 - b. Piping NPS 6 and Larger: Galvanized-steel sheet sleeves.

END OF SECTION 220517

SECTION 220518 - 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 DEFINITIONS

- A. Existing Piping to Remain: Existing piping that is not to be removed and that is not otherwise indicated to be removed and salvaged, or removed and reinstalled.

1.4 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. BrassCraft Manufacturing Co.; a Masco company.
 - 2. Dearborn Brass.
 - 3. Jones Stephens Corp.
 - 4. Keeney Manufacturing Company (The).
 - 5. Mid-America Fittings, Inc.
 - 6. ProFlo; a Ferguson Enterprises, Inc. brand.

2.2 ESCUTCHEONS

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

2.3 FLOOR PLATES

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

- f. Bare Piping in Equipment Rooms: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
 - C. Install floor plates for piping penetrations of equipment-room floors.
 - D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. New Piping and Relocated Existing Piping: One-piece, floor plate.
 - 2. Existing Piping: Split floor plate.
- 3.2 FIELD QUALITY CONTROL
- A. Using new materials, replace broken and damaged escutcheons and floor plates.

END OF SECTION 220518

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SECTION 220519 - METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Filled-system thermometers.
 - 2. Thermowells.
 - 3. Pressure gages.
 - 4. Gage attachments.
 - 5. Test plugs.
 - 6. Test-plug kits.
 - 7. Sight flow indicators.

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of meter and gage.

1.4 CLOSEOUT SUBMITTALS

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

PART 2 - PRODUCTS

2.1 FILLED-SYSTEM THERMOMETERS

- A. Direct-Mounted, Metal-Case, Vapor-Actuated Thermometers:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ashcroft Inc.

- b. [Miljoco Corporation.](#)
 - c. [Palmer Wahl Instrumentation Group.](#)
 - d. [Trerice, H. O. Co.](#)
 - e. [Weiss Instruments, Inc.](#)
- 2. Standard: ASME B40.200.
 - 3. Case: Sealed type, cast aluminum or drawn steel; 4-1/2-inch nominal diameter.
 - 4. Element: Bourdon tube or other type of pressure element.
 - 5. Movement: Mechanical, dampening type, with link to pressure element and connection to pointer.
 - 6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
 - 7. Pointer: Dark-colored metal.
 - 8. Window: Glass.
 - 9. Ring: Stainless steel.
 - 10. Connector Type(s): Union joint, adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device; with ASME B1.1 screw threads.
 - 11. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
 - a. Design for Thermowell Installation: Bare stem.
 - 12. Accuracy: Plus or minus 1 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.
- 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. Ashcroft Inc.
 - b. Miljoco Corporation.
 - c. Palmer Wahl Instrumentation Group.
 - d. Trerice, H. O. Co.
 - e. Weiss Instruments, Inc.
 - f. Winters Instruments - U.S.
2. Standard: ASME B40.100.
3. Case: Sealed 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: Stainless steel.
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 or stainless steel needle, 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. Miljoco Corporation.

2. [Nexus Valve, Inc.; Aalberts Hydronic Flow Control.](#)
3. [Trerice, H. O. Co.](#)
4. [Weiss Instruments, Inc.](#)
5. [Weksler Glass Thermometer Corp.](#)

- 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.

2.6 TEST-PLUG KITS

- A. [Manufacturers:](#) Subject to compliance with requirements, provide products by one of the following:
1. [Miljoco Corporation.](#)
 2. [Nexus Valve, Inc.; Aalberts Hydronic Flow Control.](#)
 3. [Trerice, H. O. Co.](#)
 4. [Weiss Instruments, Inc.](#)
- 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. 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.
- D. 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.
- E. Carrying Case: Metal or plastic, with formed instrument padding.

2.7 SIGHT FLOW INDICATORS

- A. [Manufacturers:](#) Subject to compliance with requirements, provide products by one of the following:

1. [Dwyer Instruments, Inc.](#)
 2. [Ernst Flow Industries.](#)
 3. [Pentair Valves & Controls; Penberthy Brand.](#)
 4. [Rosemount; Emerson Electric Co., Automation Solutions.](#)
- 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: 125 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.

PART 3 - EXECUTION

3.1 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. 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.
2. Inlets and outlets of each domestic water heat exchanger.
3. Inlet and outlet of each domestic hot-water storage tank.
4. Inlet and outlet of each remote domestic water chiller.
5. Inlet and outlet of each domestic hot water mixing valve.
6. Inlet of each domestic hot water balancing valve.

J. Install pressure gages in the following locations:

1. Building water service entrance into building.
2. Inlet and outlet of each pressure-reducing valve.
3. Suction and discharge of each domestic water pump.
4. Inlet and outlet of each water heater

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 SCALE RANGES

- A. Thermometer Scale Range for Domestic Water Piping:
1. 30 to 240 deg F.
- B. Pressure Gage Scale Range for Domestic Water Piping:
1. 0 to 160 psi.

END OF SECTION 220519

SECTION 220523.12 - BALL 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 ball valves.

1.3 DEFINITIONS

- A. CWP: Cold working pressure.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of valve.
 - 1. Certification that products comply with NSF 61 and NSF 372.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, and soldered ends.
 - 3. Set ball valves open to minimize exposure of functional surfaces.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
 - 1. ASME B1.20.1 for threads for threaded end valves.
 - 2. valve dimensions and design criteria.
 - 3. ASME B16.18 for solder-joint connections.
 - 4. ASME B31.9 for building services piping valves.
- C. NSF Compliance: NSF 61 and NSF 372 for valve materials for potable-water service.
- D. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.
- E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- F. Valve Sizes: Same as upstream piping unless otherwise indicated.
- G. Valve Actuator Types:
 - 1. Handlever: For quarter-turn valves smaller than NPS 4.
- H. Valves in Insulated Piping:
 - 1. Include 2-inch stem extensions.
 - 2. Extended operating handles of nonthermal-conductive material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.
 - 3. Memory stops that are fully adjustable after insulation is applied.

2.2 BRONZE BALL VALVES

- A. Bronze Ball Valves, Two-Piece with Full Port, and Stainless-Steel Trim, Press Ends:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - b. Center Line; a Crane Co. brand.
 - c. Hammond Valve.
 - d. Milwaukee Valve Company.
 - e. NIBCO INC.

- f. [Viega LLC.](#)
 - 2. Description:
 - a. Standard: MSS SP-110 or MSS-145.
 - b. CWP Rating: Minimum 200 psig.
 - c. Body Design: Two piece.
 - d. Body Material: Bronze.
 - e. Ends: Press.
 - f. Press Ends Connections Rating: Minimum 200 psig.
 - g. Seats: PTFE or RTPFE.
 - h. Stem: Stainless steel.
 - i. Ball: Stainless steel.
 - j. Port: Full.
 - k. O-Ring Seal: EPDM or Buna-N.
- B. Bronze Ball Valves, Two-Piece with Full Port and Stainless-Steel Trim:
 - 1. [Manufacturers:](#) Subject to compliance with requirements, provide products by one of the following:
 - a. [Apollo Valves; a part of Aalberts Integrated Piping Systems.](#)
 - b. [Center Line; a Crane Co. brand.](#)
 - c. [Hammond Valve.](#)
 - d. [Milwaukee Valve Company.](#)
 - e. [NIBCO INC.](#)
 - f. [Viega LLC.](#)
 - 2. Description:
 - a. Standard: MSS SP-110 or MSS-145.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Two piece.
 - d. Body Material: Bronze.
 - e. Ends: Threaded or soldered.
 - f. Seats: PTFE.
 - g. Stem: Stainless steel.
 - h. Ball: Stainless steel.
 - i. Port: Full.

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.

3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.

3.4 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

- A. Pipe NPS 2-1/2 and Smaller:
 - 1. Bronze ball valves, two-piece with full port and stainless steel trim. Provide with threaded solder or press connection-joint ends.

END OF SECTION 220523.12

SECTION 220523.13 - BUTTERFLY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Iron, single-flange butterfly valves.
 - 2. Iron, grooved-end butterfly valves.

1.2 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene-diene terpolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of valve.
 - 1. Certification that products comply with NSF 61 Annex G and NSF 372.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, grooves, and weld ends.
 - 3. Set butterfly valves closed or slightly open.
- 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. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
 - 1. ASME B16.1 for flanges on iron valves.
 - 2. ASME B16.5 for flanges on steel valves.
 - 3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 - 4. ASME B31.9 for building service piping valves.
- C. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.
- D. NSF Compliance: NSF 61 Annex G and NSF 372 for valve materials for potable-water service.
- E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- F. Valve Sizes: Same as upstream piping unless otherwise indicated.
- G. Valve Actuator Types:
 - 1. Gear Actuator: For valves **NPS 8** and larger.
 - 2. Handlever: For valves **NPS 6** and smaller.
- H. Valves in Insulated Piping: With **2-inch** stem extensions.

2.2 IRON, SINGLE-FLANGE BUTTERFLY VALVES

- A. Iron, Single-Flange Butterfly Valves with Stainless-Steel Disc:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - b. Jenkins Valves; a Crane Co. brand.

- c. [KITZ Corporation.](#)
- d. [Milwaukee Valve Company.](#)
- e. [NIBCO INC.](#)

2. Description:

- a. Standard: MSS SP-67, Type I.
- b. CWP Rating, **NPS 12** and Smaller: **200 psig.**
- c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
- d. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
- e. Seat: EPDM.
- f. Stem: One- or two-piece stainless steel.
- g. Disc: Stainless steel.

2.3 DUCTILE-IRON, GROOVED-END BUTTERFLY VALVES

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

- 1. [Manufacturers:](#) Subject to compliance with requirements, provide products by one of the following:
 - a. [Tyco by Johnson Controls Company.](#)
 - b. [Victaulic Company.](#)
 - c. [Zurn Industries, LLC.](#)
- 2. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. CWP Rating: **175 psig.**
 - c. Body Material: Coated, ductile iron.
 - d. Stem: Two-piece stainless steel.
 - e. Disc: Coated, ductile iron.
 - f. Seal: EPDM.

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 mating flange faces for damage. 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.
- D. 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 valve tags. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

3.3 ADJUSTING

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

3.4 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

- A. Pipe **NPS 2-1/2** and Larger:
 - 1. Iron, Single-Flange Butterfly Valves: 200 CWP, EPDM seat, stainless-steel disc.
 - 2. Ductile-Iron, Grooved-End Butterfly Valves: 175 CWP.

END OF SECTION 220523.13

SECTION 220523.14 - CHECK VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Bronze lift check valves.
2. Bronze swing check valves.
3. Bronze swing check valves, press ends.
4. Iron swing check valves.
5. Iron swing check valves with closure control.
6. Iron, grooved-end swing check valves.
7. Iron, center-guided check valves.
8. Iron, plate-type check valves.

1.2 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene-diene terpolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of valve.
1. Certification that products comply with NSF 61 and NSF 372.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
1. Protect internal parts against rust and corrosion.
 2. Protect threads, flange faces, grooves, and weld ends.
 3. Set 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. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
1. ASME B1.20.1 for threads for threaded end valves.
 2. ASME B16.1 for flanges on iron valves.
 3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 4. ASME B16.18 for solder joint.
 5. ASME B31.9 for building services piping valves.
- C. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.
- D. Drinking Water System Components - Health Effects and Drinking Water System Components - Lead Content Compliance: NSF 61 and NSF 372.
- E. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.
- F. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- G. Valve Sizes: Same as upstream piping unless otherwise indicated.
- H. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE LIFT CHECK VALVES

- A. Bronze Lift Check Valves with Bronze Disc, Class 125:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. A.Y. McDonald Mfg. Co.
 - b. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - c. Crane Valves; a Crane Co. brand.
 - d. Jenkins Valves; a Crane Co. brand.
 - e. Metraflex Company (The).
 - f. Milwaukee Valve Company.
 - g. NIBCO INC.
2. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: **200 psig**.
 - c. Body Design: Vertical flow.
 - d. Body Material: ASTM B61 or ASTM B62, bronze.
 - e. Ends: Threaded or soldered. See valve schedule articles.
 - f. Disc: Bronze.

B. Bronze Lift Check Valves with Nonmetallic Disc, Class 125:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane Valves; a Crane Co. brand.
 - b. Jenkins Valves; a Crane Co. brand.
 - c. KITZ Corporation.
 - d. Milwaukee Valve Company.
 - e. NIBCO INC.
 - f. Victaulic Company.
2. Description:
 - a. Standard: MSS SP-80, Type 2.
 - b. CWP Rating: **200 psig**.
 - c. Body Design: Vertical flow.
 - d. Body Material: ASTM B61 or ASTM B62, bronze.
 - e. Ends: Threaded or soldered. See valve schedule articles.
 - f. Disc: NBR, PTFE.

2.3 BRONZE SWING CHECK VALVES

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

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - b. Crane Valves; a Crane Co. brand.
 - c. Jenkins Valves; a Crane Co. brand.
 - d. KITZ Corporation.
 - e. Milwaukee Valve Company.
 - f. NIBCO INC.
 - g. Victaulic Company.
2. Description:
 - a. Standard: MSS SP-80, Type 3.
 - b. CWP Rating: **200 psig**.
 - c. Body Design: Horizontal flow.
 - d. Body Material: ASTM B62, bronze.
 - e. Ends: Threaded or soldered. See valve schedule articles.
 - f. Disc: Bronze.

B. Bronze Swing Check Valves with Bronze Disc, Class 150:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. A.Y. McDonald Mfg. Co.
 - b. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - c. Crane Valves; a Crane Co. brand.
 - d. Jenkins Valves; a Crane Co. brand.
 - e. KITZ Corporation.
 - f. Milwaukee Valve Company.
 - g. NIBCO INC.
2. Description:
 - a. Standard: MSS SP-80, Type 3.
 - b. CWP Rating: **300 psig**.
 - c. Body Design: Horizontal flow.
 - d. Body Material: ASTM B62, bronze.
 - e. Ends: Threaded or soldered. See valve schedule articles.

- f. Disc: Bronze.

2.4 IRON SWING CHECK VALVES

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

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. Crane; Crane Energy Flow Solutions.
 - c. KITZ Corporation.
 - d. Milwaukee Valve Company.
 - e. NIBCO INC.
2. Description:
 - a. Standard: MSS SP-71, Type I.
 - b. CWP Rating: **200 psig**.
 - c. Body Design: Clear or full waterway.
 - d. Body Material: ASTM A126, gray iron with bolted bonnet.
 - e. Ends: Flanged or threaded. See valve schedule articles.
 - f. Trim: Bronze.
 - g. Gasket: Asbestos free.

2.5 IRON SWING CHECK VALVES WITH CLOSURE CONTROL

A. Iron Swing Check Valves with Lever and Weight-Closure Control, Class 125:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. Crane; Crane Energy Flow Solutions.
 - c. Milwaukee Valve Company.
 - d. NIBCO INC.
2. Description:
 - a. Standard: MSS SP-71, Type I.
 - b. CWP Rating: **200 psig**.
 - c. Body Design: Clear or full waterway.
 - d. Body Material: ASTM A126, gray iron with bolted bonnet.

- e. Ends: Flanged or threaded. See valve schedule articles.
- f. Trim: Bronze.
- g. Gasket: Asbestos free.
- h. Closure Control: Factory-installed exterior lever and weight.

2.6 CPVC BALL CHECK VALVES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. IPEX USA LLC.
 - 2. NIBCO INC.
 - 3. Spears Manufacturing Company.
- B. Description:
 - 1. Pressure Rating and Temperature: 125 psig at 73 deg F.
 - 2. Body Material: CPVC.
 - 3. Body Design: Union-type ball check.
 - 4. End Connections for Valves NPS 2 and Smaller: Detachable, threaded.
 - 5. End Connections for Valves NPS 2-1/2 to NPS 4 : Detachable, threaded or flanged.
 - 6. Ball: CPVC.
 - 7. Seals: EPDM- or FKM-rubber O-rings.

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. Check Valves: Install check valves for proper direction of flow.
 - 1. Swing Check Valves: In horizontal position with hinge pin level.
 - 2. Center-Guided and Plate-Type Check Valves: In horizontal or vertical position, between flanges.
 - 3. Lift Check Valves: With stem upright and plumb.
- F. Install valve tags. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

3.3 ADJUSTING

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

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not indicated, use the following:
 - 1. Pump-Discharge Check Valves:
 - a. **NPS 2** and Smaller: Bronze swing check valves with bronze disc.
 - b. **NPS 2-1/2** and Larger for Domestic Water: Iron swing check valves with lever and weight or spring; or iron, center-guided, metal-seat or resilient-seat check valves.
 - c. **NPS 2-1/2** and Larger for Sanitary Waste and Storm Drainage: Iron swing check valves with lever and weight or spring.

- B. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.
- C. End Connections:
 - 1. For Copper Tubing, **NPS 2** and Smaller: Threaded or soldered or press-ends.
 - 2. For Copper Tubing, **NPS 2-1/2 to NPS 4** : Flanged or threaded or press ends.
 - 3. For Copper Tubing, **NPS 5** and Larger: Flanged.
 - 4. For Steel Piping, **NPS 2** and Smaller: Threaded.
 - 5. For Steel Piping, **NPS 2-1/2 to NPS 4**: Flanged or threaded.
 - 6. For Steel Piping, **NPS 5** and Larger: Flanged.
 - 7. For Grooved-End Copper Tubing and Steel Piping: Grooved.

3.5 LOW-PRESSURE, COMPRESSED-AIR VALVE SCHEDULE (**150 PSIG** OR LESS)

- A. Pipe **NPS 2** and Smaller:
 - 1. Vertical, Upflow Applications Only: Bronze lift check valves with bronze disc, Class 125, with threaded end connections.
 - 2. Horizontal and Vertical Applications: Bronze swing check valves with bronze disc, Class 125, with threaded end connections.
- B. Pipe **NPS 2-1/2** and Larger:
 - 1. Iron swing check valves with metal seats, Class 125, with threaded or flanged end connections.
 - 2. Iron, grooved-end swing check valves, 300 CWP.
 - 3. Iron, dual-plate check valves with metal seat, Class 125, with flanged end connections.

3.6 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

- A. Pipe **NPS 2** and Smaller:
 - 1. Bronze swing check valves with bronze disc, Class 150, with threaded end connections.
 - 2. Bronze swing check valves with press-end connections.
- B. Pipe **NPS 2-1/2** and Larger:
 - 1. Iron swing check valves with metal seats, Class 250, with flanged end connections.

2. Iron swing check valves with closure control lever and weight, Class 125, with flanged end connections.

END OF SECTION 220523.14

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SECTION 220529 - 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.
 - 6. Pipe-positioning systems.
 - 7. Equipment supports.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
 - 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. Include design calculations for designing trapeze hangers.

1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Structural-Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M.
- B. Pipe Welding Qualifications: Qualify procedures and operators according to 2015 ASME Boiler and Pressure Vessel Code, Section IX.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design trapeze pipe hangers and equipment supports.
- 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.

2.2 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, hot-dip galvanized, or electro-galvanized.
 - 3. Nonmetallic Coatings: Plastic coated or epoxy powder coated.
 - 4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 - 5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
- B. Stainless-Steel Pipe Hangers and Supports:
 - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.

2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.
- C. Copper Pipe and Tube 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.

2.3 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-58, 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.

2.4 METAL FRAMING SYSTEMS

- A. MFMA Manufacturer Metal Framing Systems:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ABB, Electrification Business.
 - b. Flex-Strut Inc.
 - c. G-Strut.
 - d. Haydon Corporation.
 - e. Unistrut; Atkore International.
 2. Description: Shop- or field-fabricated pipe-support assembly, made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
 3. Standard: Comply with MFMA-4, factory-fabricated components for field assembly.
 4. Channels: Continuous slotted carbon-steel channel with inturned lips.
 5. Channel Width: Selected for applicable load criteria.
 6. Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
 7. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
 8. Metallic Coating: Hot-dip galvanized.
- B. Non-MFMA Manufacturer Metal Framing Systems:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International/Smith-Cooper International; Tailwind Capital, LLC.

- b. [CADDY; brand of nVent Electrical plc.](#)
 - c. [Gripple Inc.](#)
 - d. [MIRO Industries.](#)
 - e. [PHD Manufacturing, Inc.](#)
2. Description: Shop- or field-fabricated pipe-support assembly, made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
3. Standard: Comply with MFMA-4, factory-fabricated components for field assembly.
4. Channels: Continuous slotted carbon-steel channel with inturned lips.
5. Channel Width: Select for applicable load criteria.
6. Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
7. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
8. Metallic Coating: Hot-dip galvanized

2.5 THERMAL HANGER-SHIELD INSERTS

- A. [Manufacturers:](#) Subject to compliance with requirements, provide products by one of the following:
 1. [CADDY; brand of nVent Electrical plc.](#)
 2. [Carpenter & Paterson, Inc.](#)
 3. [National Pipe Hanger Corporation.](#)
 4. [Pipe Shields Inc.](#)
 5. [Piping Technology & Products, Inc.](#)
- B. Insulation-Insert Material for Cold Piping: ASTM C552, Type II cellular glass with **100-psig (688-kPa)** or ASTM C591, Type VI, Grade 1 polyisocyanurate with **125-psig (862-kPa)** minimum compressive strength and vapor barrier.
- C. Insulation-Insert Material for Hot Piping: ASTM C552, Type II cellular glass with **100-psig** or ASTM C591, Type VI, Grade 1 polyisocyanurate with **125-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.

2.6 FASTENER SYSTEMS

- A. Mechanical-Expansion Anchors: Insert-wedge-type anchors, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cooper B-line; brand of Eaton, Electrical Sector.
 - b. Empire Tool and Manufacturing Co., Inc.
 - c. Hilti, Inc.
 - d. ITW Ramset/Red Head; Illinois Tool Works, Inc.
 - e. MKT Fastening, LLC.
 - 2. Indoor Applications: Zinc-coated steel.
 - 3. Outdoor Applications: Stainless steel.

2.7 PIPE-POSITIONING SYSTEMS

- A. Description: IAPMO PS 42 positioning system composed of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

2.8 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural-carbon-steel shapes.

2.9 MATERIALS

- A. Aluminum: **ASTM B221** (**ASTM B221M**).
- B. Carbon Steel: ASTM A1011/A1011M.
- C. Structural Steel: ASTM A36/A36M carbon-steel plates, shapes, and bars; black and galvanized.
- D. Stainless Steel: ASTM A240/A240M.
- E. Grout: ASTM C1107/C1107M, 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 APPLICATION

- A. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).

3.2 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. 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 A36/A36M 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. Pipe Stand Installation:
 - 1. Pipe Stand Types, except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
 - 2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 077200 "Roof Accessories" for curbs.

- G. Pipe-Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.
- H. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- I. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- J. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- K. Install lateral bracing with pipe hangers and supports to prevent swaying.
- L. 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.
- M. Load Distribution: Install hangers and supports, so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- N. 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.
- O. 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 (1.91 mm) thick.
 - e. NPS 16 to NPS 24 : 24 inches long and 0.105 inch thick.
5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
 6. Thermal Hanger Shields: Install with insulation of 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: Clean field welds and abraded, shop-painted areas. Paint exposed areas immediately after erecting hangers and supports. Use same materials as those 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.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A780/A780M.

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-58 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 finishes.
- 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 attachments for general service applications.
- F. Use stainless-steel pipe hangers and stainless-steel or corrosion-resistant attachments for hostile environment applications such as crawlspaces, exterior, mechanical rooms and natatoriums.
- 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. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F pipes NPS 4 to NPS 24, requiring up to 4 inches insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36 , with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36 , with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction occurs.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction occurs.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction occurs but vertical adjustment is unnecessary.

20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes **NPS 2 to NPS 24** if small horizontal movement caused by expansion and contraction occurs and vertical adjustment is unnecessary.
 21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes **NPS 2 to NPS 30** if vertical and lateral adjustment during installation, in addition to expansion and contraction, is required.
- 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 of up to **6 inches** for heavy loads.
 2. Steel Clevises (MSS Type 14): For **120 to 450 deg F** piping installations.
 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11 split pipe rings.
 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 5. Steel Weldless Eye Nuts (MSS Type 17): For **120 to 450 deg F** piping installations.
- L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable-Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction, to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.

10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal Hanger-Shield Inserts: For supporting insulated pipe.
- N. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
 4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
 6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
 7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load, and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.

8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- O. Comply with MSS SP-58 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.
- R. Use pipe-positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION 220529

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SECTION 220553 - 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. Valve tags.
 - 5. 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.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brady Corporation.

- b. [Brimar Industries, Inc.](#)
 - c. [Champion America.](#)
 - d. [Craftmark Pipe Markers.](#)
 - e. [Kolbi Pipe Marker Co.](#)
 - f. [Marking Services, Inc.](#)
 - g. [Seton Identification Products; a Brady Corporation company.](#)
 2. Material and Thickness: stainless steel, **0.025-inch** minimum thickness, and having predrilled or stamped holes for attachment hardware.
 3. Letter Color: White.
 4. Background Color: Red.
 5. Minimum Label Size: Length and width vary for required label content, but not less than **2-1/2 by 3/4 inch**.
 6. Minimum Letter Size: **1/4 inch** for name of units if viewing distance is less than **24 inches**, **1/2 inch** for viewing distances up to **72 inches**, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
 7. Fasteners: Stainless-steel rivets or self-tapping screws.
 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Plastic Labels for Equipment:
1. [Manufacturers:](#) Subject to compliance with requirements, provide products by one of the following:
 - a. [Brady Corporation.](#)
 - b. [Brimar Industries, Inc.](#)
 - c. [Champion America.](#)
 - d. [Craftmark Pipe Markers.](#)
 - e. [Kolbi Pipe Marker Co.](#)
 - f. [Marking Services, Inc.](#)
 - g. [Seton Identification Products; a Brady Corporation company.](#)
 2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, **1/8 inch** thick, and having predrilled holes for attachment hardware.
 3. Letter Color: White.
 4. Background Color: Red.
 5. Maximum Temperature: Able to withstand temperatures up to **160 deg F**.
 6. Minimum Label Size: Length and width vary for required label content, but not less than **2-1/2 by 3/4 inch**.
 7. Minimum Letter Size: **1/4 inch** for name of units if viewing distance is less than **24 inches**, **1/2 inch** for viewing distances up to **72 inches**, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
 8. Fasteners: Stainless-steel rivets or self-tapping screws.

- 9. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.
- D. Equipment Label Schedule: For each item of equipment to be labeled, on **8-1/2-by-11-inch (A4)** bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Brady Corporation.
 - 2. Brimar Industries, Inc.
 - 3. Champion America.
 - 4. Craftmark Pipe Markers.
 - 5. Marking Services Inc.
 - 6. Seton Identification Products; a Brady Corporation company.
- B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, **1/8 inch** thick, and having predrilled holes for attachment hardware.
- C. Letter Color: White.
- D. Background Color: Yellow.
- E. Maximum Temperature: Able to withstand temperatures up to **160 deg F.**
- F. Minimum Label Size: Length and width vary for required label content, but not less than **2-1/2 by 3/4 inch.**
- G. Minimum Letter Size: **1/4 inch** for name of units if viewing distance is less than **24 inches**, **1/2 inch** for viewing distances up to **72 inches**, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
- H. Fasteners: Stainless-steel rivets or self-tapping screws.
- I. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

- J. Label Content: Include caution and warning information plus emergency notification instructions.

2.3 PIPE LABELS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.
 - 2. Brady Corporation.
 - 3. Brimar Industries, Inc.
 - 4. Champion America.
 - 5. Craftmark Pipe Markers.
 - 6. Kolbi Pipe Marker Co.
 - 7. Marking Services Inc.
 - 8. Seton Identification Products; a Brady Corporation company.
- B. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- C. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- D. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- E. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: Size letters according to ASME A13.1 for piping At least **1/2 inch (13 mm)** for viewing distances up to **72 inches** and proportionately larger lettering for greater viewing distances.

2.4 VALVE TAGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.
 - 2. Brady Corporation.
 - 3. Brimar Industries, Inc.
 - 4. Champion America.

5. [Craftmark Pipe Markers.](#)
 6. [Kolbi Pipe Marker Co.](#)
 7. [Marking Services Inc.](#)
 8. [Seton Identification Products; a Brady Corporation company.](#)
- B. Valve Tags: Stamped or engraved with **1/4-inch** letters for piping system abbreviation and **1/2-inch** numbers.
1. Tag Material: Brass, **0.032-inch** minimum thickness, and having predrilled or stamped holes for attachment hardware.
 2. Fasteners: Brass wire-link chain or S-hook.
- C. Valve Schedules: For each piping system, on **8-1/2-by-11-inch** bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
1. Valve-tag schedule shall be included in operation and maintenance data.

2.5 WARNING TAGS

- A. [Manufacturers:](#) Subject to compliance with requirements, provide products by one of the following:
1. [Brady Corporation.](#)
 2. [Brimar Industries, Inc.](#)
 3. [Craftmark Pipe Markers.](#)
 4. [Kolbi Pipe Marker Co.](#)
 5. [Marking Services Inc.](#)
 6. [Seton Identification Products; a Brady Corporation company.](#)
 - 7.
- B. Description: Preprinted or partially preprinted accident-prevention tags of plasticized card stock with matte finish suitable for writing.
1. Size: **3 by 5-1/4 inches** minimum.
 2. Fasteners: Brass grommet and wire.
 3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
 4. Color: Safety yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.3 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

- A. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 25 feet along each run. Reduce intervals to 15 feet in areas of congested piping and equipment.
 - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- B. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

- C. Pipe Label Color Schedule:
 - 1. Domestic Water Piping
 - a. Background: Safety green.
 - b. Letter Colors: White.
 - 2. Sanitary Waste and Storm Drainage Piping:
 - a. Background Color: Safety gray.
 - b. Letter Color: Black.

3.5 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
 - 1. Valve-Tag Size and Shape:
 - a. Cold Water: 1-1/2 inches, round.
 - b. Hot Water: 1-1/2 inches, round.
 - 2. Valve-Tag Colors:
 - a. Cold Water: Natural.
 - b. Hot Water: Natural.
 - 3. Letter Colors:
 - a. Cold Water: White.
 - b. Hot Water: White.

3.6 WARNING-TAG INSTALLATION

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

END OF SECTION 220553

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SECTION 220719 - 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. Domestic chilled-water piping for drinking fountains.
 - 5. Sanitary waste piping exposed to freezing conditions.
 - 6. Storm-water piping exposed to freezing conditions.
 - 7. Roof drains and rainwater leaders.
 - 8. Supplies and drains for handicap-accessible lavatories and sinks.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).
- B. 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, equipment connections, and access panels.
 - 6. Detail application of field-applied jackets.
 - 7. Detail application at linkages of control devices.

- C. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:
 - 1. Preformed Pipe Insulation Materials: 12 inches long by NPS 2.
 - 2. Jacket Materials for Pipe: 12 inches long by NPS 2.
 - 3. Sheet Jacket Materials: 12 inches square.
 - 4. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- C. Field quality-control reports.

1.5 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 in accordance with ASTM E84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less and smoke-developed index of 150 or less.
- C. Comply with the following applicable standards and other requirements specified for miscellaneous components:
 - 1. Supply and Drain Protective Shielding Guards: ICC A117.1.

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.
- 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 into contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.

- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable in accordance with ASTM C795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C534/C534M, Type I for tubular materials.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Aeroflex USA.
 - b. Armacell LLC.
 - c. K-Flex USA.
- G. Mineral-Fiber, Preformed Pipe: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C547.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Johns Manville; a Berkshire Hathaway company.
 - b. Knauf Insulation.
 - c. Manson Insulation Inc.
 - d. Owens Corning.
 - 2. Preformed Pipe Insulation: Type I, Grade A with factory-applied ASJ.
 - 3. 850 deg F.
 - 4. Factory fabricate shapes in accordance with ASTM C450 and ASTM C585.
 - 5. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 INSULATING CEMENTS

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C195.
 - 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. Ramco Insulation, Inc.
- B. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C449.
 - 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. Ramco Insulation, Inc.

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. Flexible Elastomeric Adhesive: Solvent-based adhesive.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Aeroflex USA.
 - b. Armacell LLC.
 - c. Foster Brand; H. B. Fuller Construction Products.
 - d. K-Flex USA.
 - 2. Flame-spread index shall be 25 or less and smoke-developed index shall be 50 or less as tested in accordance with ASTM E84.
 - 3. Wet Flash Point: Below 0 deg F.
 - 4. Service Temperature Range: 40 to 200 deg F.
 - 5. Color: Black.
- C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
- D. ASJ Adhesive and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A, for bonding insulation jacket lap seams and joints.
- E. PVC Jacket Adhesive: Compatible with PVC jacket.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Johns Manville; a Berkshire Hathaway company.
 - b. P.I.C. Plastics, Inc.
 - c. Proto Corporation.
 - d. Speedline Corporation.

2.4 MASTICS AND COATINGS

- A. Materials shall be compatible with insulation materials, jackets, and substrates.
- B. Vapor-Retarder Mastic, Water Based: Suitable for indoor use on below-ambient services.
 - 1. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
 - 2. Service Temperature Range: 0 to plus 180 deg F.
 - 3. Comply with MIL-PRF-19565C, Type II, for permeance requirements.
 - 4. Color: White.

- C. Vapor-Retarder Mastic, Solvent Based, Outdoor Use: Suitable for outdoor use on below-ambient services.
 - 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. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller Construction Products.
 - 2. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
 - 3. Service Temperature Range: Minus 50 to plus 220 deg F.
 - 4. Color: White.
 - 5. Service Temperature Range: Minus 20 to plus 180 deg F.
 - 6. Color: White.

2.5 LAGGING ADHESIVES

- A. Adhesives shall comply with MIL-A-3316C, Class I, Grade A, and shall be compatible with insulation materials, jackets, and substrates.
 - 1. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
 - 2. Service Temperature Range: 0 to plus 180 deg F.
 - 3. Color: White.

2.6 SEALANTS

- A. Materials shall be as recommended by the insulation manufacturer and shall be compatible with insulation materials, jackets, and substrates.
- B. Joint Sealants:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller Construction Products.
 - c. Mon-Eco Industries, Inc.
 - d. Owens Corning.
 - 2. Permanently flexible, elastomeric sealant.
 - 3. Service Temperature Range: Minus 100 to plus 300 deg F.
 - 4. Color: White or gray.
- C. ASJ Flashing Sealants and PVC Jacket Flashing Sealants:
 - 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. [Childers Brand; H. B. Fuller Construction Products.](#)
- b. [Foster Brand; H. B. Fuller Construction Products.](#)
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: White.

2.7 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
 1. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
 2. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.
- B. Woven Glass-Fiber Fabric: Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in. for covering pipe and pipe 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. [Childers Brand; H. B. Fuller Construction Products.](#)

2.8 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C1136, 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 D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
 1. [Manufacturers:](#) Subject to compliance with requirements, provide products by one of the following:
 - a. [Johns Manville; a Berkshire Hathaway company.](#)
 - b. [P.I.C. Plastics, Inc.](#)
 - c. [Proto Corporation.](#)
 - d. [Speedline Corporation.](#)
 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.
- D. Underground Direct-Buried Jacket: 125-mil- thick vapor barrier and waterproofing membrane, consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.
 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. Owens Corning.
 - b. Polyguard Products, Inc.
- E. Self-Adhesive Outdoor Jacket: 60-mil- thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a cross-laminated polyethylene film covered with white stucco-embossed aluminum-foil facing.
 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. MFM Building Products Corp.
 - b. Polyguard Products, Inc.

2.9 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. 3M Industrial Adhesives and Tapes Division.
 - b. Avery Dennison Corporation, Specialty Tapes Division.
 - c. Ideal Tape Co., Inc., an American Biltrite Company.
 - d. Knauf Insulation.
 2. Width: 3 inches.
 3. Thickness: 11.5 mils.
 4. Adhesion: 90 ounces force/inch in width.
 5. Elongation: 2 percent.
 6. Tensile Strength: 40 lbf/inch in width.
 7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

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. 3M Industrial Adhesives and Tapes Division.
 - b. Ideal Tape Co., Inc., an American Biltrite Company.
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.

2.10 SECUREMENTS

- A. Bands:
 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. Johns Manville; a Berkshire Hathaway company.
 - b. RPR Products, Inc.
 2. Aluminum: ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal or closed seal.
- B. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

2.11 PROTECTIVE SHIELDING GUARDS

- A. Protective Shielding Pipe Covers,:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Buckaroos, Inc.
 - b. McGuire Manufacturing.
 - c. Truebro; IPS Corporation.
 - d. Zurn Industries, LLC.
 2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.
- B. Protective Shielding Piping Enclosures,:
 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. [Truebro; IPS Corporation.](#)
 - b. [Zurn Industries, LLC.](#)
2. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

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. Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. 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 of 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 of 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 tradesman 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.

3.3 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 of 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 storage, application, and finishing. Replace insulation materials that get wet.
- 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 attached to structure with vapor-barrier mastic.
 - 3. Install insert materials and 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 4 inches o.c.
 - a. For below-ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape, in accordance with 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 25 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 in similar fashion 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. Cleanouts.

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 - 4. Seal jacket to roof flashing with flashing sealant.

- B. Insulation Installation at 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."

3.5 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, Mechanical Couplings, and Unions:
 - 1. Install insulation over fittings, valves, strainers, flanges, mechanical couplings, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
 - 2. Insulate pipe elbows using preformed fitting insulation made from same material and density as that of 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 of same material and thickness as that 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 of same material, density, and thickness as that used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 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 of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 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, mechanical couplings, and unions, using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Stencil or label the outside insulation jacket of each union with the word "union" matching size and color of pipe labels.
 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.
- 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 that of adjoining pipe insulation.

2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least 2 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.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- 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 that of 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 that of 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.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. 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, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as that of 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 that of 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 FIELD-APPLIED JACKET INSTALLATION

- A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints. 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.

3.9 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. 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.

3.10 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.

3.11 INDOOR PIPING INSULATION SCHEDULE

- A. Domestic Cold Water:
 - 1. NPS 1 and Smaller: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.
 - 2. NPS 1-1/4 and Larger: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
- B. Domestic Hot and Recirculated Hot Water:
 - 1. NPS 1 and Smaller: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
 - 2. NPS 1-1/4 and Larger: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1-1/2 inches thick.
- C. Stormwater and Overflow:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
- D. Roof Drain and Overflow Drain Bodies:
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Flexible Elastomeric: 1 inch thick.
 - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
- E. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.
- F. Sanitary Waste Piping Where Heat Tracing Is Installed:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1-1/2 inches thick.
- G. Floor Drains, Traps, and Sanitary Drain Piping within 10 Feet of Drain Receiving Condensate and Equipment Drain Water below 60 Deg F:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.

3.12 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

- A. Domestic Water Piping:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.

- B. Domestic Hot and Recirculated Hot Water:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.
- C. Sanitary Waste Piping Where Heat Tracing Is Installed:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.

3.13 OUTDOOR, UNDERGROUND PIPING INSULATION SCHEDULE

- A. Sanitary Waste Piping, All Sizes, Where Heat Tracing Is Installed: Cellular glass, 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: 30 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: 40 mils thick.
 - 2. Self-Adhesive Outdoor Jacket: 60-mil- thick, rubberized bituminous resin on a cross-laminated polyethylene film covered with white stucco-embossed aluminum-foil facing

3.16 UNDERGROUND, FIELD-APPLIED INSULATION JACKET

- A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

END OF SECTION 220719

SECTION 220800 - COMMISSIONING OF PLUMBING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. The requirements of this section are supplementary to the General Commissioning Requirements for the project and do not negate or supersede the commissioning requirements specified elsewhere.
- B. This section defines the commissioning responsibilities of the Division 22 Contractor and all other subcontractors or factory-authorized service representatives responsible for the systems to be commissioned. The responsibilities of other parties, including the Commissioning Agent (CxA), Owner, and Design Team (A/E) are referenced for clarification purposes only.
- C. This section includes additional commissioning process requirements for the following plumbing systems, assemblies and equipment. This list of Systems to be Commissioned may be modified as described in 019113 "General Commissioning Requirements." The final list of Systems to be Commissioned will be included in the Commissioning Plan provided by the CxA.
 - 1. Domestic Water Heaters.
 - 2. Domestic Recirculation Pumps.
 - 3. Thermostatic Mixing Valves.
 - 4. Balancing Valves.
 - 5. Electronic Faucets.
 - 6. Electronic Flushometers.
 - 7. Submersible Pumps.
- D. Related Requirements:
 - 1. Section 019113 "General Commissioning Requirements" describes the overall commissioning process and responsibilities for which this contract is responsible.
- E. Abbreviations: The following are common abbreviations used in the Specifications. For additional definitions refer to Section 019113.
 - 1. A/E: Architects and Engineers
 - 2. Cx: Commissioning
 - 3. CxA: Commissioning Authority
 - 4. Cx Plan: Commissioning Plan Document

- 5. FT: Functional Performance Test
- 6. PFI: Pre-Functional Inspection
- 7. TAB: Test and Balance Contractor

1.2 INFORMATIONAL SUBMITTALS

A. Prefunctional Checklists

- 1. Submit according to the procedures defined in the Commissioning Plan and as agreed at the commissioning scoping meeting.

B. Startup and Manufacturer Test Reports

- 1. Obtain copies of all startup reports as well as any test reports prepared by factory authorized service representatives as required by the specification section for each commissioned system. Promptly provide copies of reports to the CxA, as requested.

C. Requests for Clarification

- 1. The CxA may request supplemental written clarification for items which are not clearly indicated in equipment submittal documentation. Where such requests are made, the contractor shall provide written responses to the CxA within 5 business days. Examples of such requests may include, but are not limited to, clarification of equipment operating sequences, performance data, startup requirements, selected options or accessories, etc.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 MEETINGS

- A. Attend commissioning meetings as described in the General Commissioning Requirements.
- B. Commissioning meetings may be scheduled separately from regular construction progress meetings, at the discretion of the construction manager or owner's representative and CxA.

3.2 COORDINATION AND SCHEDULING

- A. The contractor shall coordinate schedule for prefunctional checklists and equipment startup with CxA.
- B. CxA shall review and approve prefunctional checklists and equipment startup reports prior to scheduling functional testing.

3.3 PREFUNCTIONAL CHECKLISTS

- A. Blank copies of the required checklists will be provided by the CxA for use by the contractor.
- B. Completed copies of checklists shall be submitted to the CxA according to the procedures defined in the Commissioning Plan and as agreed at the commissioning scoping meeting.
- C. Where checklists require sign-off by multiple parties (e.g. checking of electrical connections by the contractor on equipment provided by the contractor) each party shall complete their respective portions of the checklist and shall organize all documentation into a single, comprehensive checklist record. Responsible parties shall be indicated by the CxA on each checklist.
- D. The contractor shall submit any requests for direction on completion of checklists in writing to the construction manager or owner's representative and CxA.

3.4 FUNCTIONAL PERFORMANCE TESTING

- A. The objective of functional performance testing is to demonstrate that each commissioned system is installed and operating in accordance with the documented design intent. Functional testing shall commence only after all prefunctional inspections, manufacturer testing and startup activities are complete.
- B. The detailed functional testing requirements for each commissioned system will be established in the Commissioning Plan and the Functional Testing Procedures to be developed by the CxA.
- C. Before test procedures are written, the CxA shall obtain all requested documentation related to the intended functional performance of the commissioned systems. This includes submittal documentation, change orders, requests for information, design clarifications, and updated controls system programming information (points lists, control sequences, etc).

- D. The contractor shall provide assistance to the CxA by reviewing the procedures and responding to questions and concerns posed by the CxA.
- E. General testing requirements:
 - 1. Certify that plumbing systems, subsystems, and equipment have been installed, calibrated, and started and are operating in accordance with the Contract Documents and approved Shop Drawings and submittals.
 - 2. Certify that plumbing instrumentation and control systems have been completed and calibrated, that they are operating in accordance with the Contract Documents and approved Shop Drawings and submittals, and that pretest set points have been recorded.
 - 3. Set systems, subsystems, and equipment into operating mode to be tested in accordance with approved test procedures (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
 - 4. Measure capacities and effectiveness of systems, assemblies, subsystems, equipment, and components, including operational and control functions to verify compliance with acceptance criteria.
 - 5. Test systems, assemblies, subsystems, equipment, and components operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and response in accordance with commissioning and acceptance test criteria.

3.5 SEASONAL TESTING

- A. Where seasonal tests are specified, scheduled, or otherwise required by the CxA, the contractor shall provide qualified personnel to assist with execution of tests. Where required, the contractor shall also secure the services of factory-authorized personnel who are fully capable of executing the required tests.

3.6 MANUFACTURER'S FIELD SERVICE

- A. Where required in these specifications, the contractor shall retain the services of a factory-authorized representative, vendor's representative, or third-party testing service to carry out equipment startup and testing services (hereby referred to as "Manufacturer's Field Service").
- B. The contractor shall ensure that the contract for Manufacturer's Field Service contains sufficient time, in addition to normal startup activities, for the representative to assist the commissioning team in completing functional performance tests. The scope and

schedule of testing will be directed by the CxA. This requirement applies to service contracts for each of the commissioned system identified in these specifications.

- C. It shall be the responsibility of the Contractor to specifically request and secure all Manufacturer's Field Services necessary for the startup and commissioning activities specified in the contract documents. Where the standard Manufacturer's Field Service proposed by a vendor or third party service representative may otherwise be insufficient, the necessary services shall be secured during the equipment procurement process.
- D. Following correction of deficiencies, the contractor shall arrange for Manufacturer's Field Service required to re-test previously deficient systems, as directed by the CxA.

3.7 DEFICIENCIES, NON-CONFORMANCE AND APPROVAL OF TESTS

- A. The contractor shall be responsible for responding and addressing deficiencies or items of non-conformance related to the system.
- B. Where deficiencies are identified during the commissioning process, the contractor shall issue a written response.
- C. Deficiencies shall be corrected in a timely manner. Once corrections are made, notify the CxA that the system(s) are ready for re-inspection and/or re-testing.
- D. Items which are not corrected, require multiple inspections by the CxA to resolve, or which result in scheduling delays may result in back charges to the responsible party. Refer to the section entitled "Documentation, Non-Conformance and Approval of Tests" in section 019113 for additional information on deficiency resolution.
- E. Upon successful completion of testing for each system, the CxA will document the results of testing in the functional testing record. A copy of the test record shall be included in the commissioning documentation to be provided to the Owner upon completion of commissioning.

3.8 OWNER TRAINING

- A. Training shall be provided by the contractor in coordination with the Owner, construction manager or owner's representative and CxA. Adequacy of training shall be verified by the CxA, though the CxA may opt not attend all portions of training. For detailed training requirements, refer to section 019113 "General Commissioning Requirements" as well as the requirements contained within the individual equipment specifications.

3.9 PERSONNEL

- A. Provide qualified technicians, instrumentation, tools and equipment during the startup, functional testing, and seasonal testing of the commissioned systems. Ensure the availability of at least one individual on site during commissioning tests.

END OF SECTION 220800

SECTION 221116 - 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. Copper tube and fittings.
 - 2. Piping joining materials.
 - 3. Dielectric fittings.

1.3 ACTION SUBMITTALS

- A. Product Data:
 - 1. Pipe and tube.
 - 2. Fittings.
 - 3. Joining materials.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Piping layout, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.
- B. System purging and disinfecting activities report.
- C. 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 or Owner's Representative and Owner no fewer than 7 days in advance of proposed interruption of water service.
2. Do not interrupt water service without Construction Manager's or Owners Representative's and Owner's written permission.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Potable-water piping and components shall comply with NSF 14, NSF 61, and NSF 372. Include marking "NSF-pw" on piping.

2.2 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tube: ASTM B88, Type L.
- B. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.
- C. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, pressure fittings.
- D. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
- E. Cast Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.
- F. Wrought Copper Unions: ASME B16.22.
- G. Grooved, Mechanical-Joint, Copper Tube Appurtenances:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Grinnell G-Fire by Johnson Controls Company.
 - b. Shurjoint-Apollo Piping Products USA Inc.
 - c. Victaulic Company.
 2. Grooved-End, Copper Fittings: ASTM B75 copper tube or ASTM B584 bronze castings.
 3. Grooved-End-Tube Couplings: To fit copper-tube dimensions; rigid pattern unless otherwise indicated; gasketed fitting, EPDM-rubber gasket, UL classified per NSF 61 and NSF 372, and rated for minimum 180 deg F, for use with ferrous housing and steel bolts and nuts; 300 psig minimum CWP pressure rating.
- H. Copper Tube, Pressure-Seal-Joint Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - b. Elkhart Products Corporation.
 - c. NIBCO INC.
 - d. Viega LLC.
2. Fittings: Cast-brass, cast-bronze, or wrought-copper with EPDM O-ring seal in each end.
3. Minimum 200-psig working-pressure rating at 250 deg F.

2.3 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 B32, lead-free alloys.
- D. Flux: ASTM B813, water flushable.

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, provide products by one of the following:
 - a. A.Y. McDonald Mfg. Co.
 - b. Capitol Manufacturing Company.
 - c. HART Industrial Unions, LLC.
 - d. Jomar Valve.
 - e. WATTS.
 - f. Zurn Industries, LLC.
 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.
 - b. Matco-Norca.
 - c. WATTS.
 - d. Zurn Industries, LLC.
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 G-Fire by Johnson Controls Company.
 - c. Precision Plumbing Products.
 - d. Sioux Chief Manufacturing Company, Inc.
 - e. Victaulic Company.
2. Standard: IAPMO PS 66.
3. Electroplated steel nipple complying with ASTM F1545.
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 APPLICATIONS

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
- B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
- C. Aboveground domestic water piping,, shall be one of the following:
 - 1. Drawn-temper copper tube, ASTM B88, Type L; wrought-copper, solder-joint fittings; and soldered joints.
 - 2. Drawn-temper copper tube, ASTM B88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.

3.2 INSTALLATION OF PIPING

- 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 water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Section 221119 "Domestic Water Piping Specialties."
- C. Install domestic water piping level with 0.25 percent slope downward toward drain and plumb.
- D. Rough-in domestic water piping for water-meter installation according to utility company's requirements.
- E. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- F. 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.
- G. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

- H. Install piping to permit valve servicing.
- I. 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.
- J. Install piping free of sags and bends.
- K. Install fittings for changes in direction and branch connections.
- L. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- M. Install pressure gauges on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gauges in Section 220519 "Meters and Gages for Plumbing Piping."
- N. Install thermostats in hot-water circulation piping.
- O. Install thermometers on inlet and outlet piping from each water heater.
- P. Install sleeves for piping penetrations of walls, ceilings, and floors. Retain first paragraph below for piping that penetrates an exterior concrete wall or concrete slab.
- Q. Install sleeve seals for piping penetrations of concrete walls and slabs.
- R. Install escutcheons for piping penetrations of walls, ceilings, and floors

3.3 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

- D. Soldered Joints for Copper Tubing: Apply ASTM B813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B828 or CDA's "Copper Tube Handbook."
- E. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools and procedure recommended by pressure-seal-fitting manufacturer. Leave insertion marks on pipe after assembly.
- F. 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.
- G. 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.
- H. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.4 INSTALLATION OF DIELECTRIC FITTINGS

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flange kits.

3.5 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with requirements for hangers, supports, and anchor devices in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
- B. Install hangers for copper tubing, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- C. Support horizontal piping within 12 inches of each fitting.
- D. Support vertical runs of copper tubing to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

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 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."

3.8 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.

3.9 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Piping Inspections:

- a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
- b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
 - 1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
 - 2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
- c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
- d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

2. Piping Tests:

- a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
- b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
- c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
- d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
- e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
- f. Prepare reports for tests and for corrective action required.

- B. Domestic water piping will be considered defective if it does not pass tests and inspections.

- C. Prepare test and inspection reports.

3.10 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.

END OF SECTION 221116

SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Balancing valves.
2. Temperature-actuated, water mixing valves.
3. Strainers for domestic water piping.
4. Outlet boxes.
5. Hose bibbs.
6. Wall hydrants.
7. Drain valves.
8. Water-hammer arresters.
9. Trap-seal primer device.
10. Flexible connectors.

1.2 DEFINITIONS

- A. AMI: Advanced Metering Infrastructure.
- B. AMR: Automatic Meter Reading.
- C. FKM: A family of fluoroelastomer materials defined by ASTM D1418.

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. Test and inspection reports.
- B. 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. Domestic water piping specialties intended to convey or dispense water for human consumption are to comply with the SDWA, requirements of authorities having jurisdiction, and NSF 61 and NSF 372, or to be certified in compliance with NSF 61 and NSF 372 by an American National Standards Institute (ANSI)-accredited third-party certification body that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

2.2 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure for Domestic Water Piping Specialties: **125 psig** unless otherwise indicated.

2.3 VACUUM BREAKERS

- A. Hose-Connection Vacuum Breakers:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - b. MIFAB, Inc.
 - c. WATTS.
 - d. Zurn Industries, LLC.
 - 2. Standard: ASSE 1011.
 - 3. Body: Bronze, nonremovable, with manual drain.
 - 4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
 - 5. Finish: Chrome or nickel plated.

2.4 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - b. WATTS.
 - c. Zurn Industries, LLC.
2. Standard: ASSE 1013.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 12 psig maximum, through middle third of flow range.
5. Body: Bronze or stainless steel
6. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
7. Accessories:
 - a. Valves NPS 2 (DN 50) and Smaller: Ball type with threaded ends on inlet and outlet.
 - b. Valves NPS 2-1/2 (DN 65) 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.

2.5 BALANCING VALVES

A. Memory-Stop Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - b. Crane; a Crane Co. brand.
 - c. Hammond Valve.
 - d. Milwaukee Valve Company.
 - e. NIBCO INC.
2. Standard: MSS SP-110 for two-piece, copper-alloy ball valves.
3. Pressure Rating: 400-psig minimum CWP.
4. Size: NPS 2 or smaller.
5. Body: Copper alloy.
6. Port: Standard or full port.

7. Ball: Chrome-plated brass or stainless steel.
8. Seats and Seals: Replaceable.
9. End Connections: Solder joint or threaded.
10. Handle: Vinyl-covered steel with memory-setting device.

B. Thermostatic Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Caleffi North America.
 - b. Circuit Solver.
 - c. Danfoss.
2. Flow Regulation: Fully automatic regulate flow based on water temperature. Bypass minimum flow when valve is fully closed.
 - a. Valves to be selected at domestic hot water temperature setpoint.
3. Pressure Rating: **200 psig.**
4. Size: **NPS 2** or smaller.
5. Body: Stainless steel or brass.
6. Flow Cartridge: Stainless steel or antiscaling polymer.
7. End Connections: Threaded or solder joint.

2.6 TEMPERATURE-ACTUATED, WATER MIXING VALVES

A. Water-Temperature Limiting Devices:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Engineering Company; a Division of Morris Group International.
 - b. Leonard Valve Company.
 - c. POWERS; A WATTS Brand.
 - d. Symmons Industries, Inc.
 - e. Zurn Industries, LLC.
2. Standard: ASSE 1070.
3. Pressure Rating: **125 psig.**
4. Type: Thermostatically controlled, water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Threaded union inlets and outlet.
7. Accessories: Check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.

8. Tempered-Water Setting: 110 deg F.
9. Tempered-Water Design Flow Rate: 0.5-1.5 gpm (0.03-0.09 L/s).
10. Valve Finish: Chrome plated or Rough bronze.

B. Primary, Thermostatic, Water Mixing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Bradley.
 - b. Lawler Manufacturing Co.
 - c. Leonard Valve Company.
 - d. POWERS; A WATTS Brand.
2. Standard: ASSE 1017.
3. Pressure Rating: 125 psig (860 kPa) minimum unless otherwise indicated.
4. Type: Frame mounted], thermostatically controlled, water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Threaded union inlets and outlet.
7. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.

C. Individual-Fixture, Water Tempering Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Engineering Company; a Division of Morris Group International.
 - b. Lawler Manufacturing Company, Inc.
 - c. Leonard Valve Company.
 - d. POWERS; A WATTS Brand.
 - e. Zurn Industries, LLC.
2. Standard: ASSE 1016, thermostatically controlled, water tempering valve.
3. Pressure Rating: 125 psig minimum unless otherwise indicated.
4. Material: Bronze body with corrosion-resistant interior components.
5. Temperature Control: Adjustable.
6. Connections: Threaded inlets and outlet.
7. Finish: Chrome plated.
8. Tempered-Water Setting: 110 deg F (43 deg C).
9. Tempered-Water Design Flow Rate: Insert 0.5-1.5 gpm (0.03-0.09 L/s).

2.7 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Metraflex.
 - b. Nibco.
 - c. Titan Flow Control, Inc.
 - d. WATTS.
 - e. Zurn Industries, LLC.
2. Pressure Rating: 125 psig minimum unless otherwise indicated.
3. 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.
4. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
5. Screen: Stainless steel with round perforations unless otherwise indicated.
6. 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.
7. Drain: Factory-installed, hose-end drain valve.

2.8 OUTLET BOXES

A. Clothes Washer Outlet Boxes:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. HoldRite.
 - b. Mainline.
 - c. Oatey.
 - d. Sioux Chief.
2. Mounting: Recessed. Fire rated.
3. Material and Finish: Enameled-steel or epoxy-painted-steel box and faceplate.

4. Faucet: Combination valved fitting or separate hot- and cold-water valved fittings complying with ASME A112.18.1. Include garden-hose thread complying with ASME B1.20.7 on outlets.
5. Drain Outlet Connection: **NPS 2**.
6. Accessory: Water hammer arresters.
7. Supply Shutoff Fittings: **NPS 3/4** ball valves and **NPS 3/4** copper, water tubing.
8. Drain: **NPS 2** standpipe and P-trap for direct waste connection to drainage piping.
9. Inlet Hoses: Two **60-inch- (1500-mm-)** long, rubber, household clothes washer inlet hoses with female, garden-hose-thread couplings. Include rubber washers.
10. Drain Hose: One **48-inch- (1200-mm-)** long, rubber, household clothes washer drain hose with hooked end.

2.9 HOSE BIBBS

A. Hose Bibbs:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jay R. Smith Mfg Co; a division of Morris Group International.
 - b. MIFAB, Inc.
 - c. Prier Products, Inc.
 - d. WATTS.
 - e. Zurn Industries, LLC.
2. Standard: ASME A112.18.1 for sediment faucets.
3. Body Material: Bronze.
4. Seat: Bronze, replaceable.
5. Supply Connections: **NPS 1/2 or NPS 3/4** threaded or solder-joint inlet.
6. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
7. Pressure Rating: **125 psig**
8. Vacuum Breaker: Integral nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
9. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
10. Finish for Service Areas: Rough bronze.
11. Finish for Finished Rooms: Chrome or nickel plated.
12. Operation for Equipment Rooms: Wheel handle or operating key.
13. Operation for Service Areas: Wheel handle.
14. Operation for Finished Rooms: Operating key.
15. Include operating key with each operating-key hose bibb.
16. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.10 WALL HYDRANTS

A. Nonfreeze Wall Hydrants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jay R. Smith Mfg Co; a division of Morris Group International.
 - b. Josam Company.
 - c. MIFAB, Inc.
 - d. WATTS.
 - e. Zurn Industries, LLC.
2. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.
3. Pressure Rating: **125 psig.**
4. Operation: Loose key.
5. Casing and Operating 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:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jay R. Smith Mfg Co; a division of Morris Group International.
 - b. MIFAB, Inc.
 - c. WATTS.
 - d. Zurn Industries, LLC.
2. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.
3. Pressure Rating: **125 psig.**
4. Operation: Loose key.
5. Inlet: **NPS 3/4 or NPS 1.**
6. Outlet, Concealed:

- a. 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. Outlet, Exposed:
 - a. 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.
10. Nozzle and Wall-Plate Finish: Polished nickel bronze.
11. Operating Key(s): One with each wall hydrant.

2.11 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.

2.12 WATER-HAMMER ARRESTERS

A. Water-Hammer Arresters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AMTROL, Inc.
 - b. Jay R. Smith Mfg Co; a division of Morris Group International.
 - c. Precision Plumbing Products.

- d. [Sioux Chief Manufacturing Company, Inc.](#)
 - e. [WATTS.](#)
 - f. [Zurn Industries, LLC.](#)
- 2. Standard: ASSE 1010 or PDI-WH 201.
 - 3. Type: Piston.
 - 4. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

2.13 FLEXIBLE CONNECTORS

- A. [Manufacturers:](#) Subject to compliance with requirements, provide products by one of the following:
 - 1. [Flex-Hose Co., Inc.](#)
 - 2. [Mason Industries, Inc.](#)
 - 3. [Metraflex Company \(The\).](#)
- B. Stainless Steel-Hose Flexible Connectors: Corrugated-stainless steel tubing with stainless steel wire-braid covering and ends welded to inner tubing.
 - 1. Working-Pressure Rating: Minimum **200 psig** .
 - 2. End Connections **NPS 2** and Smaller: Threaded steel-pipe nipple.
 - 3. End Connections **NPS 2-1/2** and Larger: Flanged steel nipple.

PART 3 - EXECUTION

3.1 INSTALLATION OF PIPING SPECIALTIES

- A. Backflow Preventers: Install 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. Balancing Valves: Install in locations where they can easily be adjusted. Set at indicated design flow rates.

- C. Temperature-Actuated, Water Mixing Valves: Install with check stops or shutoff valves on inlets and with shutoff valve on outlet.
 - 1. Install cabinet-type units recessed in or surface mounted on wall as specified.
- D. Y-Pattern Strainers: For water, install on supply side of each control valve water pressure-reducing valve solenoid valve and pump.
- E. Outlet Boxes: Install boxes recessed in wall or surface mounted on wall. Install **1-1/2-by-3-1/2-inch (38-by-89-mm)** fire-retardant-treated-wood blocking, wall reinforcement between studs.
- F. Nonfreeze, Draining-Type Post Hydrants: Install with **1 cu. yd.** of crushed gravel around drain hole. Set post hydrants in concrete paving or in **1 cu. ft.** of concrete block at grade.
- G. Nonfreeze, Nondraining-Type Post Hydrants: Set in concrete or pavement.
- H. Nonfreeze, Sanitary Yard Hydrants: Set with riser pipe in concrete or pavement. Do not encase canister in concrete.
- I. Nonfreeze, Draining-Type Roof Hydrants: Install with drain connection piped to nearest floor drain or to the exterior.
- J. Water-Hammer Arresters: Install in water piping in accordance with PDI-WH 201.
- K. Supply-Type, Trap-Seal Primer Device: Install with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.
- L. Drainage-Type, Trap-Seal Primer Device: Install as lavatory trap with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.

3.2 PIPING CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. When installing piping specialties adjacent to equipment and machines, allow space for service and maintenance.

3.3 ELECTRICAL CONNECTIONS

- A. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

3.4 IDENTIFICATION

- A. Plastic Labels for Equipment: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
 - 1. Backflow preventers.
 - 2. Balancing valves.
 - 3. Temperature-actuated, water mixing valves.
 - 4. Outlet boxes.
 - 5. Wall hydrants.
 - 6. Ground hydrants.
 - 7. Post hydrants.
 - 8. Roof hydrants.
- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit.

3.5 ADJUSTING

- A. Set field-adjustable pressure set points of water pressure-reducing valves.
- B. Set field-adjustable flow set points of balancing valves.
- C. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.
- D. Adjust each pressure vacuum breaker reduced-pressure-principle backflow preventer double-check, backflow-prevention assembly in accordance with manufacturer's written instructions, authorities having jurisdiction and the device's reference standard.

3.6 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative.

1. Test each pressure vacuum breaker reduced-pressure-principle backflow preventer double-check, backflow-prevention assembly according to authorities having jurisdiction and the device's reference standard.
 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 3. Operational Test: After electrical circuitry has been energized, start units to confirm unit operation.
 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

END OF SECTION 221119

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SECTION 231123 - 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. Manual gas shutoff valves.
 - 5. Motorized gas valves.
 - 6. Pressure regulators.
 - 7. Dielectric fittings.

1.3 DEFINITIONS

- A. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. 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.

1.4 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.
 2. Detail mounting, supports, and valve arrangements for service meter assembly and pressure regulator assembly.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans and details, drawn to scale, on which natural-gas piping is shown and coordinated with other installations, using input from installers of the items involved.
- B. Site Survey: Plans, drawn to scale, on which natural-gas piping is shown and coordinated with other services and utilities.
- C. Qualification Data: For qualified professional engineer.
- D. Welding certificates.
- E. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For motorized gas valves pressure regulators and service meters to include in emergency, operation, and maintenance manuals.

1.7 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.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.
- B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.
- D. Protect stored PE pipes and valves from direct sunlight.

1.9 PROJECT CONDITIONS

- A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.
- B. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide purging and startup of natural-gas supply according to requirements indicated:
 - 1. Notify Architect Construction Manager and Owner no fewer than two days in advance of proposed interruption of natural-gas service.
 - 2. Do not proceed with interruption of natural-gas service without Construction Manager's written permission.

1.10 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.
- B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Section 083113 "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Minimum Operating-Pressure Ratings:
 - 1. Piping and Valves: 100 psig minimum unless otherwise indicated.
 - 2. Service Regulators: 100 psig minimum unless otherwise indicated.
 - 3. Minimum Operating Pressure of Service Meter: 10 psig.
- B. Natural-Gas System Pressure within Buildings: 0.5 psig or less.
- C. Natural-Gas System Pressures within Buildings: Two pressure ranges. Primary pressure is more than 0.5 psig but not more than 2 psig, and is reduced to secondary pressure of 0.5 psig or less.

2.2 PIPES, TUBES, AND FITTINGS

- A. Steel Pipe: ASTM A53/A53M, 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 A234/A234M 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.
- 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. FlashShield Products; Gastite, a division of Titeflex Corp.
 - b. TracPipe CounterStrike; Omega Flex, Inc.
 - c. Tru-Flex Metal Hose Corp.
 - d. Ward Manufacturing LLC.
2. Tubing: ASTM A240/A240M, corrugated, Series 300 stainless steel.
3. Coating: PE with flame retardant.
 - a. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E84 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.

2.3 PIPING SPECIALTIES

A. Appliance Flexible Connectors:

1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
4. Corrugated stainless-steel tubing with polymer coating.
5. Operating-Pressure Rating: 0.5 psig.
6. End Fittings: Zinc-coated steel.
7. Threaded Ends: Comply with ASME B1.20.1.
8. Maximum Length: 72 inches

B. Y-Pattern Strainers:

1. Body: ASTM A126, 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.
- C. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.4 JOINING MATERIALS

- A. Joint Compound and Tape: Suitable for natural gas.
- B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.5 MANUAL GAS SHUTOFF VALVES

- A. See "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.
- B. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.
1. CWP Rating: 125 psig.
 2. Threaded Ends: Comply with ASME B1.20.1.
 3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
 4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
 6. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.
- C. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.
1. CWP Rating: 125 psig.
 2. Flanged Ends: Comply with ASME B16.5 for steel flanges.

3. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 4. Service Mark: Initials "WOG" shall be permanently marked on valve body.
- D. 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. A.Y. McDonald Mfg. Co.
 - b. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - c. BrassCraft Manufacturing Co.; a Masco company.
 - d. R.W. Lyall; brand of Hubbell Utility Solutions; Hubbell Incorporated.
 2. Body: Bronze, complying with ASTM B584.
 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 "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 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.
- E. Cast-Iron, Lubricated Plug Valves: MSS SP-78.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. A.Y. McDonald Mfg. Co.
 - b. Homestead Valve; a division of Olson Technologies, Inc.
 - c. Milliken Valve Company; a Mueller brand.
 - d. Mueller Co. LLC; Mueller Water Products, Inc.
 - e. R & M Energy Systems; Robbins & Myers.
 2. Body: Cast iron, complying with ASTM A126, 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 "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.

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. Valve Boxes:

1. Cast-iron, two-section box.
2. Top section with cover with "GAS" lettering.
3. Bottom section with base to fit over valve and barrel a minimum of 5 inches in diameter.
4. Adjustable cast-iron extensions of length required for depth of bury.
5. Include tee-handle, steel operating wrench with socket end fitting valve nut or flat head, and with stem of length required to operate valve.

2.6 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. American Gas Safety.
 - b. Eaton.
 - c. Honeywell Building Solutions; Honeywell International, Inc.
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. Pilot operated.
2. Body: Brass or aluminum.
3. Seats and Disc: Nitrile rubber.
4. Springs and Valve Trim: Stainless steel.
5. 120-V ac, 60 Hz, Class B, continuous-duty molded coil, and replaceable.
6. NEMA ICS 6, Type 4, coil enclosure.
7. Normally closed.
8. Visual position indicator.

2.7 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: a brand of ITT Controls.
 - b. American Meter Company.
 - c. Fischer; Emerson Electric Co., Automation Solutions.
 - d. Richards Industrials.
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: a brand of ITT Controls.
 - b. American Meter Company.
 - c. Fischer; Emerson Electric Co., Automation Solutions.

- d. [Maxitrol Company.](#)
 - e. [Richards Industrials.](#)
 - 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: 10 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. [Dormont; a WATTS brand.](#)
 - b. [Eaton.](#)
 - c. [Maxitrol Company.](#)
 - d. [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: 5 psig.

2.8 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. A.Y. McDonald Mfg. Co.
 - b. Capitol Manufacturing Company.
 - c. HART Industrial Unions, LLC.
 - d. Jomar Valve.
 - e. Watts Water Technologies; a Watts company.
 - f. Wilkins.
 - g. Zurn Industries, LLC.
 - 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. Matco-Norca.
 - c. Watts Water Technologies; a Watts company.
 - d. Wilkins.
 - 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.

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 and the International Fuel Gas Code to determine that natural-gas utilization devices are turned off in piping section affected.
- C. Comply with NFPA 54 and the International Fuel Gas Code requirements for prevention of accidental ignition.

3.3 OUTDOOR PIPING INSTALLATION

- A. Comply with NFPA 54 and the International Fuel Gas Code for installation and purging of natural-gas piping.
- B. 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.
- C. Install fittings for changes in direction and branch connections.
- D. Install pressure gage upstream and downstream from each service regulator.

3.4 INDOOR PIPING INSTALLATION

- A. Comply with NFPA 54 and the International Fuel Gas Code for installation and purging of natural-gas piping.

- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
- D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- G. Locate valves for easy access.
- H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.
- I. Install piping free of sags and bends.
- J. Install fittings for changes in direction and branch connections.
- K. Verify final equipment locations for roughing-in.
- L. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.
- M. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
 - 1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
- N. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.

- O. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.
- P. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.
 - 1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
 - 2. In Floors: Install natural-gas piping with welded or brazed joints and protective coating in cast-in-place concrete floors. Cover piping to be cast in concrete slabs with minimum of 1-1/2 inches of concrete. Piping may not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.
 - 3. In Floor Channels: Install natural-gas piping in floor channels. Channels must have cover and be open to space above cover for ventilation.
 - 4. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.
 - a. Exception: Tubing passing through partitions or walls does not require striker barriers.
 - 5. Prohibited Locations:
 - a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
 - b. Do not install natural-gas piping in solid walls or partitions.
- Q. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- R. Connect branch piping from top or side of horizontal piping.
- S. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.
- T. Do not use natural-gas piping as grounding electrode.
- U. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

- V. Install pressure gage upstream and downstream from each line regulator.
- W. Install sleeves for piping penetrations of walls, ceilings, and floors.
- X. Install sleeve seals for piping penetrations of concrete walls and slabs.
- Y. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.5 VALVE INSTALLATION

- A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.
- B. Install underground valves with valve boxes.
- C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

3.6 PIPING JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints:
 - 1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
 - 2. Cut threads full and clean using sharp dies.
 - 3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
 - 4. Apply appropriate tape or thread compound to external pipe threads unless 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. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.
- F. 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.

3.7 HANGER AND SUPPORT INSTALLATION

- A. Install hangers for steel piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- B. Install hangers for corrugated stainless-steel tubing, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- C. Support horizontal piping within 12 inches of each fitting.
- D. Support vertical runs of steel piping to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- E. Support vertical runs of corrugated stainless-steel tubing to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.8 CONNECTIONS

- A. Connect to utility's gas main according to utility's procedures and requirements.
- B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.
- C. Install piping adjacent to appliances to allow service and maintenance of appliances.
- D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.
- E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.9 LABELING AND IDENTIFYING

- A. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.10 PAINTING

- A. Paint exposed , exterior metal piping, valves, regulators, 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: Yellow.

- B. 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.

- 2. Alkyd System: MPI INT 5.1E.

- a. Prime Coat: Alkyd anticorrosive metal primer.
 - b. Intermediate Coat: Interior alkyd matching topcoat.
 - c. Topcoat: Interior alkyd (semigloss).
 - d. Color: Yellow.

- C. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.11 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:

1. Test, inspect, and purge natural gas according to NFPA 54 and the International Fuel Gas Code and authorities having jurisdiction.
2. Test natural gas piping at 15-psig for a minimum of 1 hour.
- C. Natural-gas piping will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.12 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain earthquake valves.

3.13 OUTDOOR PIPING SCHEDULE

- A. 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.

3.14 INDOOR PIPING SCHEDULE

- A. Aboveground, piping shall be the following:
 1. Steel pipe with malleable-iron fittings and threaded joints.

3.15 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

- A. Valves for pipe sizes NPS 2 and smaller at service meter shall be the following:
 1. Two-piece, full-port, bronze ball valves with bronze trim.
- B. Valves for pipe sizes NPS 2-1/2 and larger at service meter shall be the following:
 1. Cast-iron, lubricated plug valve.
- C. Distribution piping valves for pipe sizes NPS 2 and smaller shall be one of the following:
 1. Two-piece, full-port, bronze ball valves with bronze trim.
 2. Cast-iron, lubricated plug valve .
- D. Distribution piping valves for pipe sizes NPS 2-1/2 and larger shall be the following:

1. Cast-iron, lubricated plug valve.
- E. Valves in branch piping for single appliance shall be the following:
1. Two-piece, full-port, bronze ball valves with bronze trim.

END OF SECTION 231123

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SECTION 221316 - 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. Hub-and-spigot, cast-iron soil pipe and fittings.
 - 2. Hubless, cast-iron soil pipe and fittings.
 - 3. Copper tube and fittings.
 - 4. Specialty pipe fittings.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For hubless, single-stack drainage system. Include plans, elevations, sections, and details.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.5 FIELD CONDITIONS

- A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
 - 1. Notify Construction Manager or Owner's Representative and Owner no fewer than 7 days in advance of proposed interruption of sanitary waste service.
 - 2. Do not proceed with interruption of sanitary waste service without Construction Manager's or Owner's Representative's and Owner's written permission.

1.6 WARRANTY

- A. Listed manufacturers to provide labeling and warranty of their respective products.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
 - 1. Soil, Waste, and Vent Piping: 10-foot head of water.
 - 2. Waste, Force-Main Piping: 50 psig.

2.2 PIPING MATERIALS

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.3 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. AB & I Foundry; a part of the McWane family of companies.
 - 2. Charlotte Pipe and Foundry Company.
 - 3. Tyler Pipe; a part of McWane family of companies.
- B. Pipe and Fittings: ASTM A 74, Extra Heavy class.
- C. Gaskets: ASTM C 564, rubber.
- D. Caulking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.4 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

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

1. [AB & I Foundry; a part of the McWane family of companies.](#)
2. [Charlotte Pipe and Foundry Company.](#)
3. [Tyler Pipe; a part of McWane family of companies.](#)

B. Pipe and Fittings: ASTM A 888 or CISPI 301.

C. Heavy-Duty, Hubless-Piping Couplings:

1. [Manufacturers:](#) Subject to compliance with requirements, provide products by one of the following:
 - a. [ANACO-Husky.](#)
 - b. [Charlotte Pipe and Foundry Company.](#)
 - c. [MIFAB, Inc.](#)
 - d. [Mission Rubber Company, LLC; a division of MCP Industries.](#)
 - e. [Tyler Pipe; a subsidiary of McWane Inc.](#)
2. Standards: ASTM C 1277 and ASTM C 1540.
3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.5 SPECIALTY PIPE FITTINGS

A. Dielectric Fittings:

1. Dielectric Unions:

- a. [Manufacturers:](#) Subject to compliance with requirements, provide products by one of the following:
 - 1) [A.Y. McDonald Mfg. Co.](#)
 - 2) [Capitol Manufacturing Company.](#)
 - 3) [HART Industrial Unions, LLC.](#)
 - 4) [Jomar Valve.](#)
 - 5) [WATTS.](#)
 - 6) [Zurn Industries, LLC.](#)
- b. Description:
 - 1) Standard: ASSE 1079.
 - 2) Pressure Rating: 125 psig minimum at 180 deg F.
 - 3) End Connections: Solder-joint copper alloy and threaded ferrous.

2. Dielectric Flanges:

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

- 1) Capitol Manufacturing Company.
- 2) Matco-Norca.
- 3) WATTS.
- 4) Zurn Industries, LLC.

- b. Description:

- 1) Standard: ASSE 1079.
- 2) Factory-fabricated, bolted, companion-flange assembly.
- 3) Pressure Rating: 125 psig minimum at 180 deg F.
- 4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

3. Dielectric Nipples:

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

- 1) Anvil International/Smith-Cooper International; Tailwind Capital, LLC.
- 2) Elster Perfection; a Honeywell Company.
- 3) Matco-Norca.
- 4) Precision Plumbing Products.

- b. Description:

- 1) Standard: IAPMO PS 66.
- 2) Electroplated steel nipple.
- 3) Pressure Rating: 300 psig at 225 deg F.
- 4) End Connections: Male threaded or grooved.
- 5) Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 EARTH MOVING

- A. Comply with requirements for excavating, trenching, and backfilling specified in Division 31 .

3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.
 - 1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
 - 2. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.
 - 1. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical.
 - 2. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe.
 - a. Straight tees, elbows, and crosses may be used on vent lines.
 - 3. Do not change direction of flow more than 90 degrees.
 - 4. Use proper size of standard increasers and reducers if pipes of different sizes are connected.
 - a. Reducing size of waste piping in direction of flow is prohibited.

- K. Lay buried building waste piping beginning at low point of each system.
 - 1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
 - 2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
 - 3. Maintain swab in piping and pull past each joint as completed.
- L. Install soil and waste and vent piping at the following minimum slopes unless otherwise indicated:
 - 1. Sanitary Waste: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
 - 2. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
- M. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
- N. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."
- O. Install engineered soil and waste and vent piping systems as follows:
 - 1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
 - 2. Hubless, Single-Stack Drainage System: Comply with ASME B16.45 and hubless, single-stack aerator fitting manufacturer's written installation instructions.
 - 3. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.
- P. Plumbing Specialties:
 - 1. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary waste gravity-flow piping.
 - a. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping.
 - b. Comply with requirements for cleanouts specified in Section 221319 "Sanitary Waste Piping Specialties."
 - 2. Install drains in sanitary waste gravity-flow piping.
 - a. Comply with requirements for drains specified in Section 221319 "Sanitary Waste Piping Specialties."
- 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.
- S. Install sleeve seals for piping penetrations of concrete walls and slabs.
- T. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.3 JOINT CONSTRUCTION

- A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- B. Join 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. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1.
 - 1. Cut threads full and clean using sharp dies.
 - 2. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
 - c. Do not use pipe sections that have cracked or open welds.
- D. 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.

3.4 SPECIALTY PIPE FITTING INSTALLATION

- A. Transition Couplings:
 - 1. Install transition couplings at joints of piping with small differences in ODs.
 - 2. In Waste Drainage Piping: Shielded, nonpressure transition couplings.
 - 3. In Aboveground Force Main Piping: Fitting-type transition couplings.
 - 4. In Underground Force Main Piping:
 - a. NPS 1-1/2 and Smaller: Fitting-type transition couplings.
 - b. NPS 2 and Larger: Pressure transition couplings.
- B. Dielectric Fittings:

1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
2. Dielectric Fittings for NPS 2 and Smaller: Use dielectric nipples.
3. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges or nipples.
4. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.5 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Comply with requirements for pipe hanger and support devices and installation as specified.
 1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
 2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments including crawl spaces.
 3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
 4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
 5. Vertical Piping: MSS Type 8 or Type 42, clamps.
 6. Install individual, straight, horizontal piping runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
 7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 8. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Install hangers for soil piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- D. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.
- E. Support vertical runs of soil piping to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

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 waste and vent piping to the following:
 - 1. Plumbing Fixtures: Connect waste piping in sizes indicated, but not smaller than required by plumbing code.
 - 2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
 - 3. Plumbing Specialties: Connect waste and vent piping in sizes indicated, but not smaller than required by plumbing code.
 - 4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
 - 5. Install horizontal backwater valves with cleanout cover flush with floor.
 - 6. Equipment: Connect waste piping as indicated.
 - a. Provide shutoff valve if indicated and union for each connection.
 - b. Use flanges instead of unions for connections NPS 2-1/2 and larger.
- D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- E. 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.

3.7 IDENTIFICATION

- A. Identify exposed sanitary waste and vent piping.
- B. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.8 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 waste and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.
 - a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 2. Leave uncovered and unconcealed new, altered, extended, or replaced waste and vent piping until it has been tested and approved.
 - a. Expose work that was covered or concealed before it was tested.
 - 3. Roughing-in Plumbing Test Procedure: Test waste and vent piping except outside leaders on completion of roughing-in.
 - a. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water.
 - b. From 15 minutes before inspection starts to completion of inspection, water level must not drop.
 - c. Inspect joints for leaks.
 - 4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight.

- a. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg.
 - b. Use U-tube or manometer inserted in trap of water closet to measure this pressure.
 - c. Air pressure must remain constant without introducing additional air throughout period of inspection.
 - d. Inspect plumbing fixture connections for gas and water leaks.
5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 6. Prepare reports for tests and required corrective action.

3.9 CLEANING AND PROTECTION

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect sanitary waste and vent piping during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.
- D. Repair damage to adjacent materials caused by waste and vent piping installation.

3.10 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Aboveground, soil and waste piping shall be the following:
 1. Hubless, cast-iron soil pipe and fittings; CISPI heavy-duty hubless-piping couplings; and coupled joints.
- C. Aboveground, vent piping shall be the following:
 1. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
- D. Underground, soil, waste, and vent piping shall be the following:
 1. Extra Heavy class, cast-iron soil piping; gaskets; and gasketed joints.

END OF SECTION 221316

SECTION 221319 - 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. Cleanouts.
 - 2. Air-admittance valves.
 - 3. Miscellaneous sanitary drainage piping specialties.

1.3 DEFINITIONS

- A. ABS: Acrylonitrile butadiene styrene.
- B. PVC: Polyvinyl chloride.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
 - 1. Show fabrication and installation details for frost-resistant vent terminals.

1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For sanitary waste piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTIONS

- A. Sanitary waste piping specialties shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14 for plastic sanitary waste piping specialty components.

2.2 CLEANOUTS

A. Cast-Iron Exposed Cleanouts:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jay R. Smith Mfg Co; a division of Morris Group International.
 - b. Josam Company.
 - c. WATTS.
 - d. Zurn Industries, LLC.
- 2. Standard: ASME A112.36.2M.
- 3. Size: Same as connected drainage piping
- 4. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch as required to match connected piping.
- 5. Closure: Countersunk, brass plug.
- 6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Cast-Iron Exposed Floor Cleanouts:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jay R. Smith Mfg Co; a division of Morris Group International.
 - b. Josam Company.
 - c. WATTS.
 - d. Zurn Industries, LLC.
- 2. Standard: ASME A112.36.2M for adjustable housing
- 3. Size: Same as connected branch.
- 4. Type: Adjustable housing Cast-iron soil pipe with cast-iron ferrule.
- 5. Body or Ferrule: Cast iron.

6. Clamping Device: Not required.
7. Outlet Connection: Inside calk.
8. Closure: Brass plug with tapered threads.
9. Adjustable Housing Material: Cast iron with threads.
10. Frame and Cover Material and Finish: Stainless steel.
11. Frame and Cover Shape: Round.
12. Top-Loading Classification: Heavy Duty.
13. Riser: ASTM A74, cast-iron drainage pipe fitting and riser to cleanout.

C. Cast-Iron Wall Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jay R. Smith Mfg Co; a division of Morris Group International.
 - b. Josam Company.
 - c. WATTS.
 - d. Zurn Industries, LLC.
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 Plug:
 - a. Brass.
 - b. Countersunk head.
 - c. Drilled and threaded for cover attachment screw.
 - d. Size: Same as or not more than one size smaller than cleanout size.
6. Wall Access, Cover Plate: Round, deep, chrome-plated bronze cover plate with screw.

D. Plastic Floor Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. IPS Corporation.
 - b. Sioux Chief Manufacturing Company, Inc.
 - c. Zurn Industries, LLC.
2. Size: Same as connected branch.
3. Body: PVC.
4. Closure Plug: PVC.

5. Riser: Drainage pipe fitting and riser to cleanout of same material as drainage piping.

2.3 AIR-ADMITTANCE VALVES

A. Fixture Air-Admittance Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Oatey.
 - b. ProVent Systems.
 - c. Studor, Inc.
2. Standard: ASSE 1051, Type A for single fixture or Type B for branch piping.
3. Housing: Plastic.
4. Operation: Mechanical sealing diaphragm.
5. Size: Same as connected fixture or branch vent piping.

B. Wall Box for Air-Admittance Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Oatey.
 - b. Sioux Chief Manufacturing Company, Inc.
 - c. Studor, Inc.
2. Description: White plastic housing with white plastic grille, made for recessed installation. Include bottom pipe connection and space to contain one air-admittance valve.
3. Size: Approximately **6 inches wide by 6 inches high by 4 inches deep.**

2.4 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Open Drains:

1. Description: Shop or field fabricate from ASTM A74, 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 C564 rubber gaskets.
2. Size: Same as connected waste piping.

B. Deep-Seal Traps:

1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
2. Size: Same as connected waste piping.
 - a. **NPS 2: 4-inch-** minimum water seal.
 - b. **NPS 2-1/2 and Larger: 5-inch-** minimum water seal.

C. Floor-Drain, Inline Trap Seal:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jay R. Smith Mfg Co; a division of Morris Group International.
 - b. Josam Company.
 - c. RectorSeal Plumbing; A CSW Industrials Company.
 - d. Zurn Industries, LLC.
2. Description: Inline floor drain trap seal, forming a physical barrier to slow trap evaporation while not impeding flow from drain.
3. Material: Polymer.
4. Standard: Tested and certified in accordance with ASSE 1072.
5. Listing: ICC-ES or IAPMO listed.
6. Size: Same as floor drain outlet or strainer throat.

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.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install backwater valves in building drain piping.
 - 1. 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**. Use **NPS 4** for larger drainage piping unless larger cleanout is indicated.
 - 2. Locate at each change in direction of piping greater than 45 degrees.
 - 3. Locate at minimum intervals of **50 feet** for piping **NPS 4** and smaller and **100 feet** for larger piping.
 - 4. Locate at base of each vertical soil and waste stack.
- C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- E. Install fixture air-admittance valves on fixture drain piping.
- F. Install stack air-admittance valves at top of stack vent and vent stack piping.
- G. Install air-admittance-valve wall boxes recessed in wall.
- H. Assemble open drain fittings and install with top of hub **1 inch** above floor.
- I. Install deep-seal traps on floor drains and other waste outlets, if indicated.
- J. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
 - 1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
 - 2. Size: Same as floor drain inlet.
- K. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

- L. Install sleeve and sleeve seals with each riser and stack passing through floors with waterproof membrane.
- M. Install vent caps on each vent pipe passing through roof.
- N. Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain **1-inch** clearance between vent pipe and roof substrate.
- O. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.
- P. Install frost-proof vent caps on each vent pipe passing through roof. Maintain **1-inch** clearance between vent pipe and roof substrate.
- Q. Install wood-blocking reinforcement for wall-mounting-type specialties.
- R. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.2 PIPING CONNECTIONS

- A. Install piping adjacent to equipment, to allow service and maintenance.

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 221319

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SECTION 221319.13 - SANITARY DRAINS

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. Floor drains.
 - 2. Floor sinks.
 - 3. Trench drains.
 - 4. Channel drainage systems.

1.3 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene styrene.
- B. FRP: Fiberglass-reinforced plastic.
- C. HDPE: High-density polyethylene.
- D. PE: Polyethylene.
- E. PP: Polypropylene.
- F. PVC: Polyvinyl chloride.

1.4 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 DRAIN ASSEMBLIES

- A. Sanitary drains shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14 for plastic sanitary piping specialty components.

2.2 FLOOR DRAINS

A. Cast-Iron Floor Drains:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jay R. Smith Mfg Co; a division of Morris Group International.
 - b. Wade; a subsidiary of McWane Inc.
 - c. WATTS.
 - d. Zurn Industries, LLC.
2. Pattern: Floor drain.
3. Body Material: Gray iron.
4. Seepage Flange: Required.
5. Anchor Flange: Not required.
6. Clamping Device: Required.
7. Outlet: Bottom.
8. Top or Strainer Material: Stainless steel.
9. Top Shape: Round.
10. Top Loading Classification: Heavy Duty.
11. Trap Material: Cast iron.
12. Trap Pattern: Deep-seal P-trap.
13. Trap Features: Cleanout and trap seal.

2.3 TRENCH DRAINS

A. Trench Drains:

1. <Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jay R. Smith Mfg Co; a division of Morris Group International.
 - b. Josam Company.

- c. [WATTS.](#)
 - d. [Zurn Industries, LLC.](#)
- 2. Standard: ASME A112.6.3 for trench drains.
 - 3. Material: HDPE.
 - 4. Flange: AnchorSeepage.
 - 5. Clamping Device: Required.
 - 6. Outlet: End.
 - 7. Grate Material: Heal Proof Polyethylene.
 - 8. Grate Finish: Painted.
 - 9. Top Loading Classification: Light Duty.
 - 10. Trap Material: Cast iron.
 - 11. Trap Pattern: Standard P-trap.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
 - 1. Position floor drains for easy access and maintenance.
 - 2. Set floor drains below elevation of surrounding finished floor to allow floor drainage.
 - 3. Set with grates depressed according to the following drainage area radii:
 - a. Radius, **30 Inches (750 mm)** or Less: Equivalent to 1 percent slope, but not less than **1/4-inch (6.35-mm)** total depression.
 - b. Radius, **30 to 60 Inches (750 to 1500 mm)**: Equivalent to 1 percent slope.
 - c. Radius, **60 Inches (1500 mm)** or Larger: Equivalent to 1 percent slope, but not greater than **1-inch (25-mm)** total depression.
 - 4. Install floor-drain flashing collar or flange, so no leakage occurs between drain and adjoining flooring.
 - a. Maintain integrity of waterproof membranes where penetrated.
 - 5. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- B. Install trench drains at low points of surface areas to be drained.
 - 1. Set grates of drains flush with finished surface, unless otherwise indicated.

2. Install on support devices, so that top will be flush with adjacent surface.

3.2 CONNECTIONS

- A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Comply with requirements in Section 221319 "Sanitary Waste Piping Specialties" for backwater valves, air admittance devices and miscellaneous sanitary drainage piping specialties.
- C. Comply with requirements in Section 221323 "Sanitary Waste Interceptors" for grease interceptors, grease-removal devices, oil interceptors, sand interceptors, and solid interceptors.
- D. Install piping adjacent to equipment 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."

3.3 LABELING AND IDENTIFYING

- A. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 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 221319.13

SECTION 221413 - FACILITY STORM DRAINAGE PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Hub-and-spigot, cast-iron soil pipe and fittings.
2. Hubless, cast-iron soil pipe and fittings.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For roof drainage system. Include calculations, plans, and details.

1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Detail storm drainage piping. Show support locations, type of support, weight on each support, required clearances, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Structural members to which drainage piping will be attached or suspended from.
- B. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

1.5 FIELD CONDITIONS

- A. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Construction Manager or Owner's Representative and Owner no fewer than 7 days in advance of proposed interruption of storm drainage service.
2. Do not proceed with interruption of storm drainage service without Construction Manager's or Owner's Representative's and Owner's written permission.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
 1. Storm Drainage Piping: 10-foot head of water.

2.2 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. AB & I Foundry; a part of the McWane family of companies.
 2. Charlotte Pipe and Foundry Company.
 3. Tyler Pipe; a part of McWane family of companies.
- B. Pipe and Fittings:
 1. Marked with CISPI collective trademark and NSF certification mark.
 2. Class: ASTM A 74, Extra Heavy class.
- C. Gaskets: ASTM C 564, rubber.

2.3 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. AB & I Foundry; a part of the McWane family of companies.
 2. Charlotte Pipe and Foundry Company.
 3. Tyler Pipe; a part of McWane family of companies.
- B. Pipe and Fittings:
 1. Marked with CISPI collective trademark and NSF certification mark.

2. Standard: ASTM A 888 or CISPI 301.
- C. Heavy-Duty, Hubless-Piping Couplings:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ANACO-Husky.
 - b. Charlotte Pipe and Foundry Company.
 - c. MIFAB, Inc.
 - d. Mission Rubber Company, LLC; a division of MCP Industries.
 2. Standard: ASTM C 1540..
 3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.
 1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
 2. Install piping as indicated unless deviations from layout are approved on coordination drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.

- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. Make changes in direction for piping using appropriate branches, bends, and long-sweep bends.
 - 1. Do not change direction of flow more than 90 degrees.
 - 2. Use proper size of standard increasers and reducers if pipes of different sizes are connected.
 - a. Reducing size of drainage piping in direction of flow is prohibited.
- K. Lay buried building piping beginning at low point of each system.
 - 1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
 - 2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
 - 3. Maintain swab in piping and pull past each joint as completed.
- L. Install piping at the following minimum slopes unless otherwise indicated:
 - 1. Building Storm Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
- M. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
 - 1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.
- N. Plumbing Specialties:
 - 1. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers in storm drainage gravity-flow piping.
 - a. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping.
 - 2. Install drains in storm drainage gravity-flow piping.
- O. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

- P. Install sleeves for piping penetrations of walls, ceilings, and floors.
- Q. Install sleeve seals for piping penetrations of concrete walls and slabs.
- R. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.2 JOINT CONSTRUCTION

- A. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- B. Hubless, Cast-Iron Soil Piping Coupled Joints:
 - 1. Join according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.
- C. Joint Restraints and Sway Bracing:
 - 1. Provide joint restraints and sway bracing for storm drainage piping joints to comply with the following conditions:
 - a. Provide axial restraint for pipe and fittings 5 inches and larger, upstream and downstream of all changes in direction, branches, and changes in diameter greater than two pipe sizes.
 - b. Provide rigid sway bracing for pipe and fittings 4 inches and larger, upstream and downstream of all changes in direction 45 degrees and greater.
 - c. Provide rigid sway bracing for pipe and fittings 5 inches and larger, upstream and downstream of all changes in direction and branch openings.

3.3 INSTALLATION OF HANGERS AND SUPPORTS

- 1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
- 2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments such as natatoriums.
- 3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
- 4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
- 5. Vertical Piping: MSS Type 8 or Type 42, clamps.
- 6. Install individual, straight, horizontal piping runs:

- a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
- 7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
- 8. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Install hangers for cast-iron soil piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- C. Support horizontal piping and tubing within 12 inches of each fitting and coupling.
- D. Support vertical cast-iron piping to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent, but as a minimum at base and at each floor.

3.4 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.
- D. Where installing piping adjacent to equipment, allow space for service and maintenance.

3.5 IDENTIFICATION

- A. Identify storm drainage piping.

3.6 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.
 - a. 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.
 - a. Expose work that was covered or concealed before it was tested.
 3. Test Procedure:
 - a. Test storm drainage piping on completion of roughing-in.
 - b. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts until completion of inspection, water level must not drop. Inspect joints for leaks.
 4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 5. Prepare reports for tests and required corrective action.
- C. Piping will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.7 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.

3.8 PIPING SCHEDULE

- A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Aboveground storm drainage piping shall be the following:
 - 1. Hubless, cast-iron soil pipe and fittings; [,] heavy-duty, hubless-piping couplings; and coupled joints.
- C. Underground storm drainage piping shall be the following:
 - 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.

END OF SECTION 221413

SECTION 221423 - STORM DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal roof drains.
2. Miscellaneous storm drainage piping specialties.
3. Cleanouts.
4. Backwater valves.

1.2 ACTION SUBMITTALS

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

1.3 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. Cast-Iron, General-Purpose Roof Drains:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jay R. Smith Mfg Co; a division of Morris Group International.
 - b. Josam Company.
 - c. WATTS.
 - d. Zurn Industries, LLC.
2. Standard: ASME A112.6.4.
3. Body Material: Cast iron.
4. Dimension of Body: Nominal 14-inch to 16-inch diameter.

5. Combination Flashing Ring and Gravel Stop: Required.
6. Flow-Control Weirs: Not required.
7. Outlet: Bottom.
8. Outlet Type: No hub.
9. Top set Sump Receiver Plate: Required.
10. Adjustable extension assembly: Required.
11. Dome Material: Cast iron.
12. Perforated Gravel Guard: Not required.
13. Vandal-Proof Dome: Not required.
14. Water Dam: 2 inches high on overflow drains.

2.2 MISCELLANEOUS STORM DRAINAGE PIPING SPECIALTIES

A. Metal Downspout Nozzles:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jay R. Smith Mfg Co; a division of Morris Group International.
 - b. Wade; a subsidiary of McWane Inc.
 - c. Watts Water Technologies; a Watts company.
 - d. Zurn Industries, LLC.
2. Description: Nozzle with wall flange and mounting holes to cover rough opening and serve as anchor..
3. Size: Same as connected downspout.
4. Material: Cast bronze or nickel bronze nozzle and flange.
5. Piping Connection Type: Threaded No-hub.
6. Finish: As selected by Architect.
7. Opening Protection: Birdscreen.

2.3 CLEANOUTS

A. Cast-Iron Exposed Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jay R. Smith Mfg Co; a division of Morris Group International.
 - b. Wade; a subsidiary of McWane Inc.
 - c. Watts Water Technologies; a Watts company.
 - d. Zurn Industries, LLC.

2. Standard: ASME A112.36.2M.
3. Size: Same as connected branch.
4. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch No-hub, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk, brass plug.
6. Closure Plug Size: Same as, or not more than, one size smaller than cleanout size.

B. Cast-Iron Exposed Floor Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jay R. Smith Mfg Co; a division of Morris Group International.
 - b. Wade; a subsidiary of McWane Inc.
 - c. Watts Water Technologies; a Watts company.
 - d. Zurn Industries, LLC.
2. Standard: ASME A112.36.2M.
3. Size: Same as connected branch.
4. Type: Heavy-duty, adjustable housing Threaded, adjustable housing.
5. Body or Ferrule: Cast iron.
6. Clamping Device: Where Required.
7. Outlet Connection: No hub Hub with gasket.
8. Closure: Brass plug with tapered threads.
9. Adjustable Housing Material: Cast iron with threads.
10. Frame and Cover Material and Finish: Stainless steel.
11. Frame and Cover Shape: Round.
12. Top Loading Classification: Heavy Duty.
13. Riser: ASTM A74, Extra-Heavy class, cast-iron drainage pipe fitting and riser to cleanout.

C. Cast-Iron Wall Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jay R. Smith Mfg Co; a division of Morris Group International.
 - b. Wade; a subsidiary of McWane Inc.
 - c. Watts Water Technologies; a Watts company.
 - d. Zurn Industries, LLC.
2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: No-hub, cast-iron soil pipe test tee as required to match connected piping.

5. Closure Plug:
 - a. Brass.
 - b. Countersunk head.
 - c. Drilled and threaded for cover attachment screw.
 - d. Size: Same as, or not more than, one size smaller than cleanout size.
6. Wall Access, Cover Plate: Round, flat, chrome-plated brass or stainless steel cover plate with screw.

D. Test Tees:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jay R. Smith Mfg Co; a division of Morris Group International.
 - b. Tyler Pipe; a subsidiary of McWane Inc.
 - c. Watts Water Technologies; a Watts company.
 - d. Zurn Industries, LLC.
2. Standard: ASME A112.36.2M and ASTM A74, ASTM A888, or CISPI 301.
3. Size: Same as connected drainage piping.
4. Body Material: Hub-and-spigot, cast-iron soil-pipe T-branch or no-hub, cast-iron soil-pipe test tee as required to match connected piping.
5. Closure Plug: Countersunk, brass.
6. Closure Plug Size: Same as, or not more than, one size smaller than cleanout size.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install roof drains at low points of roof areas in accordance with 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 downspout adapters on outlet of back-outlet parapet roof drains and connect to sheet metal downspouts.

- C. Install downspout boots at grade with top **18 inches** above grade. Secure to building wall.
- D. Install downspout nozzles at exposed bottom of conductors where they spill onto grade.
- E. Install cleanouts in aboveground piping and building drain piping in accordance with the following instructions unless otherwise indicated:
 - 1. Use cleanouts the same size as drainage piping up to **NPS 4**. Use **NPS 4** for larger drainage piping unless larger cleanout is indicated.
 - 2. Locate cleanouts at each change in direction of piping greater than 45 degrees.
 - 3. Locate cleanouts at minimum intervals of **50 feet** for piping **NPS 4** and smaller and **100 feet** for larger piping.
 - 4. Locate cleanouts at base of each vertical storm piping conductor.
- F. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- G. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- H. Install horizontal backwater valves in floor with cover flush with floor.
- I. Install drain-outlet backwater valves in outlet of drains.
- J. Install test tees in vertical conductors and near floor.
- K. Install wall cleanouts in vertical conductors. Install access door in wall if indicated.
- L. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface unless otherwise indicated.
- M. Assemble channel drainage system components in accordance with manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.
- N. Install through-penetration firestop assemblies for penetrations of fire- and smoke-rated assemblies.

3.2 INSTALLATION OF FLASHING

- A. Fabricate flashing from single piece of metal unless large pans, sumps, or other drainage shapes are required.

- B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
- C. Set flashing on floors and roofs in solid coating of bituminous cement.
- D. 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 221423

SECTION 221429 - SUMP PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Submersible sump pump and oil detection and control system for installation in elevator sump pits in compliance with ASME A17.1.
2. Fiberglass sump basins

B. Related Sections include the following:

1. Division 7 Section "Firestopping" for fire resistive penetrations.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, construction materials, and furnished specialties and accessories.

1.3 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For pumps and controls, to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: UL/CSA listed.
- B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Retain shipping flange protective covers and protective coatings during storage.
- B. Protect bearings and couplings against damage.
- C. Comply with pump manufacturer's written rigging instructions for handling.

PART 2 - PRODUCTS

2.1 ELEVATOR PIT SUMP PUMP SYSTEM

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following :
1. Franklin Electric Co., Inc. (Little Giant Pumps).
 2. Liberty Pumps.
 3. Stancor Pumps, Inc.
 4. Weil Pumps.
 5. Xylem, Inc (Gould Pumps).
- B. Submersible Sump Pump: Factory assembled and tested sump pump unit.
1. Outer Casing: Cast Iron.
 2. Motor Housing Liner: Stainless Steel.
 3. Lower Diffuser Material: Cast Iron.
 4. Hardware: Stainless Steel.
 5. Mechanical Seal Material: Silicon Carbide vs Silicon Carbide.
 6. Impeller: Bronze.
- C. Control System: Provide complete control system including probes, floats, cables and accessories required for a complete functional system. The control system shall control pump operation based on water level in the sump and prevent pump operation if oil is detected in the sump.
1. Solid state tested to meet UL508 standards.
 2. NEMA 4X enclosure with terminal strip for field wiring to the J-Box in the hoistway.
 3. Field adjustable switch with variable oil sensitivity settings.
 4. Separate over-current relay and field adjustable motor overload; range of 5 to 15 amps.
 5. Combination manual reset/push to test switch for motor overload with both automatic, manual reset and control diagnostics.
 6. Hermetically sealed stainless steel probe detection system with self-cleaning technology.
 7. Oil sensor-level probe set no higher than 4" from the bottom of the pit.
 8. Main float switch to automatically start the pump on a level increase in the sump pit fluid level.
 9. Pump control float and oil sensing probe shall be factory mounted and positioned on the pump and factory tested as a complete system.

- 1) High decibel warning horn with illuminated red light with alarm silencing switch and separate dry alarm contacts.

2.2 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.
 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.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with manufacturer's installation instructions.
- B. Provide union and check valve at pump discharge.
- C. Install piping adjacent to equipment to allow service and maintenance.

3.2 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 1. Perform each visual and mechanical inspection.
 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

- B. Pumps and controls will be considered defective if they do not pass tests and inspections.

3.3 STARTUP SERVICE

- A. Perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.

3.4 ADJUSTING

- A. Adjust pumps to function smoothly, and lubricate as recommended by manufacturer.
- B. Adjust control set points.

END OF SECTION 221429

SECTION 223400 - FUEL-FIRED, DOMESTIC-WATER HEATERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Commercial, gas-fired, high-efficiency, storage, domestic-water heaters.
 - 2. Domestic-water heater accessories.
 - 3. Gas Vents

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings:
 - 1. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Equipment room drawing or BIM model, drawn to scale, on which the items described in this Section are shown and coordinated with all building trades.
- B. Product Certificates: For each type of domestic-water heater.
- C. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.
- D. Source quality-control reports.
- E. Field quality-control reports.
- F. Sample Warranty: For special warranty.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fuel-fired, domestic-water heaters to include in emergency, operation, and maintenance manuals.

1.5 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.6 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of fuel-fired, domestic-water heaters that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including storage tank and supports.
 - b. Faulty operation of controls.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
 - 2. Warranty Periods: From date of Substantial Completion.
 - a. Commercial, Gas-Fired, Storage, Domestic-Water Heaters:
 - 1) Storage Tank: Five years.
 - 2) Controls and Other Components: Two year(s).
 - b. Expansion Tanks: Five years.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.
- B. ASHRAE/IES Compliance: Fabricate and label fuel-fired, domestic-water heaters to comply with ASHRAE/IES 90.1.
- C. ASME Compliance:
 - 1. Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 and NSF 372.

2.2 COMMERCIAL, GAS-FIRED, STORAGE, DOMESTIC-WATER HEATERS

- A. Commercial, Gas-Fired, High-Efficiency, Storage, Domestic-Water Heaters:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AERCO; A WATTS Brand.
 - b. Lochinvar LLC.
 - c. PVI; A WATTS Brand.
 - 2. Source Limitations: Obtain domestic-water heaters from single source from single manufacturer.
 - 3. Standard: ANSI Z21.10.3/CSA 4.3.
 - 4. Description: Manufacturer's proprietary design to provide at least 95 percent combustion efficiency at optimum operating conditions.
 - 5. Storage-Tank Construction: ASME-code steel with 150-psig minimum working-pressure rating.

- a. Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.
 - 1) NPS 2 and Smaller: Threaded ends in accordance with ASME B1.20.1.
 - 2) NPS 2-1/2 and Larger: Flanged ends in accordance with ASME B16.5 for steel and stainless steel flanges and in accordance with ASME B16.24 for copper and copper-alloy flanges.
- b. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
- c. Lining: Glass complying with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending lining into and through tank fittings and outlets.
6. Factory-Installed, Storage-Tank Appurtenances:
 - a. Anode Rod: Replaceable magnesium.
 - b. Dip Tube: Required unless cold-water inlet is near bottom of tank.
 - c. Drain Valve: Corrosion-resistant metal with hose-end connection.
 - d. Insulation: Comply with ASHRAE/IES 90.1. Surround entire storage tank except connections and controls.
 - e. Jacket: Steel with enameled finish.
 - f. Burner or Heat Exchanger: Comply with UL 795 or approved testing agency requirements for gas-fired, high-efficiency, domestic-water heaters and natural-gas fuel.
 - g. Temperature Control: Adjustable thermostat.
 - h. Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems.
 - i. Combination Temperature-and-Pressure Relief Valves: ANSI Z21.22/CSA 4.4. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select one relief valve with sensing element that extends into storage tank.

2.3 DOMESTIC-WATER HEATER ACCESSORIES

- A. Domestic-Water Expansion Tanks:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. A. O. Smith Corporation.
 - b. AMTROL, Inc.
 - c. Taco Comfort Solutions.
 2. Source Limitations: Obtain domestic-water heaters from single source from single manufacturer.
 3. 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.
 4. Construction:
 - a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
 - b. Interior Finish: Comply with NSF 61 and NSF 372 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
 - c. Air-Charging Valve: Factory installed.
 5. Capacity and Characteristics:

- a. Working-Pressure Rating: 100 psig.
- B. Piping-Type Heat Traps: Field-fabricated piping arrangement in accordance with ASHRAE/IES 90.1.
- C. Heat-Trap Fittings: ASHRAE 90.2.
- D. Gas Shutoff Valves: ANSI Z21.15/CSA 9.1, manually operated. Furnish for installation in piping.
- E. Gas Pressure Regulators: ANSI Z21.18/CSA 6.3, appliance type. Include 1/2-psig pressure rating as required to match gas supply.
- F. Automatic Gas Valves: ANSI Z21.21/CSA 6.5, appliance, electrically operated, on-off automatic valve.
- G. Combination Temperature-and-Pressure Relief Valves: Include relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of domestic-water heater. Select relief valves with sensing element that extends into storage tank.
 - 1. Gas-Fired, Domestic-Water Heaters: ASME rated and stamped.

2.4 GAS VENTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Heatfab SAF-T VENT CI PLUS; Selkirk Corporation.
 - 2. Corr/Guard Model CG; Metal-Fab, Inc.
- B. Description: Double-wall metal vents tested according to UL 1738 and rated for 480 deg F continuously, with positive or negative flue pressure complying with NFPA 211.
- C. Construction: Inner shell and outer jacket separated by at least 1/2-inch airspace.
- D. Inner Shell: ASTM A 959, Type 29-4C stainless steel.
- E. Outer Jacket: Aluminized steel.
- F. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.

2.5 SOURCE QUALITY CONTROL

- A. Factory Tests: Test and inspect assembled domestic-water heaters specified to be ASME-code construction, in accordance with ASME Boiler and Pressure Vessel Code.
- B. Hydrostatically test commercial domestic-water heaters and storage tanks to minimum of one and one-half times pressure rating before shipment.

- C. Domestic-water heaters will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 DOMESTIC-WATER HEATER INSTALLATION

- A. Commercial, Domestic-Water Heater Mounting: Install commercial domestic-water heaters on concrete base.
 - 1. Maintain manufacturer's recommended clearances.
 - 2. Arrange units so controls and devices that require servicing are accessible.
 - 3. 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.
- B. Tankless, Domestic-Water Heater Mounting: Install tankless, domestic-water heaters at least 18 inches above floor on wall bracket.
 - 1. Maintain manufacturer's recommended clearances.
 - 2. Arrange units so controls and devices that require servicing are accessible.
 - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 5. Anchor domestic-water heaters to substrate.
- C. Install domestic-water heaters level and plumb, in accordance with layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
 - 1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping.
- D. Install gas-fired, domestic-water heaters in accordance with NFPA 54.
 - 1. Install gas shutoff valves on gas supply piping to gas-fired, domestic-water heaters without shutoff valves.
 - 2. Install gas pressure regulators on gas supplies to gas-fired, domestic-water heaters without gas pressure regulators if gas pressure regulators are required to reduce gas pressure at burner.
 - 3. Install automatic gas valves on gas supplies to gas-fired, domestic-water heaters if required for operation of safety control.
- E. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend domestic-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- F. Install combination temperature-and-pressure relief valves in water piping for domestic-water heaters without storage. Extend domestic-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

- G. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for domestic-water heaters that do not have tank drains.
- H. Install thermometer on outlet piping of domestic-water heaters.
- I. Assemble and install inlet and outlet piping manifold kits for multiple domestic-water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each domestic-water heater. Include shutoff valve and thermometer in each domestic-water heater inlet and outlet, and throttling valve in each domestic-water heater outlet.
- J. Install piping-type heat traps on inlet and outlet piping of domestic-water heater storage tanks without integral or fitting-type heat traps.
- K. Fill domestic-water heaters with water.
- L. Charge domestic-water expansion tanks with air to required system pressure.
- M. Install dielectric fittings in all locations where piping of dissimilar metals is to be joined. The wetted surface of the dielectric fitting contacted by potable water shall contain less than 0.25 percent of lead by weight.

3.2 PIPING CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to fuel-fired, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.3 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections with the assistance of a factory-authorized service representative.
- E. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

- F. Domestic-water heaters will be considered defective if they do not pass tests and inspections.
- G. Prepare test and inspection reports.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain domestic-water heaters. Training shall be a minimum of one hour(s).

3.5 INSTALLATION OF GAS VENTS

- A. Coordinate roof penetrations with other trades.
- B. Comply with minimum clearances from combustibles and minimum termination heights according to product listing or NFPA 211, whichever is most stringent.
- C. Seal between sections of positive-pressure vents according to manufacturer's written installation instructions, using sealants recommended by manufacturer.
- D. Support vents at intervals recommended by manufacturer to support weight of vents and all accessories. Vents shall not be supported by appliances.
- E. Lap joints in direction of flow.

END OF SECTION 223400

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SECTION 224213.13 - COMMERCIAL WATER CLOSETS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Floor-mounted, bottom-outlet water closets.
2. Wall-mounted water closets.
3. Flushometer valves.
4. Toilet seats.
5. Supports.

1.2 DEFINITIONS

- A. Standard-Efficiency Flush Volume: 1.6 gal. per flush.
- B. High-Efficiency Flush Volume: 1.28 gal. or less per flush.
- C. WaterSense Fixture: Water closet and/or flushometer valve/tank certified by the EPA to meet the WaterSense performance criteria.

1.3 ACTION SUBMITTALS

A. Product Data:

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for water closets.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

- B. Shop Drawings: Include diagrams for power and control wiring.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For flushometer valves and electronic sensors to include in operation and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Extra Stock Materials: Furnish extra materials to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Flushometer-Valve Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than one of each type.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Standards:
 - 1. Comply with ASME A112.19.2/CSA B45.1 for water closets.
 - 2. Comply with ASME A112.19.5/CSA B45.15 for flush valves and spuds for water closets and tanks.
 - 3. Comply with ASSE 1037/ASME A112.1037/CSA B125.37 for flush valves.
 - 4. Comply with IAMPO/ANSI Z124.5 for water-closet (toilet) seats.
 - 5. Comply with ASME A112.6.1M for water-closet supports.
 - 6. Comply with ICC A117.1 for ADA-compliant water closets.
 - 7. Comply with ASTM A1045 for flexible PVC gaskets used in connection of vitreous china water closets to sanitary drainage systems.
 - 8. Comply with ASME A112.4.3 for plastic fittings used in connection of vitreous china water closets to sanitary drainage systems.

2.2 FLOOR-MOUNTED, BOTTOM-OUTLET WATER CLOSETS

- A. Water Closets - Floor Mounted, Bottom Outlet, Top Spud: .
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Standard.
 - b. Kohler Co.
 - c. Mansfield Plumbing Products LLC.
 - d. Sloan Valve Company.
 - e. TOTO USA, INC.
 - f. Zurn Industries, LLC.
 - 2. Source Limitations: Obtain water closets from single source from single manufacturer.

3. Bowl:
 - a. Material: Vitreous china.
 - b. Type: Siphon jet.
 - c. Style: Flushometer valve.
 - d. Height: Standard: 15", ADA compliant:17".
 - e. Rim Contour: Elongated.
 - f. Water Consumption: 1.28 gal. per flush.
 - g. Spud Size and Location: NPS 1-1/2; top.
 - h. Color: White.

2.3 WALL-MOUNTED WATER CLOSETS

A. Water Closets - Wall Mounted, Top Spud:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Standard.
 - b. Kohler Co.
 - c. Mansfield Plumbing Products LLC.
 - d. Sloan Valve Company.
 - e. TOTO USA, INC.
 - f. Zurn Industries, LLC.
2. Source Limitations: Obtain water closets from single source from single manufacturer.
3. Bowl:
 - a. Material: Vitreous china.
 - b. Type: Siphon jet.
 - c. Style: Flushometer valve.
 - d. Rim Contour: Elongated.
 - e. Water Consumption: 1.28 gal. per flush.
 - f. Spud Size and Location: NPS 1-1/2; top.
 - g. Color: White.
4. Support: Water-closet carrier.

2.4 FLUSHOMETER VALVES

A. Flushometer Valves - Diaphragm, Solenoid Actuated:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Delany Products.
 - b. Sloan Valve Company.
 - c. Zurn Industries, LLC.
2. Source Limitations: Obtain flushometer valve from single source from single manufacturer.
3. Minimum Pressure Rating: 125 psig.
4. Features: Include integral check stop, backflow-prevention device, and manual override button.
5. Material: Brass body with corrosion-resistant components.
6. Style: **[Exposed]** **[Concealed]**.
7. Exposed Flushometer-Valve Finish: Chrome-plated metal.
8. Panel Finish: Chrome-plated or stainless steel.
9. Actuator: Side or top mounted; listed and labeled as defined in NFPA 70, by qualified testing agency, and marked for intended location and application.
10. Trip Mechanism: Battery-powered electronic sensor; listed and labeled as defined in NFPA 70, by qualified testing agency, and marked for intended location and application.
11. Consumption: 1.28 gal. per flush.
12. Minimum Inlet: NPS 1.
13. Minimum Outlet: NPS 1-1/4.

2.5 TOILET SEATS

A. Toilet Seats: .

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Standard.
 - b. Church Seats; Bemis Manufacturing Company.
 - c. Kohler Co.
 - d. TOTO USA, INC.
 - e. Zurn Industries, LLC.
2. Source Limitations: Obtain toilet seat from single source from single manufacturer.
3. Material: Plastic.
4. Type: Commercial (Heavy duty).
5. Shape: Elongated rim, open front.
6. Hinge: Self-sustaining, check.

7. Hinge Material: Noncorroding metal.
8. Seat Cover: Not required.
9. Color: White.
10. Surface Treatment: Antimicrobial.

2.6 SUPPORTS

A. Water-Closet Carrier:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jay R. Smith Mfg Co; a division of Morris Group International.
 - b. MIFAB, Inc.
 - c. Zurn Industries, LLC.
2. Source Limitations: Obtain water-closet carrier from single source from single manufacturer.
3. Description: Waste-fitting assembly, as required to match drainage piping material and arrangement with faceplates, couplings gaskets, and feet; bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for water-supply piping and sanitary drainage and vent piping systems to verify actual locations of piping connections before water-closet installation.
- B. Examine walls and floors for suitable conditions where water closets will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Water-Closet Installation:

1. Install level and plumb.
2. Install floor-mounted water closets on bowl-to-drain connecting fitting attachments to piping or building substrate.

3. Install accessible, wall-mounted water closets at mounting height in accordance with ICC A117.1.

B. Support Installation:

1. Install supports, affixed to building substrate, for floor-mounted, back-outlet water closets.
2. Use carrier supports with waste-fitting assembly and seal.
3. Install floor-mounted, back-outlet water closets attached to building floor substrate, onto waste-fitting seals; and attach to support.
4. Install wall-mounted, back-outlet water-closet supports with waste-fitting assembly and waste-fitting seals; and affix to building substrate.
5. Measure support height installation from finished floor, not structural floor.

C. Flushometer-Valve Installation:

1. Install flushometer-valve, water-supply fitting on each supply to each water closet.
2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
3. Install lever-handle flushometer valves for accessible water closets with handle mounted on open side of water closet.
4. Install actuators in locations easily reachable for people with disabilities.
5. Install new batteries in battery-powered, electronic-sensor mechanisms.

D. Install toilet seats on water closets.

E. Wall Flange and Escutcheon Installation:

1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork.
2. Install deep-pattern escutcheons if required to conceal protruding fittings.
3. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

F. Joint Sealing:

1. Seal joints between water closets and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
2. Match sealant color to water-closet color.
3. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.3 PIPING CONNECTIONS

- A. Connect water closets with water supplies and soil, waste, and vent piping. Use size fittings required to match water closets.
- B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."
- D. Where installing piping adjacent to water closets, allow space for service and maintenance.
- E. Install electrical devices furnished by manufacturer, but not factory mounted in accordance with NFPA 70 and NECA 1.

3.4 ADJUSTING

- A. Operate and adjust water closets and controls. Replace damaged and malfunctioning water closets, fittings, and controls.
- B. Adjust water pressure at flushometer valves to produce proper flow.
- C. Install new batteries in battery-powered, electronic-sensor mechanisms.

3.5 CLEANING AND PROTECTION

- A. Clean water closets and fittings with manufacturers' recommended cleaning methods and materials.
- B. Install protective covering for installed water closets and fittings.
- C. Do not allow use of water closets for temporary facilities unless approved in writing by Owner.

END OF SECTION 224213.13

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SECTION 224213.16 - COMMERCIAL URINALS

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. Wall-hung urinals.
 - 2. Urinal flushometer valves.
 - 3. Supports.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for urinals.
 - 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. Operation and Maintenance Data: For flushometer valves and electronic sensors to include in operation and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Flushometer-Valve Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than one of each type.

2. Waterless Urinal Trap-Seal Liquid: Equal to 1 gal. for each urinal installed.

PART 2 - PRODUCTS

2.1 WALL-HUNG URINALS

- A. Urinals - Wall Hung, Back Outlet, Washout: Accessible.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Standard.
 - b. Gerber Plumbing Fixtures LLC.
 - c. Kohler Co.
 - d. TOTO USA, INC.
 - e. Zurn Industries, LLC.
2. Fixture:
 - a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5/CSA B45.15.
 - b. Material: Vitreous china.
 - c. Type: Washout with extended shields.
 - d. Strainer or Trapway: Manufacturer's standard strainer with integral trap.
 - e. Water Consumption: 0.125 gpf.
 - f. Spud Size and Location: NPS 3/4, top.
 - g. Outlet Size and Location: NPS 2, back.
 - h. Color: White.
3. Waste Fitting:
 - a. Standard: ASME A112.18.2/CSA B125.2 for coupling.
 - b. Size: NPS 2.
4. Support: Type I urinal carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture. Include rectangular, steel uprights.

2.2 URINAL FLUSHOMETER VALVES

- A. Solenoid-Actuator, Diaphragm Flushometer Valves: .

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

- a. [American Standard.](#)
 - b. [Gerber Plumbing Fixtures LLC.](#)
 - c. [Sloan Valve Company.](#)
 - d. [Zurn Industries, LLC.](#)
2. Standard: ASSE 1037/ASME 112.1037/CSA B125.37.
 3. Minimum Pressure Rating: 125 psig.
 4. Features: Include integral check stop, backflow-prevention device, and manual override button.
 5. Material: Brass body with corrosion-resistant components.
 6. Exposed Flushometer-Valve Finish: Chrome plated metal.
 7. Panel Finish: Chrome plated or stainless steel.
 8. Style: Exposed.
 9. Actuator: Solenoid complying with UL 1951; listed and labeled as defined in NFPA 70, by a qualified testing agency; and marked for intended location and application.
 10. Trip Mechanism: Battery-powered electronic sensor complying with UL 1951; listed and labeled as defined in NFPA 70, by a qualified testing agency; and marked for intended location and application.
 11. Consumption: 0.125 gal. per flush.
 12. Minimum Inlet: NPS 3/4.
 13. Minimum Outlet: NPS 3/4.

2.3 SUPPORTS

A. Type I Urinal Carrier:

1. [Manufacturers:](#) Subject to compliance with requirements, provide products by one of the following:
 - a. [Jay R. Smith Mfg Co; a division of Morris Group International.](#)
 - b. [Josam Company.](#)
 - c. [WATTS.](#)
 - d. [Zurn Industries, LLC.](#)
2. Standard: ASME A112.6.1M.

B. Type II Urinal Carrier:

1. [Manufacturers:](#) Subject to compliance with requirements, provide products by one of the following:
 - a. [Jay R. Smith Mfg Co; a division of Morris Group International.](#)

- b. [Josam Company.](#)
- c. [WATTS.](#)
- d. [Zurn Industries, LLC.](#)

- 2. Standard: ASME A112.6.1M.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before urinal installation.
- B. Examine walls and floors for suitable conditions where urinals will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Urinal Installation:

- 1. Install urinals level and plumb according to rough-in drawings.
- 2. Install wall-hung, back-outlet urinals onto waste fitting seals and attached to supports.
- 3. Install wall-hung, bottom-outlet urinals with tubular waste piping attached to supports.
- 4. Install accessible, wall-mounted urinals at mounting height for the handicapped/elderly, according to ICC A117.1.
- 5. Install trap-seal liquid in waterless urinals.

B. Support Installation:

- 1. Install supports, affixed to building substrate, for wall-hung urinals.
- 2. Use off-floor carriers with waste fitting and seal for back-outlet urinals.
- 3. Use carriers without waste fitting for urinals with tubular waste piping.
- 4. Use chair-type carrier supports with rectangular steel uprights for accessible urinals.

C. Flushometer-Valve Installation:

- 1. Install flushometer-valve water-supply fitting on each supply to each urinal.
- 2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.

3. Install lever-handle flushometer valves for accessible urinals with handle mounted on open side of compartment.
4. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

D. Wall Flange and Escutcheon Installation:

1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations.
2. Install deep-pattern escutcheons if required to conceal protruding fittings.
3. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

E. Joint Sealing:

1. Seal joints between urinals and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
2. Match sealant color to urinal color.
3. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.3 PIPING CONNECTIONS

- A. Connect urinals with water supplies and soil, waste, and vent piping. Use size fittings required to match urinals.
- B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."
- D. Where installing piping adjacent to urinals, allow space for service and maintenance.

3.4 ADJUSTING

- A. Operate and adjust urinals and controls. Replace damaged and malfunctioning urinals, fittings, and controls.
- B. Adjust water pressure at flushometer valves to produce proper flow.
- C. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

3.5 CLEANING AND PROTECTION

- A. Clean urinals and fittings with manufacturers' recommended cleaning methods and materials.
- B. Install protective covering for installed urinals and fittings.
- C. Do not allow use of urinals for temporary facilities unless approved in writing by Owner.

END OF SECTION 224213.16

SECTION 224216.13 - COMMERCIAL LAVATORIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Vitreous-china, wall-mounted lavatories.
 - 2. Lavatory systems.
 - 3. Manually operated lavatory faucets.
 - 4. Automatically operated lavatory faucets.
 - 5. Supply fittings.
 - 6. Waste fittings.
 - 7. Lavatory supports.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for lavatories.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: Include diagrams for power, signal, and control wiring of automatic faucets.

1.3 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For lavatories and faucets to include in operation and maintenance manuals.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
 - 2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.

PART 2 - PRODUCTS

2.1 VITREOUS-CHINA, WALL-MOUNTED LAVATORIES

- A. Lavatory - Vitreous China, Wall Mounted,;
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Standard.
 - b. Gerber Plumbing Fixtures LLC.
 - c. Sloan Valve Company.
 - d. Zurn Industries, LLC.
 2. Fixture:
 - a. Standard: ASME A112.19.2/CSA B45.1.
 - b. Type: For wall hanging.
 - c. Nominal Size: Rectangular, 20 by 18 inches .
 - d. Faucet-Hole Punching: Three holes, 2-inch centers.
 - e. Faucet-Hole Location: Top.
 - f. Color: White.
 - g. Mounting Material: Chair carrier.
 3. Support: Type II, concealed-arm lavatory carrier. Include rectangular, steel uprights.

2.2 LAVATORY SYSTEMS

- A. Lavatory System - Single or Multiple Stations:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Bradley Corporation.
 - b. Sloan Valve Company.
 - c. Willoughby.
 - d. Zurn Industries, LLC.
 2. Standards: ASME A112.18.1/CSA B125.1, ANSI A117.1, CSA B45.5/IAPMO Z124, NSF 61, NSF 372, and UPC, IPC, and GREENGUARD Certified.
 3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 4. Bowl(s) and Counter:
 - a. Material: Solid-surface or natural quartz surface.
 - b. Color or Finish: Selected by architect from full list available.
 - c. Access Panel: Full stainless steel access panel.
 - d. Mounting: Wall hung.
 - e. Drain: Grid with NPS 1-1/2 tailpiece, each bowl.

5. Faucets:
 - a. Type: Manufacturer's standard, chrome-plated solid brass, each bowl.
 - b. Control: Battery-powered, sensor actuated, pressure-balancing thermostatic mixing valve with check stops for each user station .
6. Mounting: Off floor on wall brackets and frame enclosure.
7. Supply Fittings:
 - a. Piping: **NPS 1/2 (DN 15)** copper tubing, each bowl.
 - b. Valves: Shutoff valve on each supply.
 - c. Supply Piping: From wall.
8. Waste Fittings:
 - a. Standard: ASME A112.18.2/CSA B125.2.
 - b. Trap and Drain Piping: **NPS 1-1/2 (DN 40)**, each bowl.

2.3 AUTOMATICALLY OPERATED LAVATORY FAUCETS

- A. Lavatory faucets intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), requirements of the Authority Having Jurisdiction (AHJ), and with NSF 61/NSF 372, or be certified in compliance with NSF 61/NSF 372 by an American National Standards Institute (ANSI) accredited third-party certification body, that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.
- B. Lavatory Faucets - Automatic Type: Battery Powered Electronic Sensor Operated, Mixing,:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Chicago Faucets; Geberit Company.
 - b. Kohler Co.
 - c. Krowne.
 - d. Moen Incorporated.
 - e. Zurn Industries, LLC.
 2. Standards: ASME A112.18.1/CSA B125.1 and UL 1951.
 3. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 4. General: Include hot- and cold-water indicators and thermostatic mixing valve; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.
 5. Body Type: Three hole.
 6. Body Material: Commercial, solid-brass, or die-cast housing with brazed copper and brass waterway.
 7. Finish: Polished chrome plate.
 8. Maximum Flow Rate: **0.5 gpm (1.5 L/min.)**.

- 9. Mounting Type: Deck, concealed.
- 10. Spout: Rigid type.
- 11. Spout Outlet: Aerator.

2.4 SUPPLY FITTINGS

- A. NSF Standard: Comply with NSF 61 and NSF 372 for supply-fitting materials that will be in contact with potable water.
- B. Standard: ASME A112.18.1/CSA B125.1.
- C. Supply Piping: Chrome-plated-brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated-brass or stainless steel wall flange.
- D. Supply Stops: Chrome-plated-brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.
- E. Operation: Loose key.
- F. Risers:
 - 1. **NPS 1/2**
 - 2. ASME A112.18.6/CSA B125.6, braided- or corrugated-stainless steel, flexible hose riser.

2.5 WASTE FITTINGS

- A. Standard: ASME A112.18.2/CSA B125.2.
- B. Drain: Grid type with **NPS 1-1/4** offset and straight tailpiece.
- C. Trap:
 - 1. Size: **NPS 1-1/2 by NPS 1-1/4** .
 - 2. Material:
 - a. Chrome-plated, two-piece, cast-brass trap and ground-joint swivel elbow with **0.032-inch** thick brass tube to wall; and chrome-plated, brass or steel wall flange.
 - b. Stainless steel, two-piece trap and swivel elbow with **0.012-inch** thick stainless steel tube to wall, and stainless steel wall flange.

2.6 LAVATORY SUPPORTS

- A. Lavatory Carrier:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jay R. Smith Mfg Co; a division of Morris Group International.
 - b. Josam Company.
 - c. WATTS.
 - d. Zurn Industries, LLC.
2. Standard: ASME A112.6.1M.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before lavatory installation.
- B. Examine counters and walls for suitable conditions where lavatories will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install lavatories level and plumb in accordance with roughing-in drawings.
- B. Install supports, affixed to building substrate, for wall-mounted lavatories.
- C. Install accessible wall-mounted lavatories at handicapped/elderly mounting height for people with disabilities or the elderly, in accordance with ICC A117.1.
- D. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings.
- E. Seal joints between lavatories, counters, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color.
- F. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories.
- G. Install ASSE 1070 Mixing valve at each lavatory faucet.

3.3 PIPING CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, mixing valve, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

3.4 ELECTRICAL CONNECTIONS

- A. Install electrical devices furnished by manufacturer, but not factory mounted in accordance with NFPA 70 and NECA 1.
- B. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
 - 1. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least **1/2 inch** high.

3.5 ADJUSTING

- A. Operate and adjust lavatories and controls. Replace damaged and malfunctioning lavatories, fittings, and controls.
- B. Install new batteries in battery-powered, electronic-sensor mechanisms.

3.6 CLEANING AND PROTECTION

- A. After completing installation of lavatories, inspect and repair damaged finishes.
- B. Clean lavatories, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
- C. Provide protective covering for installed lavatories and fittings.
- D. Do not allow use of lavatories for temporary facilities unless approved in writing by Owner.

END OF SECTION 224216.13

SECTION 224216.16 - COMMERCIAL SINKS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Service sinks.
 - 2. Kitchen/utility sinks.
 - 3. Handwash sinks.
 - 4. Manually operated sink faucets.
 - 5. Automatically operated sink faucets.
 - 6. Supply fittings.
 - 7. Waste fittings.
 - 8. Sink supports.
 - 9. Grout.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for sinks.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Counter cutout templates for mounting of counter-mounted sinks.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For sinks and faucets to include in 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. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed but not less than 3.
 - 2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed but not less than 3.

PART 2 - PRODUCTS

2.1 SERVICE SINKS

- A. Service Sinks - Terrazzo, Floor Mounted: MSB-1.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Engineering Company; a Division of Morris Group International.
 - b. Florestone Products Co., Inc.
 - c. Krowne.
 - d. Stern-Williams Co., Inc.
 - 2. Source Limitations: Obtain sinks from single source from single manufacturer.
 - 3. Fixture:
 - a. Material: Marble chips cast in portland cement to produce a compressive strength of not less than 3000 psi, seven days after casting.
 - b. Shape: Square.
 - c. Nominal Size: 36 by 36 inches.
 - d. Height: 12 inches with dropped front.
 - e. Tiling Flange: On two sides.
 - f. Rim Guard: On all top surfaces.
 - g. Color: Not applicable.
 - h. Drain: Grid with NPS 3 outlet.

- i. Wall Guard: 24 inch tall Stainless Steel guard on all adjacent walls.
- 4. Mounting: On floor and flush to wall.
- 5. Faucet: Manually Operated Sink Faucet.

2.2 KITCHEN/UTILITY SINKS

A. Kitchen/Utility Sinks - Stainless Steel, Counter Mounted or Under Mounted: .

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Advance Tabco.
 - b. Elkay.
 - c. Just Manufacturing.
- 2. Source Limitations: Obtain sinks from single source from single manufacturer.
- 3. Fixture:
 - a. Standard: ASME A112.19.3/CSA B45.4.
 - b. Type: Stainless steel, self-rimming, sound-deadened unit less ledge back .
 - c. Material: 18 gauge, Type 304 stainless steel.
 - d. Compartment:
 - 1) Drain: NPS 1-1/2 tailpiece with stopper.
 - 2) Drain Location: Off center near back of compartment.
- 4. Faucet(s): Manually Operated Sink Faucet.
 - a. Mounting: On ledge or countertop.
- 5. Supply Fittings:
 - a. Standard: ASME A112.18.1/CSA B125.1.
 - b. Supplies: Chrome-plated brass compression stop with inlet connection matching water-supply piping type and size.
 - 1) Operation: Loose key.
 - 2) Risers: NPS 1/2, ASME A112.18.6/CSA B125.6, braided or corrugated stainless steel flexible hose.
- 6. Waste Fittings:
 - a. Standard: ASME A112.18.2/CSA B125.2.

b. Trap(s):

- 1) Size: NPS 1-1/2.
- 2) Material:

- a) Chrome-plated, two-piece, cast-brass trap and ground-joint swivel elbow with 17-gauge brass tube to wall; and chrome-plated brass or steel wall flange.

c. Continuous Waste:

- 1) Size: NPS 1-1/2.
- 2) Material: Chrome-plated, 17-gauge brass tube.

7. Mounting: On counter with sealant.

2.3 MANUALLY OPERATED SINK FAUCETS

- A. Sink faucets intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), with requirements of the Authority Having Jurisdiction (AHJ), and with NSF 61 and NSF 372, or be certified in compliance with NSF 61 and NSF 372 by an ANSI-accredited third-party certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

B. Commercial Sink Faucets - Manual Type: Two-handle mixing.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Standard.
 - b. Chicago Faucets; Geberit Company.
 - c. Elkay.
 - d. Just Manufacturing.
 - e. Zurn Industries, LLC.
2. Source Limitations: Obtain sink faucets from single source from single manufacturer.
3. Standard: ASME A112.18.1/CSA B125.1.
4. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and sink receptor.
5. Body Type: Centerset.

6. Body Material: Commercial, solid brass, or die-cast housing with brazed copper and brass waterway.
7. Finish: Polished chrome plate.
8. Maximum Flow Rate: 1.5 gpm.
9. Mounting Type: Deck, concealed.
10. Valve Handle(s): 4-inch wrist blade.
11. Spout Type: Swivel gooseneck.
12. Spout Outlet: Aerator.
13. Thermostatic Mixing Valve: ASSE 1070 below deck, with check valves.

C. Commercial Service Sink Faucets - Manual Type:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Chicago Faucets; Geberit Company.
 - b. Kohler Co.
 - c. Stern-Williams Co., Inc.
 - d. Zurn Industries, LLC.
2. Source Limitations: Obtain sink faucets from single source from single manufacturer.
3. Description: Wall/back mounted, brass body, with integral service stops, checks, spout with bucket/pail hook, 3/4-inch hose thread end, integral vacuum breaker, inlets 8 inches o.c., and two-handle mixing.
4. Faucet:
 - a. Standards:
 - 1) ASME A112.18.1/CSA B125.1.
 - 2) NSF 61 and NSF 372.
 - 3) ICC A117.1.
 - 4) ASSE 1001 (VB).
 - b. Finish: Polished chrome plated.
 - c. Handles: 4-inch wrist blade.
 - d. Cartridges: One-fourth turn compression.
 - e. Brace: Adjustable top brace.

2.4 SUPPLY FITTINGS

- A. NSF Standard: Comply with NSF 61 and NSF 372 for supply-fitting materials that will be in contact with potable water.
- B. Standard: ASME A112.18.1/CSA B125.1.
- C. Supply Piping: Chrome-plated brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated brass or stainless steel wall flange.
- D. Supply Stops: Chrome-plated brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.
- E. Operation: Loose key.
- F. Risers:
 - 1. NPS 1/2.
 - 2. ASME A112.18.6/CSA B125.6, braided or corrugated stainless steel flexible hose.

2.5 WASTE FITTINGS

- A. Standard: ASME A112.18.2/CSA B125.2.
- B. Drain: Grid type with NPS 1-1/2 offset and straight tailpiece.
- C. Trap:
 - 1. Size: NPS 1-1/2.
 - 2. Material:
 - a. Chrome-plated, two-piece, cast-brass trap and ground-joint swivel elbow with 17-gauge brass tube to wall; and chrome-plated brass or steel wall flange.

2.6 GROUT

- A. Standard: ASTM C1107/C1107M, 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 EXAMINATION

- A. Examine roughing-in for water-supply piping and sanitary drainage and vent piping systems to verify actual locations of piping connections before sink installation.
- B. Examine walls, floors, and counters for suitable conditions where sinks will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install sinks level and plumb in accordance with rough-in drawings.
- B. Install supports, affixed to building substrate, for wall-hung sinks.
- C. Install wall-mounted sinks at accessible mounting height in accordance with ICC A117.1.
- D. Set floor-mounted sinks in leveling bed of cement grout.
- E. Install water-supply piping with stop on each supply to each sink faucet.
 - 1. Install stops in locations where they can be easily reached for operation.
- F. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings.
- G. Seal joints between sinks and counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color.
- H. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks.
- I. Install ASSE 1070 mixing valve at each sink faucet.

3.3 PIPING CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, mixing valve, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

3.4 ELECTRICAL CONNECTIONS

- A. Install electrical devices furnished by manufacturer, but not factory mounted in accordance with NFPA 70 and NECA 1.
- B. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
 - 1. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.5 ADJUSTING

- A. Operate and adjust sinks and controls. Replace damaged and malfunctioning sinks, fittings, and controls.
- B. Install new batteries in battery-powered, electronic-sensor mechanisms.

3.6 CLEANING AND PROTECTION

- A. After completing installation of sinks, inspect and repair damaged finishes.
- B. Clean sinks, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
- C. Provide protective covering for installed sinks and fittings.
- D. Do not allow use of sinks for temporary facilities unless approved in writing by Owner.

END OF SECTION 224216.16

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Shower heads and shower valves.

1.2 DEFINITIONS

- A. FRP: Fiberglass-reinforced plastic.
- B. PMMA: Polymethyl methacrylate; also known as "acrylic."

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for showers and basins.
 - 2. Include rated capacities, operating characteristics, and furnished specialties and accessories.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For shower valves 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. Shower Valve Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
 - 2. Shower Valve Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Shower valves intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), with requirements of the Authority Having Jurisdiction (AHJ), and with NSF 61 and NSF 372, or be certified in compliance with NSF 61 and NSF 372 by an ANSI-accredited third-party certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

2.2 SHOWER HEADS AND SHOWER VALVES

- A. Shower Head with Single-Handle, Thermostatic/Pressure-Balancing Mixing Valve: .
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Chicago Faucets; Geberit Group.
 - b. Kohler Co.
 - c. Lawler Manufacturing Company, Inc.
 - d. POWERS; A WATTS Brand.
 - e. Zurn Industries, LLC.
 2. Source Limitations: Obtain shower heads and shower valves from single source from single manufacturer.
 3. Description: Single-handle, accessible, thermostatic/pressure-balancing mixing valve with hot- and cold-water indicators; diverting valve check stops; and hose with handheld shower head on sliding rod shower head.
 4. Shower Valve:
 - a. Standards: ASME A112.18.1/CSA B125.1 and ASSE 1016/ASME A112.1016/CSA B125.16.
 - b. Body Material: Solid brass.
 - c. Finish: Polished chrome plate.
 - d. Mounting: Concealed.
 - e. Operation: Single-handle, twist or rotate control.
 - f. Antiscald Device: Integral with mixing valve.
 - g. Check Stops: Check-valve type, integral with or attached to body; on hot- and cold-water supply connections.
 5. Supply Connections: **NPS 1/2 (DN 15).**

6. Shower Head:

- a. Standard: ASME A112.18.1/CSA B125.1.
- b. Type: Ball joint with arm and flange.
- c. EPA WaterSense: Required.
- d. Shower Head Maximum Flow Rate: [1.5 gpm (5.7 L/min.)] [1.75 gpm (6.6 L/min.)] [2.0 gpm (7.6 L/min.)] [2.5 gpm (9.5 L/min.)].
- e. Shower Head Material: Metallic with chrome-plated finish.
- f. Spray Pattern: Adjustable.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine rough-in of water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before shower installation.
- B. Examine walls and floors for suitable conditions where showers will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Assemble shower components according to manufacturers' written instructions.
- B. Install showers level and plumb.
- C. Install shower flow-control fittings with specified maximum flow rates in shower arms.
- D. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheons requirements specified in Section 220500 "Common Work Results for Plumbing."
- E. Seal joints between showers and floors and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.3 PIPING 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. Comply with traps and soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

- A. Operate and adjust showers and controls. Replace damaged and malfunctioning showers, fittings, and controls.
- B. Adjust water pressure at shower valves to produce proper flow.

3.5 CLEANING AND PROTECTION

- A. After completing installation of showers and basins, inspect and repair damaged finishes.
- B. Clean showers and basins, shower valves, and other fittings with manufacturers' recommended cleaning methods and materials.
- C. Provide protective covering for installed fixtures and fittings.
- D. Do not allow use of showers and basins for temporary facilities unless approved in writing by Owner.

END OF SECTION 224223

SECTION 224500 - EMERGENCY PLUMBING FIXTURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Emergency showers.
2. Eye/face wash equipment.
3. Combination units.
4. Laboratory recessed safety station.
5. Water-tempering equipment.

1.2 DEFINITIONS

- A. Accessible Fixture: Emergency plumbing fixture that can be approached, entered, and used by people with disabilities.
- B. Plumbed Emergency Plumbing Fixture: Fixture with fixed, potable-water supply.
- C. Portable, Self-Contained Emergency Plumbing Fixture: Fixture with flushing-fluid supply.
- D. Tepid: Between 60 and 100 deg F (16 and 38 deg C).

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include flow rates and capacities, furnished specialties, and accessories.
- B. Shop Drawings:
1. Plans, elevations, sections, mounting and attachment details.
 2. Details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 3. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

1.4 INFORMATIONAL SUBMITTALS

- A. Field Quality-Control Submittals:
 - 1. Field quality-control reports.
- B. Emergency fixture third-party certification documentation.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For emergency plumbing fixtures.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Extra Stock Material: Furnish extra materials to Owner that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Flushing-Fluid Solution: Separate lot and equal to at least 200 percent of amount of solution installed for each self-contained unit.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Comply with ANSI/ISEA Z358.1 for emergency plumbing fixtures including third-party certification of fixtures.
- B. Comply with ASSE 1071 for temperature-actuated mixing valves for plumbed emergency fixtures.
- C. Comply with ASME A112.18.1/CSA B125.1 for water-supply fittings.
- D. Comply with ASME A112.18.2/CSA B125.2 for plumbing waste fittings.
- E. Comply with NSF 61 and NSF 372 for fixture materials that will be in contact with potable water.
- F. Comply with requirements in ICC A117.1 for plumbing fixtures for people with disabilities.

2.2 EYE/FACE WASH EQUIPMENT

A. Eye/Face Wash Units - Accessible, Wall Mounted, Plumbed: .

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Safety; a Division of Morris Group International.
 - b. Bradley Corporation.
 - c. Guardian Equipment Co.
 - d. Stingray Systems LLC.
2. Source Limitations: Obtain eye/face wash units, accessible, wall mounted, plumbed, from single manufacturer.
3. Capacity: Not less than 3.0 gpm (11.4 L/min.) for at least 15 minutes.
4. Supply Piping: NPS 1/2 (DN 15) chrome-plated brass or stainless steel with flow regulator and stay-open control valve.
5. Control-Valve Actuator: Paddle.
6. Spray-Head Assembly: Two or four receptor-mounted spray heads.
7. Receptor: Chrome-plated brass or stainless steel bowl.
8. Mounting: Wall bracket.
9. Accessories:
 - a. Thermostatic mixing valve assembly including ball valve shutoffs and outlet temperature gauge.
 - b. Dust covers.

2.3 WATER-TEMPERING EQUIPMENT

A. Water-Tempering Equipment - Hot and Cold Water: .

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Safety; a Division of Morris Group International.
 - b. Bradley Corporation.
 - c. Guardian Equipment Co.
 - d. Lawler Manufacturing Company, Inc.
 - e. Leonard Valve Company.
2. Source Limitations: Obtain water-tempering equipment, hot and cold water, from single manufacturer.
3. Description: Factory-fabricated equipment with thermostatic mixing valve.

- a. Thermostatic Mixing Valve: Designed to provide 85 deg F (29 deg C) tepid, potable water at emergency plumbing fixtures, to maintain temperature at plus or minus 5 deg F (3 deg C) 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.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for water and waste piping systems to verify actual locations of piping connections before plumbed emergency plumbing fixture installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF EMERGENCY PLUMBING FIXTURE

- 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, to facilitate maintenance of equipment. Use ball or gate 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.
- E. Install dielectric fitting in supply piping to emergency equipment if piping and equipment connections are made of different metals.
- F. Install thermometers in supply and outlet piping connections to water-tempering equipment.
- G. Install trap and waste piping on drain outlet of emergency equipment receptors that are indicated to be directly connected to drainage system.
- H. Install indirect waste piping on drain outlet of emergency equipment receptors that are indicated to be indirectly connected to drainage system.

- I. 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."
- J. Fill self-contained fixtures with flushing fluid.

3.3 PIPING CONNECTIONS

- A. Connect hot- and cold-water-supply piping to hot- and cold-water, water-tempering equipment. Connect output from water-tempering equipment to emergency plumbing fixtures.
- B. Directly connect emergency plumbing fixture receptors with trapped drain outlet to sanitary waste and vent piping.
- C. Where installing piping adjacent to emergency plumbing fixtures, allow space for service and maintenance of fixtures.

3.4 IDENTIFICATION

- A. Install equipment nameplates or equipment markers on emergency plumbing fixtures and equipment and equipment signs on water-tempering equipment.

3.5 FIELD QUALITY CONTROL

- A. Mechanical-Component Testing: After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve indicated capacities.
- B. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection.
 - 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 3. Emergency plumbing fixtures and water-tempering equipment will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.6 ADJUSTING

- A. Operate and adjust emergency plumbing fixtures and controls. Replace damaged and malfunctioning fixtures and controls.
- B. Adjust or replace fixture flow regulators for proper flow.
- C. Adjust equipment temperature settings.

3.7 CLEANING AND PROTECTION

- A. Clean emergency plumbing fixtures with manufacturers' recommended cleaning methods and materials.
- B. Install protective covering for installed emergency plumbing fixtures and fittings.
- C. Do not allow use of emergency plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 224500

SECTION 224716 - PRESSURE WATER COOLERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Pressure water coolers.
 - 2. Bottle filling stations.
 - 3. Supports.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of pressure water cooler and bottle filling station.
 - 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:
 - 1. Include diagrams for power wiring.

1.3 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For pressure water coolers and bottle filling stations to include in maintenance manuals.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Filter Cartridges: Equal to 10 percent of quantity installed for each type and size indicated, but no fewer than 3 of each.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Standards:

1. Pressure water coolers and bottle filling stations intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act (SDWA), requirements of the Authority Having Jurisdiction (AHJ), and with NSF 61 or NSF 372, or be certified in compliance with NSF 61 or NSF 372 by an ANSI-accredited third-party certification body, that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.
2. Comply with ASHRAE 34 for water coolers. Provide HFC 134a (tetrafluoroethane) refrigerant unless otherwise indicated.
3. Comply with UL 399.
4. Comply with ASME A112.19.3/CSA B45.4.
5. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
6. Comply with NSF 42 and NSF 53 for water filters for water coolers and bottle filling stations.
7. Comply with ICC A117.1 for accessible water coolers and bottle filling stations.

2.2 PRESSURE WATER COOLERS

A. Pressure Water Coolers - Surface Wall-Mounted, Stainless Steel: .

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Elkay.
 - b. Halsey Taylor.
 - c. Murdock Manufacturing; A Division of Morris Group International.
 - d. Oasis International.
2. Source Limitations: Obtain surface wall-mounted, stainless steel, pressure water coolers from single source from single manufacturer.
3. Bubbler: One, with adjustable stream regulator, located on each cabinet deck.
4. Control: Push button.
5. Bottle Filler: Sensor activation, with 20-second automatic shutoff timer: Fill rate **0.5 to 1.5 gpm (0.03155 to 0.09464 L/s).**
6. Drain: Grid with **NPS 1-1/4 (DN 32)** tailpiece.
7. Supply: **NPS 3/8 (DN 10)** with shutoff valve.
8. Waste Fitting: ASME A112.18.2/CSA B125.2, **NPS 1-1/4 (DN 32)** brass P-trap.
9. Filter: One or more water filters with capacity sized for unit peak flow rate.
10. 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.
11. Support: Water-cooler carrier.
12. Capacities and Characteristics:
 - a. Cooled Water: **8 gph (0.0084 L/s).**
 - b. Ambient-Air Temperature: **90 deg F (32 deg C).**

- c. Inlet-Water Temperature: 80 deg F (27 deg C).
- d. Cooled-Water Temperature: 50 deg F (10 deg C).
- e. Electrical Characteristics:
 - 1) Volts: 120 V ac.
 - 2) Phase: Single.
 - 3) Hertz: 60 Hz.

2.3 SUPPORTS

A. Water-Cooler Carrier:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jay R. Smith Mfg Co; a division of Morris Group International.
 - b. Josam Company.
 - c. Wade; a subsidiary of McWane Inc.
 - d. Zurn Industries, LLC.
- 2. Standard: ASME A112.6.1M.

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. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.
- C. Install mounting frames, affixed to building construction, and attach recessed, pressure water coolers, and bottle filling stations to mounting frames.

- D. Install water-supply piping with shutoff valve on supply to each fixture to be connected to domestic-water distribution piping. Use ball valve. Install valves in locations where they can be easily reached for operation.
- E. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.
- F. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding fittings.
- G. Seal joints between fixtures and walls using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color.

3.3 PIPING 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. Install ball shutoff valve on water supply to each fixture. Install valve upstream from filter for water cooler.

3.4 ELECTRICAL CONNECTIONS

- A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.
- C. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

3.5 ADJUSTING

- A. Adjust fixture flow regulators for proper flow and stream height.
- B. Adjust pressure water-cooler temperature settings.

3.6 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 224716

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SECTION 230500 - COMMON HVAC REQUIREMENTS

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 and all Division 23 Sections.

1.2 PLANS AND SPECIFICATIONS

- A. All work under this title, on drawings or specified, is subject to the general and special contract conditions for the entire project, and the contractor for this portion of the work is required to refer especially thereto, and to the architectural drawings.
- B. Drawings are diagrammatic and specifications are complementary and must be so interpreted to determine the full scope of work under this heading. Wherever any material, article, operation or method is either specified or shown on the drawings, this contractor is required to provide each item and perform each prescribed operation according to the designate quality, qualification or condition, furnishing all necessary labor, equipment or incidentals.
- C. Wherever the designation "Architect" appears, it shall imply Architect or Engineer. Wherever the term "Contractor" or "MC" appears, it shall imply the Contractor responsible for Division 23, Mechanical Work.

1.3 CONFLICTS

- A. If, in the interpretation of contract documents, it appears that the drawings and specifications are not in agreement, the Contractor is to contact the Engineer. The Engineer shall be the final authority. Addenda supersede the provisions which they amend.
- B. In the absence of a written clarification by the engineer, the Contractor must install his work in accordance with the more stringent and/or costly condition. Contractor assumes full responsibility for any and all items furnished and installed without the written approval by the Architect or Engineer. Under no circumstances will a change order be approved for work installed that was not approved by the Architect or Engineer.

1.4 DIMENSIONS, LAYOUTS AND OBSTACLES

- A. Verify dimensions and elevations from actual field measurements after building construction has sufficiently progressed.
- B. Assume full and final responsibility for the accuracy of any or all work performed under this Division and make repairs and corrections as required or directed at no extra cost to the Owner.
- C. Layouts of piping, ductwork, and equipment shown on drawings are diagrammatic. Contractor shall verify dimensions and layouts for specific project conditions, field verify any existing conditions, and coordinate with all other trades prior to procurement, fabrication and installation of equipment and material. Existing Conditions shall be field verified by contractor prior to bid submissions. Unknown conditions during construction due to omission of contractor field verification prior to bid shall be resolved by the contractor at no cost to the owner or project. Contractor assumes full responsibility for completeness of installation including coordination of work with other trades.
- D. Make actual installations in accord with design layouts, but with necessary adjustments as determined by trade coordination, actual material and equipment procured, field verifications, and other project conditions in order to provide a fully functional and complete system, save and maintainable in all aspects. Any such required adjustments and deviations shall require specific approval of the Engineer/Architect prior to procurement, fabrication, and installation.
- E. Take particular care to coordinate all piping, ductwork, and equipment under this Division to prevent conflict and remove and relocate work as may be made necessary by such conflict at no extra cost to the Owner or project.
- F. Unless expressly permitted by the Engineer/Architect or shown otherwise on the Drawings, all piping, ducts and similar items shall be installed so that they are concealed except as permitted by the Engineer/Architect in service rooms noted on the Drawings.
- G. The Owner or Owner's Representative reserves the right to relocate terminal equipment six (6) feet in any direction from locations indicated on plans, before roughing-in, with no extra cost to the Owner or project.

1.5 REVIEW OF PROPOSED EQUIPMENT AND MATERIALS

- A. Submittals:
 - 1. Contractor shall submit a complete list and schedule, including all proposed equipment and materials to the Construction Manager or Owner's Representative and Engineer for review and approval within 10 business days of contract award..

2. Submit all proposed material, equipment, and fabrication shop drawings to the Engineer for approval prior to procurement, fabrication, and installation.

B. Substitution Requests:

1. Substitutions are defined as any manufacturer and/or model not indicated in drawings or specifications. Requests for substitutions must be made in writing ten (10) days prior to bid date so that an addendum may reach all contractors.
2. In addition to other contract provisions regarding substitution requests, , Contactor must certify by letter that he has checked the proposed substitution products or materials for conformance to applicable codes, standards, and regulations, specifications, and space limitations and assumes full responsibility thereafter.
3. Approval of substitution requests is at the sole discretion of the Engineer and Owner.
4. If substitutions are proposed after the bids are received, the Contractor shall state amount of credit to the Owner for substitution. Substitutions that are considered equal by the Contractor and carried in bid without approval by Engineer shall be the responsibility of the Contractor. The Engineer and/or Owner shall not be made liable or responsible for losses incurred by the Contractor, due to the rejection of said items for installation.
5. Where equipment requiring different arrangement or connections other than as indicated is acceptable, it shall be the responsibility of this Contractor to furnish revised layouts and install the equipment to operate properly and in harmony with the intent of the drawings and specifications. All changes in the work required by the different arrangement shall be done at no additional cost to the Owner or Project, including but not limited to structural steel modifications. Control and power wiring modifications required by Contractor, imposed modifications, and the additional cost of these modifications, shall be the responsibility of this Contractor.

1.6 PERMITS, CODES AND ORDINANCES

- A. The Contractor shall arrange and pay for all permits, inspections, etc., as required by local utilities or applicable agencies.
- B. All work and material shall be in complete accordance with the ordinances, regulations, codes, etc., of all political entities exercising jurisdictions.

1.7 QUALITY ASSURANCE

- A. Install HVAC Systems in accordance with applicable industry standards.

- B. Install HVAC Systems in accordance with manufacturer's installation, operations and maintenance instructions.

1.8 COORDINATION WITH OTHER TRADES

- A. Check mechanical drawings with all other trades including electrical, plumbing, fire protection and general construction.
- B. Anticipate, avoid, and resolve interferences with other trades.
- C. Take particular care to coordinate all piping, ductwork, plumbing and major electrical components above ceiling, to prevent conflict. Remove and relocate work as may be made necessary by such conflict, at no extra cost to the Owner. The use of coordination drawings is recommended but may not be required (refer to Division 1 for additional requirements). Lack of coordination drawings assumes contractor has verified and coordinated all work associated with installation.
- D. Obtain decision for approval from project Engineer for proposed grouped installations before proceeding, and for clearance in structure and finish of the building.
- E. Verify with drawings all ductwork and equipment layout in concealed areas.
- F. The Contractor to coordinate with, receive and install, Owner furnished equipment where indicated.
- G. Coordinate location of controls and instrumentation devices, including but not limited to control valves, control dampers, thermowells, pressure probes, flow switches, insertion flow meters, and ultrasonic flow meters, with Building Automation System (BAS) requirements.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Delivery of Materials: Make provisions for delivery and safe storage of all materials. Check and properly receipt material to be "furnished by others" to contractor and assume full responsibility for all materials while in storage with full visible identification and information.

1.10 PROJECT CONDITIONS

- A. Existing Conditions: Field verify existing conditions that will determine exact locations, distances, levels, dimensions, elevations, etc. Review all drawings of other trades and report any conflicts to the Architect/Engineer which will affect the project cost. Lack of field verification does not constitute a basis for change orders and additional costs

incurred by the owner or project. Contractor assumes full responsibility for completeness of installation including coordination of work with other trades.

- B. Existing facilities shall be considered occupied and functioning during the entire duration of construction. Care shall be taken when working in or around occupied spaces. There will be no interruption in mechanical systems or utilities without written approval from the Owner.

1.11 SUPPORTS

- A. Mechanical Contractor is responsible for providing all support components necessary for properly supporting HVAC Systems including hangers, rods, anchors, steel, and bases.

PART 2 - PRODUCTS (not used)

PART 3 - EXECUTION

3.1 COMMON HVAC SYSTEMS INSTALLATION REQUIREMENTS

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of HVAC systems.
- B. Indicated locations and arrangements were used to size systems and address other design considerations. Install systems as indicated unless deviations to layout are approved by Architect and Engineer.
- C. Install systems in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install systems indicated to be exposed and in equipment rooms and service areas at right angles or parallel to building walls.
- E. Install equipment level and plumb, parallel and perpendicular to other building systems and components, unless otherwise indicated.
- F. Install equipment to allow maximum possible headroom unless specific mounting heights are indicated.
- G. Diagonal runs of piping and ductwork are prohibited unless specifically indicated otherwise.
- H. Install systems above accessible ceilings to allow sufficient space for ceiling panel removal.

- I. Install systems and 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
- J. Install equipment with all required manufacturer's service clearances maintained.
- K. Install systems at indicated slopes.
- L. Install systems free of sags and bends.
- M. Install fittings for changes in direction and branch connections.
- N. Install systems to allow application of insulation.
- O. Select system components with pressure rating equal to or greater than system operating pressure.
- P. Install escutcheons for penetrations of walls, ceilings, and floors.
- Q. Running pipe and ductwork over electrical equipment and in elevator machine rooms is prohibited.
- R. Running piping and ductwork into or through interior exit stairways, other than systems serving such stairwells as permitted by the International Building Code, is prohibited.
- S. Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe and duct penetrations. Such Penetrations shall be sealed with firestop materials and required fire and smoke rated dampers shall be provided.
- T. Install HVAC systems on required supports and bases meeting maximum allowable spans and sized for the specific loads.
- U. Install controls and instrumentation devices for HVAC systems required for system operations and as indicated.

END OF SECTION 230500

SECTION 230502 – COMMON HVAC DEMOLITION REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Description of Work: Provide removal systems as indicated and as required for removal and/or abandonment of systems, equipment and devices, etc. made obsolete by this Project, and as required for removal and remodeling by other trades.

1.2 EXISTING CONDITIONS

- A. Existing HVAC systems, equipment and devices may not all be shown on the Drawings. Existing conditions, where indicated, are based on preliminary field observations and/or existing conditions documentation made available to the Architect and Engineer and must be verified. Report any discrepancies to the Architect and Engineer before disturbing the existing installation.
- B. Prior to bidding, examine the site to determine all actual observable conditions. Additional work or scope changes due to the Contractor's failure to investigate such existing conditions shall not be grounds for change orders or cause additional costs to the owner and project.

1.3 COORDINATION

- A. Adjoining Areas: It is expected that the Contractor understands that adjoining areas of the building (or project site) must remain in operation and HVAC Systems and services must remain in operation at all times, unless specifically approved otherwise.
- B. Scheduling: Demolition work and any required shut-downs shall be scheduled in conjunction with all other trades and the owner. Contractor cooperation will be expected under all conditions.
- C. Area Limits: Construction traffic and removal of debris will be limited to specific areas and routes. Confirm with the Construction Manager or Owner's Representative and Owner.
- D. Coordinate and ensure that all equipment affected by the work is de-energized and electrically disconnected by a qualified and authorized contractor or owner's representative prior to proceeding with demolition.

1.4 ADJACENT MATERIALS

- A. Protection: During execution of removal work, primary consideration shall be given to protecting from damage, building structure, furnishings, finishes and the like, which are not specifically indicated to be removed.
- B. Repairs: Existing items or surfaces to remain, which are damaged as a result of this work shall be refinished, repaired or replaced to the satisfaction of the Owner, at no cost to the Owner or Project.

1.5 TRANSIENT SERVICES

- A. Locate and identify any and all services passing through the project area which serve areas outside the work limits.
- B. Maintain all services to areas outside the work limits unless specifically authorized otherwise in writing by the Engineer or Owner's Representative. When transient services must be interrupted, provide temporary services for affected areas outside the work limits.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Patching: Materials used for patching shall be in conformance with the applicable sections of the Project Manual. Where materials are not specifically described, but required for proper completion of the Work, they shall be as selected by the Contractor, subject to approval of the Architect and Engineer.

PART 3 - EXECUTION

3.1 INSPECTION/VERIFICATION

- A. Inspection: Before commencing work of this Section, carefully inspect the project site and become familiar with existing systems and conditions.
- B. Items to be Salvaged: Verify with the Architect, Engineer, and Owner's Representative, all systems, materials and equipment which are to be salvaged, and those which must be removed. The Owner reserves the right to salvage any or all existing materials and equipment at the project site.

3.2 DEMOLITION

- A. General: Remove equipment, ductwork, piping, controls and related materials within the project work limits, as indicated.
- B. Protection: Perform all removal work in such a manner so that damage to adjacent items and surfaces is minimized.
- C. Patching: When materials are removed, patch and finish surfaces to remain to match surrounding surfaces.
- D. Disassembly: Disassemble equipment as required for removal through existing openings.

3.3 EXISTING SYSTEMS TO REMAIN

- A. General: Protect and maintain access to existing systems which must remain. Reinstall existing systems disturbed.
- B. Reconnections: Where systems in adjoining areas or indicated to remain, become disconnected or affected by demolition work, they shall be reconnected as required to restore original operation. Restoration work shall comply with requirements for new work.

3.4 EXISTING SYSTEMS WORK TO BE RELOCATED

- A. General: Disconnect, remove, reinstall and reconnect equipment indicated to be relocated and where required to accommodate remodeling or new construction. Extend existing installations as required. Materials and methods used for relocations and extensions shall conform to requirements for new work.

3.5 DISPOSITION OF EXISTING MATERIALS AND EQUIPMENT

- A. Items to Salvage: Material and equipment which is indicated (or directed by Owner) to be salvaged, shall be carefully removed and stored where directed on the site.
- B. Items to Reuse/Relocate: Carefully remove and store on site, all material and equipment indicated to be reused or relocated. Thoroughly clean, and make any necessary minor repairs to such equipment, prior to installation.
- C. Items to Remove: Remove and legally dispose of all other materials and debris resulting from demolition work on a daily basis.

3.6 CLEANING

Remove from the Project Site all dirt, dust and debris resulting from removal operations on a daily basis. Refuse shall not be allowed to block or otherwise impair circulation in corridors, stairs, sidewalks, roadways or other traffic areas.

END OF SECTION 230502

SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 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: Premium efficient, as defined in NEMA MG 1.
- C. Service Factor: 1.15.

- D. Multispeed Motors: Separate winding for each speed.
- E. Rotor: Random-wound, squirrel cage.
- F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- G. Temperature Rise: Class B.
- H. Insulation: Class F.
- I. 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.
- J. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 ADDITIONAL REQUIREMENTS FOR POLYPHASE MOTORS

- 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: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
 - 1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width-modulated inverters.
 - 2. 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.
 - 5. Provide microfiber shaft grounding ring kits.
- D. 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, microfiber shaft grounding ring kits.
- 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.

2.6 ELECTRONICALLY COMMUTATED MOTORS (ECM)

- A. Motors shall be, variable-speed, DC, brushless motors, specifically designed for the voltage, frequency, and phase indicated.
- B. Motors shall be complete with and operated by an integrated controller/inverter that operates the wound stator and senses rotor position to electronically commute the stator.
- C. Motors shall be designed for synchronous rotation.
- D. Rotors shall be permanent magnet type with near zero rotor losses.
- E. Motors shall have built-in soft start and soft speed change ramps.
- F. Motors shall be able to be mounted with shaft in horizontal or vertical orientation.
- G. Motors shall be permanently lubricated with ball bearings.
- H. Motors shall maintain a minimum of 70% efficiency over the entire operating range.

- I. Provide microfiber shaft grounding ring kits.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 230513

SECTION 230517 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Sleeves.
 - 2. Sleeve-seal systems.
 - 3. Sleeve-seal fittings.
 - 4. Grout.
 - 5. Silicone sealants.

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Advance Products & Systems, Inc.
 - 2. CALPICO, Inc.
 - 3. GPT; an EnPro Industries company.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop collar.
- C. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, anti-corrosion coated or zinc coated, with plain ends and integral welded waterstop collar.

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

2.2 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. GPT; an EnPro Industries company.
4. Metraflex Company (The).
5. Proco Products, Inc.

- B. Description:

1. Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
2. Designed to form a hydrostatic seal of 20-psig.
3. Sealing Elements: EPDM-rubber or Nitrile (Buna N) interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size.
4. Pressure Plates: Carbon steel.
5. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, ASTM B633 or Stainless steel of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

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

1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. GPT; an EnPro Industries company.
4. Metraflex Company (The).
5. Proco Products, Inc.

- B. Description:

1. Manufactured plastic, sleeve-type, waterstop assembly, made for imbedding in concrete slab or wall.
2. Plastic or rubber waterstop collar with center opening to match piping OD.

2.4 GROUT

- A. Description: Nonshrink, recommended for interior and exterior sealing openings in nonfire-rated walls or floors.
- B. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

- A. Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant, ASTM C920, Type S, Grade NS, Class 25, use NT.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. GE Construction Sealants; Momentive Performance Materials Inc.
 - b. Pecora Corporation.
 - c. Permathane®/Acryl-R®; ITW Polymers Sealants North America.
 - d. Sherwin-Williams Company (The).
 - e. The Dow Chemical Company.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
 - 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 or silicone sealant, seal space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
1. Cut sleeves to length for mounting flush with both surfaces.
 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 3. Seal annular space between sleeve and piping or piping insulation; use sealants appropriate for size, depth, and location of joint.
- E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke-Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Section 078413 "Penetration
- F. 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.
 3. Install section of cast-iron soil pipe to extend sleeve to 3 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 waterproof silicone sealant, seal space between top hub of stack-sleeve fitting and pipe.
- B. Fire-Resistance-Rated, Horizontal Assembly, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of floors at pipe penetrations. Seal pipe penetrations with

fire- and smoke-stop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal-system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.
- C.

3.4 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings as new walls and slabs 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 or silicone sealant, seal space around outside of sleeve-seal fittings.

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.
- B. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

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 : Cast-iron sleeves.
 - b. Piping NPS 6 and Larger: Sleeve-seal fittings.
- 2. Exterior Concrete Walls Below Grade:
 - a. Piping Smaller Than NPS 6: Cast-iron 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: Steel pipe sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
- 3. Concrete Slabs-on-Grade:
 - a. Piping Smaller Than NPS 6: Cast-iron 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: 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.
- 4. Concrete Slabs Above Grade:
 - a. Piping Smaller Than NPS 6: Steel pipe sleeves.
 - b. Piping NPS 6 and Larger: Steel pipe sleeves.
- 5. Interior Partitions:
 - a. Piping Smaller Than NPS 6: Steel pipe sleeves.
 - b. Piping NPS 6 and Larger: Galvanized-steel sheet sleeves.

END OF SECTION 230517

SECTION 230518 - ESCUTCHEONS FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Escutcheons.
2. Floor plates.

1.2 DEFINITIONS

- A. Existing Piping to Remain: Existing piping that is not to be removed and that is not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. BrassCraft Manufacturing Co.; a Masco company.
2. Dearborn Brass.
3. Keeney Manufacturing Company (The).
4. Mid-America Fittings, Inc.
5. ProFlo; a Ferguson Enterprises, Inc. brand.

2.2 ESCUTCHEONS

- A. One-Piece, Steel Type: With polished, chrome-plated finish and setscrew fastener.
- B. One-Piece, Stainless-Steel Type: With polished stainless-steel finish.

- C. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
- D. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped steel with polished, chrome-plated finish and spring-clip fasteners.
- E. One-Piece, Stamped-Steel Type: With polished, chrome-plated finish and spring-clip fasteners.
- F. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; concealed hinge; and spring-clip fasteners.

2.3 FLOOR PLATES

- A. Split Floor Plates: Steel with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. Escutcheons for New Piping and Relocated Existing Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep pattern.
 - b. Chrome-Plated Piping: One-piece steel or split-plate steel with polished, chrome-plated finish.
 - c. Insulated Piping: One-piece steel with polished, chrome-plated finish.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece steel with polished, chrome-plated finish.
 - e. Bare Piping in Unfinished Service Spaces: One-piece steel with polished, chrome-plated finish.
 - f. Bare Piping in Equipment Rooms: One-piece steel with polished, chrome-plated finish.
 - 2. Escutcheons for Existing Piping to Remain:
 - a. Chrome-Plated Piping: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.

- b. Insulated Piping: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
 - C. Install floor plates for piping penetrations of equipment-room floors.
 - D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. New Piping and Relocated Existing Piping: Split floor plate.
 - 2. Existing Piping to Remain: Split floor plate.
- 3.2 FIELD QUALITY CONTROL
- A. Using new materials, replace broken and damaged escutcheons and floor plates.

END OF SECTION 230518

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SECTION 230519 - METERS AND GAUGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Thermometers, liquid in glass.
 - 2. Duct-thermometer mounting brackets.
 - 3. Thermowells.
 - 4. Pressure gauges, dial type.
 - 5. Gauge attachments.
 - 6. Test plugs.
 - 7. Test-plug kits.
 - 8. Sight flow indicators.
 - 9. Flowmeters.
 - 10. Thermal-energy meters.

1.2 ACTION SUBMITTALS

- A. Product Data:
 - 1. Thermometers, liquid in glass.
 - 2. Duct-thermometer mounting brackets.
 - 3. Thermowells.
 - 4. Pressure gauges, dial type.
 - 5. Gauge attachments.
 - 6. Test plugs.
 - 7. Test-plug kits.
 - 8. Sight flow indicators.
 - 9. Flowmeters.
 - 10. Thermal-energy meters.
- B. Product Data Submittals: For each type of product.
- C. Shop Drawings:
 - 1. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of meter.

1.4 CLOSEOUT SUBMITTALS

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

PART 2 - PRODUCTS

2.1 THERMOMETERS, LIQUID IN GLASS

- A. Thermometers, Liquid in Glass - Metal Case, Industrial Style:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Flo Fab Inc.
 - b. Miljoco Corporation.
 - c. Trerice, H. O. Co.
 - d. Weiss Instruments, Inc.
 - e. Weksler Glass Thermometer Corp.
 - 2. Source Limitations: Provide liquid-in-glass, metal-case, industrial-style thermometers from single manufacturer.
 - 3. Standard: ASME B40.200.
 - 4. Case: Cast aluminum; 7-inch nominal size unless otherwise indicated.
 - 5. Case Form: Adjustable angle unless otherwise indicated.
 - 6. Tube: Glass with magnifying lens and blue or red organic liquid, mercury free.
 - 7. Tube Background: Nonreflective aluminum with permanent scale markings graduated in deg F.
 - 8. Window: Glass or acrylic plastic.
 - 9. Stem: Aluminum and of length to suit installation.
 - a. Design for Air-Duct Installation: With ventilated shroud.
 - b. Design for Thermowell Installation: Bare stem.
 - 10. Connector: 1-1/4 inches, with ASME B1.1 or ASME B1.20.1 screw threads to fit thermowell.
 - 11. Accuracy: Plus or minus 1 percent of span range or one scale division, to a maximum of 1.5 percent of span.

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 in piping tee fitting.
 - 3. Material for Use with Copper Tubing: Copper.
 - 4. Material for Use with Steel Piping: Type 304 stainless steel.
 - 5. Type: Stepped shank unless straight or tapered shank is indicated.
 - 6. External Threads: NPS 1/2, NPS 3/4, or NPS 1 , with 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 GAUGES, DIAL TYPE

- A. Pressure Gauges, Dial Type - Direct Mounted, Metal Case:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ametek U.S. Gauge.
 - b. Ashcroft Inc.
 - c. Flo Fab Inc.
 - d. Miljoco Corporation.
 - e. Trerice, H. O. Co.
 - f. WATTS; A Watts Water Technologies Company.
 - g. Weiss Instruments, Inc.
 - h. Weksler Glass Thermometer Corp.

2. Source Limitations: Provide dial-type, direct-mounted, metal-case pressure gauges from single manufacturer.
3. Standard: ASME B40.100.
4. Case: Liquid-filled type(s); cast aluminum or drawn steel; 4-1/2-inch nominal diameter.
5. Pressure-Element Assembly: Bourdon tube.
6. 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.
7. Movement: Mechanical, with link to pressure element and connection to pointer.
8. Dial: Nonreflective aluminum with permanent scale markings graduated in psi.
9. Pointer: Dark-colored metal.
10. Window: Glass or acrylic plastic.
11. Ring: Metal.
12. Accuracy: Grade A, plus or minus 1 percent of middle half of span.

B. Pressure Gauges, Dial Type - Remote Mounted, Metal Case:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ashcroft Inc.
 - b. Flo Fab Inc.
 - c. Miljoco Corporation.
 - d. Tel-Tru Manufacturing Company.
 - e. Terice, H. O. Co.
 - f. WATTS; A Watts Water Technologies Company.
 - g. Weiss Instruments, Inc.
2. Source Limitations: Provide dial-type, remote-mounted, metal-case pressure gauges from a single manufacturer.
3. Standard: ASME B40.100.
4. Case: Liquid-filled type;; 4-1/2-inch nominal diameter with back flange and holes for panel mounting.
5. Pressure-Element Assembly: Bourdon tube.
6. 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.
7. Movement: Mechanical, with link to pressure element and connection to pointer.
8. Dial: Nonreflective aluminum with permanent scale markings graduated in psi.
9. Pointer: Dark-colored metal.
10. Window: Glass or acrylic plastic.
11. Ring: Metal.
12. Accuracy: Grade A, plus or minus 1 percent of middle half of span.

2.5 GAUGE 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. Siphons: Loop-shaped section of steel pipe with NPS 1/4 or NPS 1/2 pipe threads.
- C. Valves: Brass or stainless steel needle, 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. IMI Flow Design, Inc.
 - 2. Peterson Equipment Co., Inc.
 - 3. Trerice, H. O. Co.
 - 4. WATTS; A Watts Water Technologies Company.
 - 5. Weiss Instruments, Inc.
 - 6. Weksler Glass Thermometer Corp.
- B. Source Limitations: Provide test plugs from single manufacturer.
- C. Description: Test-station fitting made for insertion in piping tee fitting.
- D. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
- E. Thread Size: NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe thread.
- F. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.
- G. Core Inserts: EPDM self-sealing rubber.

2.7 TEST-PLUG KITS

- 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. Blue Ribbon Corp.

2. Peterson Equipment Co., Inc.

- B. Source Limitations: Provide test-plug kits from single manufacturer.
- C. Furnish one test-plug kit(s) containing one thermometer(s), one pressure gauge and adapter, and carrying case. Thermometer sensing elements, pressure gauge, and adapter probes are to be of diameter to fit test plugs and of length to project into piping.
- D. High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch diameter dial and tapered-end sensing element. Dial range is to be at least 0 to 220 deg F.
- E. 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. KOBOLD Instruments, Inc. - USA.
 - 4. OPW Engineered Systems; OPW Fluid Transfer Group; a Dover company.
- B. Source Limitations: Provide sight flow indicators from single manufacturer.
- C. Description: Piping inline-installation device for visual verification of flow.
- D. Construction: Bronze or stainless steel body, with sight glass and ball, flapper, or paddle wheel indicator, and threaded or flanged ends.
- E. Minimum Pressure Rating: 125 psig.
- F. Minimum Temperature Rating: 200 deg F.
- G. End Connections for NPS 2 (DN 50) and Smaller: Threaded.
- H. End Connections for NPS 2-1/2 (DN 65) and Larger: Flanged.

2.9 FLOWMETERS

- A. Performance Requirements: Manufacturer is to certify that each flowmeter complies with specified performance requirements and characteristics.

B. Flowmeters - Venturi:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Armstrong International, Inc.
 - b. Gerand Engineering Co.
 - c. Hyspan Precision Products, Inc.
 - d. Nexus Valve, Inc.; Aalberts Hydronic Flow Control.
 - e. Preso Meters; Badger Meter Inc.
 - f. Rosemount; Emerson Electric Co., Automation Solutions.
2. Source Limitations: Provide venture flowmeters from single manufacturer.
3. Description: Flowmeter with calibrated flow-measuring element, hoses or tubing, fittings, valves, indicator, and conversion chart.
4. Flow Range: Sensor and indicator is to cover operating range of equipment or system served.
5. Flow-Measuring Element:
 - a. Design: Differential-pressure-type measurement for water.
 - b. Venturi type with in-line or insertion element.
 - c. Construction: Bronze, brass, or factory-primed steel, with brass fittings and attached tag with flow conversion data.
 - d. Minimum Pressure Rating: 250 psig.
 - e. Minimum Temperature Rating: 250 deg F.
 - f. End Connections for NPS 2 (DN 50) and Smaller: Threaded.
 - g. End Connections for NPS 2-1/2 (DN 65) and Larger: Flanged or welded.
 - h. Flow Range: Flow-measuring element and flowmeter are to cover operating range of equipment or system served.
6. Permanent Indicators: Meter suitable for wall or bracket mounting, calibrated for connected flowmeter element, and has 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.
7. Display: Shows rate of flow, with register to indicate total volume in gallons.
8. Conversion Chart: Flow rate data compatible with sensor.
9. Operating Instructions: Include complete instructions with each flowmeter.

2.10 THERMAL-ENERGY METERS

- A. Performance Requirements: Manufacturer is to certify that each flowmeter complies with specified performance requirements and characteristics.
- B. Thermal-Energy Meters - Ultrasonic:
 - 1. <Double click here to find, evaluate, and insert list of manufacturers and products.>
 - 2. Source Limitations: Provide ultrasonic thermal-energy meters from single manufacturer.
 - 3. Description: Meter with flow sensor, two temperature sensors, transmitter, indicator, and connecting wiring.
 - 4. Flow Sensor: Transit-time ultrasonic type with transmitter.
 - 5. Temperature Sensors: Insertion-type or strap-on transducer.
 - 6. Indicator: Solid-state, integrating-type meter with integral battery pack.
 - a. Data Output: Six-digit electromechanical counter with readout in kilowatts per hour or British thermal units .
 - b. Battery Pack: Five-year lithium battery.
 - 7. Accuracy: Plus or minus 1 percent.
 - 8. Display: Visually indicates total fluid volume in gallons and thermal-energy flow in kilowatts per hour or British thermal units.
 - 9. Operating Instructions: Include complete instructions with each thermal-energy meter system.

PART 3 - EXECUTION

3.1 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. Fill thermowells with heat-transfer medium.
- E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

- F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing, and support tubing to prevent kinks. Use minimum tubing length.
- G. Install pipe-mounted thermal-energy temperature sensors in thermowells and extend wiring to indicator.
- H. Install duct-thermometer-mounting brackets in walls of ducts. Attach to duct with screws.
- I. Install direct-mounted pressure gauges in piping tees with pressure gauge located on pipe at the most readable position.
- J. Install remote-mounted pressure gauges on panel.
- K. Install valve and snubber in piping for each pressure gauge for fluids (except steam).
- L. Install valve and syphon fitting in piping for each pressure gauge for steam.
- M. Install test plugs in piping tees.
- N. Install flow indicators in piping systems in accessible positions for easy viewing.
- O. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.
- P. Install flowmeter elements in accessible positions in piping systems.
- Q. Install wafer-orifice flowmeter elements between orifice-type pipe flanges.
- R. Install all flowmeter elements, with at least minimum straight lengths of pipe, upstream and downstream from element according to manufacturer's written instructions.
- S. Install permanent indicators on walls or brackets in accessible and readable positions.
- T. Install connection fittings in accessible locations for attachment to portable indicators.
- U. Mount thermal-energy meters on wall if accessible; if not, provide brackets to support meters.
- V. Install thermometers in the following locations:
 - 1. Inlet and outlet of each hydronic zone.
 - 2. Inlet and outlet of each hydronic boiler.
 - 3. Two inlets and two outlets of each chiller.

4. Inlet and outlet of each hydronic coil in air-handling units.
5. Two inlets and two outlets of each hydronic heat exchanger.
6. Inlet and outlet of each thermal-storage tank.
7. Outside-, return-, supply-, and mixed-air ducts.

W. Install pressure gauges in the following locations:

1. Discharge of each pressure-reducing valve.
2. Inlet and outlet of each chiller chilled-water and condenser-water connection.
3. Suction and discharge of each pump.

3.2 CONNECTIONS

- A. Install meters and gauges adjacent to machines and equipment to allow space for service and maintenance of meters, gauges, machines, and equipment.
- B. Connect flowmeter-system elements to meters.
- C. Connect flowmeter transmitters to meters.
- D. Connect thermal-energy meter transmitters to meters.

3.3 ADJUSTING

- A. After installation, calibrate meters according to manufacturer's written instructions.
- B. Adjust faces of meters and gauges to proper angle for best visibility.

3.4 THERMOMETER SCHEDULE

- A. Thermometers at inlet and outlet are to be the following:
 1. Industrial-style, liquid-in-glass type.
- B. Thermometer stems are to be of length to match thermowell insertion length.

3.5 THERMOMETER SCALE-RANGE SCHEDULE

- A. Scale Range for Chilled-Water Piping:
 1. Minus 40 to plus 160 deg F.
- B. Scale Range for Condenser-Water Piping:

1. 0 to 150 deg F.

C. Scale Range for Heating, Hot-Water Piping:

1. 0 to 250 deg F.

D. Scale Range for Steam and Steam-Condensate Piping:

1. 0 to 250 deg F.

E. Scale Range for Air Ducts:

1. Minus 40 to plus 160 deg F.

3.6 PRESSURE-GAUGE SCHEDULE

A. Pressure gauges are to be the following:

1. Liquid-filled, direct mounted, metal case.

3.7 PRESSURE-GAUGE SCALE-RANGE SCHEDULE

A. Scale Range for Chilled-Water Piping:

1. 0 to 160 psi.

B. Scale Range for Condenser-Water Piping:

1. 0 to 160 psi.

C. Scale Range for Heating, Hot-Water Piping:

1. 0 to 160 psi.

D. Scale Range for Steam Piping:

1. 0 to 100 psi.

3.8 FLOWMETER SCHEDULE

A. Flowmeters are to be: Venturi type.

3.9 THERMAL-ENERGY METER SCHEDULE

- A. Thermal-Energy Meters are to be: Ultrasonic type.

END OF SECTION 230519

SECTION 230523.12 - BALL 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. Section Includes:
 - 1. Bronze ball valves.

1.3 DEFINITIONS

- A. CWP: Cold working pressure.

1.4 ACTION SUBMITTALS

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

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, and weld ends.
 - 3. Set ball valves open to minimize exposure of functional surfaces.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
 - 1. ASME B1.20.1 for threads for threaded-end valves.
 - 2. ASME B16.1 for flanges on iron valves.
 - 3. ASME B16.5 for flanges on steel valves.
 - 4. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 - 5. ASME B16.18 for solder-joint connections.
 - 6. ASME B31.1 for power piping valves.
 - 7. ASME B31.9 for building services piping valves.
- C. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.
- D. Refer to HVAC valve schedule articles for applications of valves.
- E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- F. Valve Sizes: Same as upstream piping unless otherwise indicated.
- G. Valve Actuator Types:
 - 1. Handlever: For quarter-turn valves smaller than NPS 4.
- H. Valves in Insulated Piping:
 - 1. Include 2-inch stem extensions.
 - 2. Extended operating handle of nonthermal-conductive material, and protective sleeves that allow operation of valves without breaking the vapor seals or disturbing insulation.
 - 3. Memory stops that are fully adjustable after insulation is applied.
- I. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE BALL VALVES

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

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. Milwaukee Valve Company.
 - c. NIBCO INC.
 - d. 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.
 - h. Stem: Stainless steel.
 - i. Ball: Stainless steel, vented.
 - j. Port: Full.

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 valve tags. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for valve tags and schedules.

3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valves with specified SWP classes or CWP ratings are unavailable, the same types of valves with higher SWP classes or CWP ratings may be substituted.
- B. Select valves with the following end connections:
 - 1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option or press-end option is indicated in valve schedules below.

3.4 CHILLED-WATER VALVE SCHEDULE

- A. Pipe NPS 2 and Smaller: bronze ball valves, two piece, with stainless-steel trim, full port, solder or press connection-joint ends.
 - 1. Valves may be provided with solder-joint ends instead of threaded ends.

3.5 CONDENSER-WATER VALVE SCHEDULE

- A. Pipe NPS 2 and Smaller: bronze ball valves, two piece with stainless-steel trim, full port, solder or press connection-joint ends.
 - 1. Valves may be provided with solder-joint ends instead of threaded ends.

3.6 HEATING-WATER VALVE SCHEDULE

- A. Pipe NPS 2 and Smaller: bronze ball valves, two piece with stainless-steel trim, full port, solder or press connection-joint ends.

END OF SECTION 230523.12

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SECTION 230523.13 - BUTTERFLY 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. Section Includes:
 - 1. Iron, single-flange butterfly valves.
 - 2. Iron, grooved-end butterfly valves.

1.3 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene copolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

1.4 ACTION SUBMITTALS

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

1.5 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 butterfly valves closed or slightly open.
- 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. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
 1. ASME B16.1 for flanges on iron valves.
 2. ASME B16.5 for pipe flanges and flanged fittings, NPS 1/2 through NPS 24.
 3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 4. ASME B31.1 for power piping valves.
 5. ASME B31.9 for building services piping valves.
- C. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.
- D. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- E. Valve Sizes: Same as upstream piping unless otherwise indicated.
- F. Valve Actuator Types:
 1. Gear Actuator: For valves NPS 8 and larger.
 2. Handlever: For valves NPS 6 and smaller.
 3. Chainwheel: Device for attachment to gear, stem, or other actuator of size and with chain for mounting height, according to "Valve Installation" Article.
- G. Valves in Insulated Piping: With 2-inch stem extensions with extended necks.

2.2 IRON, SINGLE-FLANGE BUTTERFLY VALVES

- A. Iron, Single-Flange Butterfly Valves with Aluminum-Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Flow Controls; Conbraco Industries, Inc.
 - b. Milwaukee Valve Company.
 - c. NIBCO INC.
 - d. WATTS.
2. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. NPS 12 and Smaller CWP Rating: 200 psig.
 - c. NPS 14 and Larger CWP Rating: 150 psig.
 - d. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - e. Body Material: ASTM A536, ductile iron.
 - f. Seat: EPDM.
 - g. Stem: One- or two-piece stainless steel.
 - h. Disc: Aluminum bronze.

2.3 DUCTILE-IRON, GROOVED-END BUTTERFLY VALVES

A. Iron, Grooved-End Butterfly Valves, 300 CWP:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. NIBCO INC.
 - b. Shurjoint-Apollo Piping Products USA Inc.
 - c. Victaulic Company.
2. Description:
 - a. Standard: MSS SP-67, Type I.
 - b. NPS 8 and Smaller CWP Rating: 300 psig.
 - c. NPS 10 and Larger CWP Rating: 200 psig.
 - d. Body Material: Coated, ductile iron.
 - e. Stem: Two-piece stainless steel.
 - f. Disc: Coated, ductile iron.
 - g. Seal: EPDM.

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 mating flange faces for damage. 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.
- D. 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 valve tags. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for valve tags and schedules.

3.3 ADJUSTING

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

3.4 CHILLED-WATER VALVE SCHEDULE

- A. Pipe NPS 2-1/2 and Larger:

1. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12: Aluminum-bronze disc, 200 CWP, and EPDM seat.
2. Iron, Single-Flange Butterfly Valves, NPS 14 to NPS 24: Aluminum-bronze disc, 150 CWP, and EPDM seat.
3. Iron, Grooved-End Butterfly Valves, NPS 2-1/2 to NPS 12: 300 CWP.
4. High-Performance Butterfly Valves: Single flange, Class 300.

3.5 CONDENSER-WATER VALVE SCHEDULE

A. Pipe NPS 2-1/2 and Larger:

1. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12: Aluminum-bronze disc, 200 CWP, and EPDM seat.
2. Iron, Single-Flange Butterfly Valves, NPS 14 to NPS 24: Aluminum-bronze disc, 150 CWP, and EPDM seat.
3. Iron, Grooved-End Butterfly Valves, NPS 2-1/2 to NPS 12: 300 CWP.
4. High-Performance Butterfly Valves: Single flange, Class 300.

3.6 HEATING-WATER VALVE SCHEDULE

A. Pipe NPS 2-1/2 and Larger:

1. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12: Aluminum-bronze disc, 200 CWP, and EPDM seat.
2. Iron, Single-Flange Butterfly Valves, NPS 14 to NPS 24: Aluminum-bronze disc, 150 CWP, and EPDM seat.
3. Iron, Grooved-End Butterfly Valves, NPS 2-1/2 to NPS 12: 300 CWP.
4. High-Performance Butterfly Valves: Single flange, Class 300.

END OF SECTION 230523.13

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SECTION 230523.14 - CHECK 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. Section Includes:
 - 1. Bronze swing check valves.
 - 2. Iron swing check valves.
 - 3. Iron swing check valves with closure control.

1.3 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene copolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- D. SWP: Steam working pressure.

1.4 ACTION SUBMITTALS

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

1.5 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. 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. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
1. ASME B1.20.1 for threads for threaded-end valves.
 2. ASME B16.1 for flanges on iron valves.
 3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 4. ASME B16.18 for solder joint.
 5. ASME B31.1 for power piping valves.
 6. ASME B31.9 for building services piping valves.
- C. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.
- D. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.
- E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- F. Valve Sizes: Same as upstream piping unless otherwise indicated.
- G. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE SWING CHECK VALVES

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

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. NIBCO, Inc.
 - b. WATTS
 - c. Crane; a Crane brand
2. Description:
 - a. Standard: MSS SP-80, Type 3.
 - b. CWP Rating: 200 psig (1380 kPa).
 - c. Body Design: Horizontal flow.
 - d. Body Material: ASTM B62, bronze.
 - e. Ends: Threaded.
 - f. Disc: Bronze.

2.3 IRON SWING CHECK VALVES

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

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. NIBCO, Inc.
 - b. WATTS
 - c. Crane; a Crane brand
2. Description:
 - a. Standard: MSS SP-71, Type I.
 - b. NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
 - c. Body Design: Clear or full waterway.
 - d. Body Material: ASTM A126, gray iron with bolted bonnet.
 - e. Ends: Flanged.
 - f. Trim: Bronze.
 - g. Gasket: Asbestos free.

2.4 IRON SWING CHECK VALVES WITH CLOSURE CONTROL

A. Iron Swing Check Valves with Lever- and Spring-Closure Control, Class 125:

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. NIBCO, Inc.
- 2. Description:
 - a. Standard: MSS SP-71, Type I.
 - b. NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
 - c. Body Design: Clear or full waterway.
 - d. Body Material: ASTM A126, gray iron with bolted bonnet.
 - e. Ends: Flanged.
 - f. Trim: Bronze.
 - g. Gasket: Asbestos free.
 - h. Closure Control: Factory-installed, exterior lever and spring.

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.
- F. Install valve tags. Comply with requirements for valve tags and schedules in Section 230553 "Identification for HVAC Piping and Equipment."

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. Pump-Discharge Check Valves:
 - a. NPS 2 (DN 50) and Smaller: Bronze swing check valves with bronze disc.
 - b. NPS 2-1/2 (DN 65) and Larger: Iron swing check valves with lever and weight or with spring or iron, center-guided, metal-seat check valves.
- B. If valves with specified SWP classes or CWP ratings are unavailable, 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.
 - 2. 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.
 - 3. For Steel Piping, NPS 5 (DN 125) and Larger: Flanged ends.

3.5 CHILLED-WATER VALVE SCHEDULE

- A. Pipe NPS 2 (DN 50) and Smaller:
 - 1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
 - 2. Bronze swing check valves with bronze disc, Class 125.
- B. Pipe NPS 2-1/2 (DN 65) and Larger:

1. Iron swing check valves with metal seats, Class 125.

3.6 HEATING-WATER VALVE SCHEDULE

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

1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Bronze swing check valves with bronze disc, Class 125.

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

1. Iron swing check valves with metal seats, Class 125.

END OF SECTION 230523.14

SECTION 230529 - 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. Section Includes:
 - 1. Metal pipe hangers and supports.
 - 2. Trapeze pipe hangers.
 - 3. Metal framing systems.
 - 4. Thermal-hanger shield inserts.
 - 5. Fastener systems.
 - 6. Equipment stands.
 - 7. Equipment supports.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.5 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, Section IX.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. 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.

2.2 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, hot-dip galvanized, or electro-galvanized.
 - 3. Nonmetallic Coatings: Plastic coated, or epoxy powder-coated.
 - 4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 - 5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
- B. Stainless Steel Pipe Hangers and Supports:
 - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 - 2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 - 3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.
- C. Copper Pipe and Tube Hangers:
 - 1. Description: MSS SP-58, Types 1 through 58, copper-plated steel, factory-fabricated components.
 - 2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-plated steel.

2.3 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-58, 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.

2.4 PLASTIC PIPE HANGERS

- A. Description: Similar to MSS SP-58, Types 1 through 58, factory-fabricated steel pipe hanger except hanger is made of plastic.
- B. Hanger Rods: Continuous-thread rod, nuts, and washer made of galvanized steel.
- C. Flammability: ASTM D635, ASTM E84, and UL 94.

2.5 METAL FRAMING SYSTEMS

- A. MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ABB, Electrification Business.
 - b. B-line; Eaton, Electrical Sector.
 - c. Flex-Strut Inc.
 - d. MIRO Industries.
 - e. Unistrut; Atkore International.
 - f. Wesanco, Inc.
2. Description: Shop- or field-fabricated, pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
3. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
4. Channels: Continuous slotted carbon-steel channel with inturred lips.
5. Channel Width: Selected for applicable load criteria.
6. Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
7. Hanger Rods: Continuous-thread rod, nuts, and washer made of galvanized steel.
8. Metallic Coating: Hot-dip galvanized.
9. Paint Coating: For Pools, epoxy, acrylic, or urethane, color selected by architect.

- B. Non-MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International/Smith-Cooper International; Tailwind Capital, LLC.
 - b. CADDY; nVent.
 - c. MIRO Industries.
 - d. PHD Manufacturing, Inc.
 - e. RectorSeal HVAC; a CSW Industrials Company.
2. Description: Shop- or field-fabricated, pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
3. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
4. Channels: Continuous slotted carbon-steel channel with inturned lips.
5. Channel Width: Select for applicable load criteria.
6. Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
7. Hanger Rods: Continuous-thread rod, nuts, and washer made of galvanized steel.
8. Metallic Coating: Hot-dip galvanized.
9. Paint Coating: For pools, epoxy, acrylic, or urethane color selected by architect.

2.6 THERMAL-HANGER SHIELD INSERTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Buckaroos, Inc.
 2. CADDY; nVent.
 3. National Pipe Hanger Corporation.
 4. Pipe Shields Inc.
 5. Piping Technology & Products, Inc.
 6. Rilco Manufacturing Co., Inc.
- B. Insulation-Insert Material for Cold Piping: ASTM C552, Type II cellular glass with 100-psi or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psi minimum compressive strength and vapor barrier.
- C. Insulation-Insert Material for Hot Piping: ASTM C552, Type II cellular glass with 100-psi or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psi 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.

2.7 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hilti, Inc.
 - b. ITW Ramset/Red Head; Illinois Tool Works, Inc.
 - c. MKT Fastening, LLC.
 - d. Simpson Strong-Tie Co., Inc.
- B. Mechanical-Expansion Anchors: Insert-wedge-type anchors for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. B-line; Eaton, Electrical Sector.
 - b. Empire Tool and Manufacturing Co., Inc.
 - c. Hilti, Inc.
 - d. ITW Ramset/Red Head; Illinois Tool Works, Inc.
 - e. MKT Fastening, LLC.
 - 2. Indoor Applications: Zinc-coated steel.
 - 3. Outdoor Applications: Stainless steel.

2.8 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.9 MATERIALS

- A. Aluminum: ASTM B221.
- B. Carbon Steel: ASTM A1011/A1011M.
- C. Structural Steel: ASTM A36/A36M, carbon-steel plates, shapes, and bars; galvanized.
- D. Stainless Steel: ASTM A240/A240M.
- E. Threaded Rods: Continuously threaded. Zinc-plated or galvanized steel for indoor applications and stainless steel for outdoor applications. Mating nuts and washers of similar materials as rods.
- F. Grout: ASTM C1107/C1107M, 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 APPLICATION

- A. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-58. 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-58. 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 A36/A36M, 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 strut 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.
 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- F. 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 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.
- 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, 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.
- 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 and larger if pipe is installed on rollers.
3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
 - e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 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: 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.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780/A780M.

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-58 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 stainless steel pipe hangers and stainless steel or corrosion-resistant attachments for hostile environment applications such as crawlspaces, exterior, mechanical rooms and natatoriums.
- G. Use copper-plated pipe hangers and copper or stainless steel attachments for copper piping and tubing.
- H. Use padded hangers for piping that is subject to scratching.
- I. Use thermal-hanger shield inserts for insulated piping and tubing.
- J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
 - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
 - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
 - 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
 - 5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
 - 6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
 - 7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 - 8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.

9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
 11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
 12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
 13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
 14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
 15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
 16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
 17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
 18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
 19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is unnecessary.
 20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is unnecessary.
 21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- K. 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.

- L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- N. 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.
- O. 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.
- P. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

- Q. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- R. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 230529

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Warning tape.
4. Pipe labels.
5. Duct labels.
6. Valve tags.
7. Warning tags.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- 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: Provide for each piping system. Include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Plastic Labels for Equipment:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brady Corporation.
 - b. Brimar Industries, Inc.
 - c. Craftmark Pipe Markers.

- d. [Marking Services, Inc.](#)
 - 2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, with predrilled holes for attachment hardware.
 - 3. Letter and Background Color: As indicated for specific application under Part 3.
 - 4. Maximum Temperature: Able to withstand temperatures of 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 of 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.
- B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

2.2 WARNING SIGNS AND LABELS

- A. [Manufacturers:](#) Subject to compliance with requirements, provide products by one of the following:
 - 1. [Brady Corporation.](#)
 - 2. [Brimar Industries, Inc.](#)
 - 3. [Craftmark Pipe Markers.](#)
 - 4. [Marking Services Inc.](#)
- B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, with predrilled holes for attachment hardware.
- C. Letter and Background Color: As indicated for specific application under Part 3.
- D. Maximum Temperature: Able to withstand temperatures of 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 of 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-taping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Arc-Flash Warning Signs: Provide arc-flash warning signs in locations and with content in accordance with requirements of OSHA and NFPA70E and other applicable codes and standards.
- J. Label Content: Include caution and warning information plus emergency notification instructions.

2.3 WARNING TAPE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Brady Corporation.
 - 2. Brimar Industries, Inc.
 - 3. Craftmark Pipe Markers.
- B. Material: Vinyl.
- C. Minimum Thickness: 0.005 inch.
- D. Letter, Pattern, and Background Color: As indicated for specific application under Part 3.
- E. Waterproof Adhesive Backing: Suitable for indoor or outdoor use.
- F. Maximum Temperature: 160 deg F.
- G. Minimum Width: 4 inches.

2.4 PIPE LABELS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Brady Corporation.
 - 2. Brimar Industries, Inc.
 - 3. Craftmark Pipe Markers.
 - 4. Marking Services Inc.

- B. General Requirements for Manufactured Pipe Labels: Preprinted, color coded, with lettering indicating service and showing flow direction in accordance with ASME A13.1.
- C. Letter and Background Color: As indicated for specific application under Part 3.
- D. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- E. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings. Also include:
 - 1. Pipe size.
 - 2. Flow-Direction Arrows: Include flow-direction arrows on distribution piping. Arrows may be either integral with label or applied separately.
 - 3. Lettering Size: At least 1/2 inch for viewing distances of up to 72 inches and proportionately larger lettering for greater viewing distances.

2.5 DUCT LABELS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Brady Corporation.
 - 2. Brimar Industries, Inc.
 - 3. Craftmark Pipe Markers.
 - 4. Marking Services Inc.
- B. Self-Adhesive Duct Labels: Printed plastic with contact-type, permanent-adhesive backing.
- C. Letter and Background Color: As indicated for specific application under Part 3.
- 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 of 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. Also include the following:
1. Duct size.
 2. Flow-Direction Arrows: Include flow-direction arrows on distribution ducts. Arrows may be either integral with label or may be applied separately.
 3. Lettering Size: At least 1/2 inch for viewing distances of up to 72 inches and proportionately larger lettering for greater viewing distances.

2.6 VALVE TAGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Brady Corporation.
 2. Brimar Industries, Inc.
 3. Craftmark Pipe Markers.
 4. Marking Services Inc.
- B. Description: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
1. Tag Material: Brass, 0.04-inch minimum thickness, with predrilled or stamped holes for attachment hardware.
 2. Fasteners: Brass wire or S-hook.
- C. Letter and Background Color: As indicated for specific application under Part 3.
- D. 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. Include valve-tag schedule in operation and maintenance data.

2.7 WARNING TAGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Brady Corporation.
 2. Brimar Industries, Inc.
 3. Craftmark Pipe Markers.

4. Marking Services Inc.

- B. Description: Preprinted accident-prevention tags of plasticized card stock.
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. Letter and Background Color: As indicated for specific application under Part 3.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 INSTALLATION, GENERAL REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.
- D. Locate identifying devices so that they are readily visible from the point of normal approach.

3.3 INSTALLATION OF EQUIPMENT LABELS, WARNING SIGNS, AND LABELS

- A. Permanently fasten labels on each item of mechanical equipment.
- B. Sign and Label Colors:
 1. White letters on an ANSI Z535.1 safety-blue background.
- C. Locate equipment labels where accessible and visible.
- D. Arc-Flash Warning Signs: Provide arc-flash warning signs on electrical disconnects and other equipment where arc-flash hazard exists, as indicated on Drawings, and in

accordance with requirements of OSHA and NFPA 70E, and other applicable codes and standards.

3.4 INSTALLATION OF WARNING TAPE

- A. Warning Tape Color and Pattern: Yellow background with black diagonal stripes.
- B. Install warning tape on pipes and ducts, with cross-designated walkways providing less than 6 ft. of clearance.
- C. Locate tape so as to be readily visible from the point of normal approach.

3.5 INSTALLATION OF PIPE LABELS

- A. Install pipe labels showing service and flow direction with permanent adhesive on pipes.
- B. Pipe-Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Within 3 ft. of each valve and control device.
 - 2. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 3. Within 3 ft. of equipment items and other points of origination and termination.
 - 4. Spaced at maximum intervals of 25 ft. along each run. Reduce intervals to 10 ft. in areas of congested piping, ductwork, and equipment.
- C. Do not apply plastic pipe labels or plastic tapes directly to bare pipes conveying fluids at temperatures of 125 deg F or higher. Where these pipes are to remain uninsulated, use a short section of insulation or use stenciled labels.
- D. Flow-Direction Arrows: Use arrows to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
- E. Pipe-Label Color Schedule:
 - 1. Dual Temperature Piping: White letters on an ANSI Z535.1 safety-green background.
 - 2. Condenser-Water Piping: White letters on an ANSI Z535.1 safety-green background.
 - 3. Dual Temperature Glycol Piping: White letters on blue background.

3.6 INSTALLATION OF DUCT LABELS

- A. Install self-adhesive duct labels showing service and flow direction with permanent adhesive on air ducts.
 - 1. Provide labels in the following color codes:
 - a. For air supply ducts: White letters on blue background.
 - b. For air return ducts: White letters on blue background.
 - c. For exhaust-, outside-, relief-, return-, and mixed-air ducts: White letters on blue background.
- B. Locate label near each point where ducts enter into and exit from concealed spaces and at maximum intervals of 20 ft. where exposed or are concealed by removable ceiling system.

3.7 INSTALLATION OF VALVE TAGS

- A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule in the operating and maintenance manual.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in "Valve-Tag Size and Shape" Subparagraph below.
 - 1. Valve-Tag Size and Shape:
 - a. Chilled Water: 1-1/2 inches, round.
 - b. Condenser Water: 1-1/2 inches, round.
 - c. Refrigerant: 1-1/2 inches, round.
 - d. Hot Water: 1-1/2 inches, round.
 - e. Gas: 1-1/2 inches, round.
 - f. Low-Pressure Steam: 1-1/2 inches, round.
 - g. High-Pressure Steam: 1-1/2 inches, round.
 - h. Steam Condensate: 1-1/2 inches, round.
 - 2. Valve-Tag Colors:
 - a. For each piping system, use the same lettering and background coloring system on valve tags as used for the Pipe Label Schedule text and background.

3.8 INSTALLATION OF WARNING TAGS

- A. Warning Tag Color: Black letters on an ANSI Z535.1 safety-yellow background.
- B. Attach warning tags, with proper message, to equipment and other items where scheduled.

END OF SECTION 230553

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SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Balancing Air Systems:
 - a. Constant-volume air systems.
 - b. Multizone systems.
 - c. Induction-unit systems.
2. Balancing Hydronic Piping Systems:
 - a. Variable-flow hydronic systems.
 - b. Primary-secondary hydronic systems.
3. Testing, Adjusting, and Balancing Equipment:
 - a. Motors.
 - b. Chillers.
 - c. Condensing units.
 - d. Boilers.
 - e. Heat-transfer coils.
4. Testing, adjusting, and balancing existing systems and equipment.
5. Sound tests.
6. Vibration tests.
7. Duct leakage tests.
8. Control system verification.

1.2 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. BAS: Building automation systems.
- C. NEBB: National Environmental Balancing Bureau.
- D. TAB: Testing, adjusting, and balancing.

- E. TABB: Testing, Adjusting, and Balancing Bureau.
- F. TAB Specialist: An independent entity meeting qualifications to perform TAB work.
- G. TDH: Total dynamic head.

1.3 PREINSTALLATION MEETINGS

- A. TAB Conference: If requested by the Owner, conduct a TAB conference at Project site after approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Provide a minimum of 14 days' advance notice of scheduled meeting time and location.
 - 1. Minimum Agenda Items:
 - a. The Contract Documents examination report.
 - b. The TAB plan.
 - c. Needs for coordination and cooperation of trades and subcontractors.
 - d. Proposed procedures for documentation and communication flow.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Contract Documents Examination Report: Within 60 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. System Readiness Checklists: Within 60 days of Contractor's Notice to Proceed, submit system readiness checklists as specified in "Preparation" Article.
- E. Examination Report: Submit a summary report of the examination review required in "Examination" Article.
- F. Certified TAB reports.
- G. Sample report forms.
- H. 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.

1.5 QUALITY ASSURANCE

- A. TAB Specialists Qualifications: Certified by AABC.
 1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC.
 2. TAB Technician: Employee of the TAB specialist and certified by AABC as a TAB technician.
- B. TAB Specialists Qualifications: Certified by NEBB.
 1. TAB Field Supervisor: Employee of the TAB specialist and certified by NEBB.
 2. TAB Technician: Employee of the TAB specialist and certified by NEBB as a TAB technician.
- C. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."
- D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."

1.6 FIELD CONDITIONS

- A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.
- B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.
- B. Examine installed systems for 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 applicable for intended purpose and 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 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 verify that bearings are greased, belts are aligned and tight, filters are clean, 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 have been replaced by permanent screens with indicated perforations.
- L. Examine control valves for proper installation for their intended function of throttling, 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.

3.2 PREPARATION

- A. Prepare a TAB plan that includes the following:
 - 1. Equipment and systems to be tested.
 - 2. Strategies and step-by-step procedures for balancing the systems.
 - 3. Instrumentation to be used.
 - 4. Sample forms with specific identification for all equipment.
- B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:
 - 1. Airside:
 - a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
 - b. Duct systems are complete with terminals installed.
 - c. Volume, smoke, and fire dampers are open and functional.
 - d. Clean filters are installed.
 - e. Fans are operating, free of vibration, and rotating in correct direction.
 - f. Variable-frequency controllers' startup is complete and safeties are verified.

- g. Automatic temperature-control systems are operational.
- h. Ceilings are installed.
- i. Windows and doors are installed.
- j. Suitable access to balancing devices and equipment is provided.

2. Hydronics:

- a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed.
- b. Piping is complete with terminals installed.
- c. Water treatment is complete.
- d. Systems are flushed, filled, and air purged.
- e. Strainers are pulled and cleaned.
- f. Control valves are functioning per the sequence of operation.
- g. Shutoff and balance valves have been verified to be 100 percent open.
- h. Pumps are started and proper rotation is verified.
- i. Pump gage connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
- j. Variable-frequency controllers' startup is complete and safeties are verified.
- k. Suitable access to balancing devices and equipment is provided.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" and in this Section.
- 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.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross-check 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."

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 - 1. Measure total airflow.
 - a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
 - b. Where duct conditions allow, measure airflow by main Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses, close to the fan and prior to any outlets, to obtain total airflow.
 - c. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.

2. Measure fan static pressures as follows:
 - a. Measure static pressure directly at the fan outlet or through the flexible connection.
 - b. Measure static pressure directly at the fan inlet or through the flexible connection.
 - c. Measure static pressure across each component that makes up the air-handling system.
 - d. Report artificial loading of filters at the time static pressures are measured.
 3. 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.
 4. Obtain approval from Architect 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.
 5. 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 occurs. 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.
1. Measure airflow of submain and branch ducts.
 2. Adjust submain and branch duct volume dampers for specified airflow.
 3. Re-measure each submain and branch duct after all have been adjusted.
- C. Adjust air inlets and outlets for each space to indicated airflows.
1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
 2. Measure inlets and outlets airflow.
 3. Adjust each inlet and outlet for specified airflow.
 4. Re-measure each inlet and outlet after they have been adjusted.
- D. Verify final system conditions.
1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to design if necessary.
 2. Re-measure and confirm that total airflow is within design.
 3. Re-measure all final fan operating data, rpms, volts, amps, and static profile.
 4. Mark all final settings.

5. Test system in economizer mode. Verify proper operation and adjust if necessary.
6. Measure and record all operating data.
7. Record final fan-performance data.

3.6 PROCEDURES FOR INDUCTION-UNIT SYSTEMS

- A. Balance primary-air risers by measuring static pressure at the nozzles of the top and bottom units of each riser to determine which risers must be throttled. Adjust risers to indicated airflow within specified tolerances.
- B. Adjust each induction unit.
- C. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 1. Measure total airflow.
 - a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
 - b. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
 - c. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
 - d. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.
 2. Measure fan static pressures as follows:
 - a. Measure static pressure directly at the fan outlet or through the flexible connection.
 - b. Measure static pressure directly at the fan inlet or through the flexible connection.
 - c. Measure static pressure across each component that makes up the air-handling system.
 - d. Report artificial loading of filters at the time static pressures are measured.
 3. 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.
 4. 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 occurs. Measure

amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

- D. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.
 - 1. Measure airflow of submain and branch ducts.
 - 2. Adjust submain and branch duct volume dampers for specified airflow.
 - 3. Re-measure each submain and branch duct after all have been adjusted.
- E. Balance airflow to each induction unit by measuring the nozzle pressure and comparing it to the manufacturer's published data for nozzle pressure versus cfm. Adjust the unit's inlet damper to achieve the required nozzle pressure for design cfm.
- F. Verify final system conditions.
 - 1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
 - 2. Re-measure and confirm that total airflow is within design.
 - 3. Re-measure all final fan operating data, rpms, volts, amps, and static profile.
 - 4. Mark all final settings.
 - 5. Test system in economizer mode. Verify proper operation and adjust if necessary.
 - 6. Measure and record all operating data.
 - 7. Record final fan-performance data.

3.7 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

- A. Prepare test reports for pumps, coils, and heat exchangers. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required coil and heat exchanger flow rates with pump design flow rate.
- B. Prepare schematic diagrams of systems' "as-built" piping layouts.
- C. In addition to requirements in "Preparation" Article, prepare hydronic systems for testing and balancing as follows:
 - 1. Check liquid level in expansion tank.
 - 2. Check highest vent for adequate pressure.
 - 3. Check flow-control valves for proper position.
 - 4. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
 - 5. Verify that motor starters are equipped with properly sized thermal protection.
 - 6. Check that air has been purged from the system.

3.8 PROCEDURES FOR PRIMARY-SECONDARY HYDRONIC SYSTEMS

- A. Balance the primary circuit flow first.
- B. Balance the secondary circuits after the primary circuits are complete.
- C. Adjust pumps to deliver total design gpm.
 - 1. Measure total water flow.
 - a. Position valves for full flow through coils.
 - b. Measure flow by main flow meter, if installed.
 - c. If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.
 - 2. Measure pump TDH as follows:
 - a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
 - b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
 - c. Convert pressure to head and correct for differences in gage heights.
 - d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
 - e. With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.
 - 3. Monitor motor performance during procedures and do not operate motor in an overloaded condition.
- D. Adjust flow-measuring devices installed in mains and branches to design water flows.
 - 1. Measure flow in main and branch pipes.
 - 2. Adjust main and branch balance valves for design flow.
 - 3. Re-measure each main and branch after all have been adjusted.
- E. Adjust flow-measuring devices installed at terminals for each space to design water flows.
 - 1. Measure flow at terminals.
 - 2. Adjust each terminal to design flow.
 - 3. Re-measure each terminal after it is adjusted.
 - 4. Position control valves to bypass the coil and adjust the bypass valve to maintain design flow.

5. Perform temperature tests after flows have been balanced.
- F. For systems with pressure-independent valves at terminals:
 1. Measure differential pressure and verify that it is within manufacturer's specified range.
 2. Perform temperature tests after flows have been verified.
- G. For systems without pressure-independent valves or flow-measuring devices at terminals:
 1. Measure and balance coils by either coil pressure drop or temperature method.
 2. If balanced by coil pressure drop, perform temperature tests after flows have been verified.
- H. Verify final system conditions as follows:
 1. Re-measure and confirm that total water flow is within design.
 2. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
 3. Mark final settings.
- I. Verify that memory stops have been set.

3.9 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. Phase and hertz.
 5. Nameplate and measured voltage, each phase.
 6. Nameplate and measured amperage, each phase.
 7. Starter size and thermal-protection-element rating.
 8. Service factor and frame size.
- B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.

3.10 PROCEDURES FOR CHILLERS

- A. Balance water flow through each evaporator[and condenser] to within specified tolerances of indicated flow with all pumps operating. With only one chiller operating in a multiple chiller installation, do not exceed the flow for the maximum tube velocity recommended by the chiller manufacturer. Measure and record the following data with each chiller operating at design conditions:
 - 1. Evaporator-water entering and leaving temperatures, pressure drop, and water flow.
 - 2. For water-cooled chillers, condenser-water entering and leaving temperatures, pressure drop, and water flow.
 - 3. Evaporator and condenser refrigerant temperatures and pressures, using instruments furnished by chiller manufacturer.
 - 4. Power factor if factory-installed instrumentation is furnished for measuring kilowatts.
 - 5. Kilowatt input if factory-installed instrumentation is furnished for measuring kilowatts.
 - 6. Capacity: Calculate in tons of cooling.
 - 7. For air-cooled chillers, verify condenser-fan rotation and record fan and motor data including number of fans and entering- and leaving-air temperatures.

3.11 PROCEDURES FOR BOILERS

- A. Hydronic Boilers:
 - 1. Measure and record entering- and leaving-water temperatures.
 - 2. Measure and record water flow.
 - 3. Record relief valve pressure setting.

3.12 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 for major (more than 20 gpm) equipment coils, excluding unitary equipment such as reheat coils, unit heaters, and fan-coil units.
 - 4. Dry-bulb temperature of entering and leaving air.
 - 5. Wet-bulb temperature of entering and leaving air for cooling coils.
 - 6. Airflow.

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.
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.

3.13 DUCT LEAKAGE TESTS

- A. Witness the duct pressure testing performed by Installer.
- B. Verify that proper test methods are used and that leakage rates are within specified tolerances.
- C. Report deficiencies observed.

3.14 CONTROLS VERIFICATION

- A. In conjunction with system balancing, perform the following:
 1. Verify temperature control system is operating within the design limitations.
 2. Confirm that the sequences of operation are in compliance with Contract Documents.
 3. Verify that controllers are calibrated and function as intended.
 4. Verify that controller set points are as indicated.
 5. Verify the operation of lockout or interlock systems.
 6. Verify the operation of valve and damper actuators.
 7. Verify that controlled devices are properly installed and connected to correct controller.
 8. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.
 9. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.

- B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

3.15 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

- A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.
 - 1. Measure and record the operating speed, airflow, and static pressure of each fan.
 - 2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
 - 3. Check the refrigerant charge.
 - 4. Check the condition of filters.
 - 5. Check the condition of coils.
 - 6. Check the operation of the drain pan and condensate-drain trap.
 - 7. Check bearings and other lubricated parts for proper lubrication.
 - 8. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.
- B. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished. Verify the following:
 - 1. New filters are installed.
 - 2. Coils are clean and fins combed.
 - 3. Drain pans are clean.
 - 4. Fans are clean.
 - 5. Bearings and other parts are properly lubricated.
 - 6. Deficiencies noted in the preconstruction report are corrected.
- C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.
 - 1. Compare the indicated airflow of the renovated work to the measured fan airflows, and determine the new fan speed and the face velocity of filters and coils.
 - 2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
 - 3. If calculations increase or decrease the airflow rates and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.

4. Balance each air outlet.

3.16 TOLERANCES

- A. Set HVAC system's airflow rates and water flow rates within the following tolerances:
 1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
 2. Air Outlets and Inlets: Plus or minus 10 percent.
 3. Heating-Water Flow Rate: Plus or minus 10 percent.
 4. Cooling-Water Flow Rate: Plus or minus 10 percent.
- B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.17 PROGRESS 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.

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.
 3. Certify validity and accuracy of field data.
- 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 specialist.
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 (in American standard units):
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 (mm), and bore.
 - i. Center-to-center dimensions of sheave and amount of adjustments in inches (mm).
 - 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 (mm), and bore.
 - f. Center-to-center dimensions of sheave and amount of adjustments in inches (mm).
 3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm (L/s).
 - b. Total system static pressure in inches wg (Pa).
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg (Pa).
 - e. Filter static-pressure differential in inches wg (Pa).
 - f. Preheat-coil static-pressure differential in inches wg (Pa).
 - g. Cooling-coil static-pressure differential in inches wg (Pa).
 - h. Heating-coil static-pressure differential in inches wg (Pa).
 - i. Outdoor airflow in cfm (L/s).
 - j. Return airflow in cfm (L/s).
 - k. Outdoor-air damper position.

- l. Return-air damper position.
- m. Vortex 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 (mm) o.c.
- f. Make and model number.
- g. Face area in sq. ft. (sq. m).
- h. Tube size in NPS (DN).
- i. Tube and fin materials.
- j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

- a. Airflow rate in cfm (L/s).
- b. Average face velocity in fpm (m/s).
- c. Air pressure drop in inches wg (Pa).
- d. Outdoor-air, wet- and dry-bulb temperatures in deg F (deg C).
- e. Return-air, wet- and dry-bulb temperatures in deg F (deg C).
- f. Entering-air, wet- and dry-bulb temperatures in deg F (deg C).
- g. Leaving-air, wet- and dry-bulb temperatures in deg F (deg C).
- h. Water flow rate in gpm (L/s).
- i. Water pressure differential in feet of head or psig (kPa).
- j. Entering-water temperature in deg F (deg C).
- k. Leaving-water temperature in deg F (deg C).
- l. Refrigerant expansion valve and refrigerant types.
- m. Refrigerant suction pressure in psig (kPa).
- n. Refrigerant suction temperature in deg F (deg C).
- o. Inlet steam pressure in psig (kPa).

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 (kW).
 - 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 (mm), and bore.
 - n. Center-to-center dimensions of sheave and amount of adjustments in inches (mm).
2. Test Data (Indicated and Actual Values):
- a. Total airflow rate in cfm (L/s).
 - b. Entering-air temperature in deg F (deg C).
 - c. Leaving-air temperature in deg F (deg C).
 - d. Air temperature differential in deg F (deg C).
 - e. Entering-air static pressure in inches wg (Pa).
 - f. Leaving-air static pressure in inches wg (Pa).
 - g. Air static-pressure differential in inches wg (Pa).
 - h. Low-fire fuel input in Btu/h (kW).
 - i. High-fire fuel input in Btu/h (kW).
 - j. Manifold pressure in psig (kPa).
 - k. High-temperature-limit setting in deg F (deg C).
 - l. Operating set point in Btu/h (kW).
 - m. Motor voltage at each connection.
 - n. Motor amperage for each phase.
 - o. Heating value of fuel in Btu/h (kW).
- 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 (kW).
 - e. Number of stages.
 - f. Connected volts, phase, and hertz.
 - g. Rated amperage.

- h. Airflow rate in cfm (L/s).
 - i. Face area in sq. ft. (sq. m).
 - j. Minimum face velocity in fpm (m/s).
 - 2. Test Data (Indicated and Actual Values):
 - a. Heat output in Btu/h (kW).
 - b. Airflow rate in cfm (L/s).
 - c. Air velocity in fpm (m/s).
 - d. Entering-air temperature in deg F (deg C).
 - e. Leaving-air temperature in deg F (deg C).
 - 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 (mm), and bore.
 - h. Center-to-center dimensions of sheave and amount of adjustments in inches (mm).
 - 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 (mm), and bore.
 - f. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
 - g. Number, make, and size of belts.
 - 3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm (L/s).
 - b. Total system static pressure in inches wg (Pa).
 - 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 (mm).
 - f. Duct area in sq. ft. (sq. m).
 - g. Indicated airflow rate in cfm (L/s).
 - h. Indicated velocity in fpm (m/s).
 - i. Actual airflow rate in cfm (L/s).
 - j. Actual average velocity in fpm (m/s).
 - k. Barometric pressure in psig (Pa).
- 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. (sq. m).
 - 2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in cfm (L/s).
 - b. Air velocity in fpm (m/s).
 - c. Preliminary airflow rate as needed in cfm (L/s).
 - d. Preliminary velocity as needed in fpm (m/s).
 - e. Final airflow rate in cfm (L/s).
 - f. Final velocity in fpm (m/s).
 - g. Space temperature in deg F (deg C).

- L. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:
1. Unit Data:
 - a. System and air-handling-unit identification.
 - b. Location and zone.
 - c. Room or riser served.
 - d. Coil make and size.
 - e. Flowmeter type.
 2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in cfm (L/s).
 - b. Entering-water temperature in deg F (deg C).
 - c. Leaving-water temperature in deg F (deg C).
 - d. Water pressure drop in feet of head or psig (kPa).
 - e. Entering-air temperature in deg F (deg C).
 - f. Leaving-air temperature in deg F (deg C).
- M. 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 (L/s).
 - g. Water pressure differential in feet of head or psig (kPa).
 - h. Required net positive suction head in feet of head or psig (kPa).
 - i. Pump rpm.
 - j. Impeller diameter in inches (mm).
 - 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 (kPa).
- b. Pump shutoff pressure in feet of head or psig (kPa).
- c. Actual impeller size in inches (mm).
- d. Full-open flow rate in gpm (L/s).
- e. Full-open pressure in feet of head or psig (kPa).
- f. Final discharge pressure in feet of head or psig (kPa).
- g. Final suction pressure in feet of head or psig (kPa).
- h. Final total pressure in feet of head or psig (kPa).
- i. Final water flow rate in gpm (L/s).
- j. Voltage at each connection.
- k. Amperage for each phase.

N. 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 VERIFICATION OF TAB REPORT

- A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of Construction Manager or Owner's Representative and the commissioning authority.
- B. The Architect and/or the Commissioning authority 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.
- C. 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."
- D. 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.
- E. If TAB work fails, proceed as follows:

1. TAB specialists shall 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 specialist to complete TAB work according to the Contract Documents and deduct the cost of the services from the original TAB specialist's final payment.
3. If the second verification also fails, design professional may contact AABC Headquarters regarding the AABC National Performance Guaranty.

F. 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 230593

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SECTION 230713 - DUCT INSULATION

PART 1 - GENERAL

1.1 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. 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.
 - 4. Detail application at linkages of control devices.

1.2 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- C. Field quality-control reports.

1.3 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or craft training program.
- B. Mockups: Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups in the location indicated or, if not indicated, as directed by Architect. Use materials indicated for the completed Work.

1. Ductwork Mockups:
 - a. One 10-foot section each of rectangular and round straight duct.
 - b. One each of a 90-degree mitered round and rectangular elbow, and one each of a 90-degree radius round and rectangular elbow.
 - c. One rectangular branch takeoff and one round branch takeoff from a rectangular duct. One round tee fitting.
 - d. One rectangular and round transition fitting.
 - e. Four support hangers for round and rectangular ductwork.
 - f. Each type of damper and specialty.
2. For each mockup, fabricate cutaway sections to allow observation of application details for insulation materials, adhesives, mastics, attachments, and jackets.
3. Notify Architect seven days in advance of dates and times when mockups will be constructed.
4. Obtain Architect's approval of mockups before starting insulation application.
5. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
7. Demolish and remove mockups when directed.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers are to be marked with the manufacturer's name, appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.5 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields.
- 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.

1.6 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation, jacket materials, adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.
 - 1. All Insulation Installed Indoors and Outdoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2.2 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 are to be applied.
- B. Products do not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.
- D. Insulation materials for use on austenitic stainless steel are qualified as acceptable in accordance with ASTM C795.
- E. Foam insulation materials do not use CFC or HCFC blowing agents in the manufacturing process.
- F. Glass-Fiber Blanket: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature up to 450 deg F in accordance with ASTM C411. Comply with ASTM C553, Type II, and ASTM C1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. [Johns Manville; a Berkshire Hathaway company.](#)
 - b. [Knauf Insulation.](#)
 - c. [Manson Insulation Inc.](#)
 - d. [Owens Corning.](#)
- G. Glass-Fiber Board Insulation: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature between 35 deg F and 250 deg F for jacketed and between 35 deg F and 450 deg F for unfaced in accordance with ASTM C411. Comply with ASTM C612, 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. [Manufacturers:](#) Subject to compliance with requirements, provide products by one of the following:
 - a. [Johns Manville; a Berkshire Hathaway company.](#)
 - b. [Knauf Insulation.](#)
 - c. [Manson Insulation Inc.](#)
 - d. [Owens Corning.](#)
- H. Glass-Fiber, Pipe and Tank: Glass fibers bonded with a thermosetting resin; suitable for maximum use temperature between 35 deg F and 850 deg F, in accordance with ASTM C411. Comply with ASTM C1393.
 1. [Manufacturers:](#) Subject to compliance with requirements, provide products by one of the following:
 - a. [Johns Manville; a Berkshire Hathaway company.](#)
 - b. [Knauf Insulation.](#)
 - c. [Manson Insulation Inc.](#)
 - d. [Owens Corning.](#)
 2. Semirigid board material with factory-applied FSK jacket.
 3. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- I. Polyolefin: Polyethylene thermal plastic insulation. Comply with ASTM C1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials.
 1. [Manufacturers:](#) Subject to compliance with requirements, provide products by one of the following:
 - a. [Armacell LLC.](#)

- b. [Nomaco.](#)
- c. [Sekisui Voltek, LLC.](#)
- d. [Thermaduct.](#)

2.3 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 C656, Type II, Grade 6. Tested and certified to provide a 2-hour fire rating by an NRTL acceptable to authorities having jurisdiction.
 - 1. [Manufacturers:](#) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. [Johns Manville; a Berkshire Hathaway company.](#)
- 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. [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. [3M.](#)
 - b. [Thermal Ceramics.](#)
 - c. [Unifrax Corporation.](#)

2.4 ADHESIVES

- A. Materials are compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Glass-Fiber and Mineral Wool Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. [Manufacturers:](#) Subject to compliance with requirements, provide products by one of the following:
 - a. [Childers Brand; H. B. Fuller Construction Products.](#)
 - b. [Eagle Bridges - Marathon Industries.](#)
 - c. [Foster Brand; H. B. Fuller Construction Products.](#)
 - d. [Mon-Eco Industries, Inc.](#)

- C. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Eagle Bridges - Marathon Industries.
 - c. Foster Brand; H. B. Fuller Construction Products.
 - d. Mon-Eco Industries, Inc.
- D. PVC Jacket Adhesive: Compatible with PVC jacket.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Johns Manville; a Berkshire Hathaway company.
 - b. Proto Corporation.
 - c. Sekisui Voltek, LLC.
 - d. Speedline Corporation.

2.5 MASTICS AND COATINGS

- A. Materials are compatible with insulation materials, jackets, and substrates.
- B. Vapor-Retarder Mastic, Water Based, Interior Use: Suitable for indoor use on below ambient services.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller Construction Products.
 - c. Knauf Insulation.
 - d. Vimasco Corporation.
 - 2. Water-Vapor Permeance: Comply with ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions.
 - 3. Service Temperature Range: Minus 20 to plus 180 deg F.
 - 4. Comply with MIL-PRF-19565C, Type II, for permeance requirements.
 - 5. Color: White.
- C. Vapor-Retarder Mastic, Solvent Based, Exterior Use: Suitable for outdoor use on below ambient services.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Eagle Bridges - Marathon Industries.
 - c. Foster Brand; H. B. Fuller Construction Products.
 2. Water-Vapor Permeance: Comply with ASTM C755, Section 7.2.2, Table 2, for insulation type and service conditions.
 3. Service Temperature Range: Minus 50 to plus 220 deg F.
 4. Color: White.
- D. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Eagle Bridges - Marathon Industries.
 - c. Foster Brand; H. B. Fuller Construction Products.
 - d. Knauf Insulation.
 - e. Vimasco Corporation.
 2. Water-Vapor Permeance: ASTM E96/E96M, greater than 1.0 perm at manufacturer's recommended dry film thickness.
 3. Service Temperature Range: Minus 20 to plus 180 deg F.
 4. Color: White.

2.6 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C, Class I, Grade A and are compatible with insulation materials, jackets, and substrates.
1. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct insulation.
 2. Service Temperature Range: 0 to plus 180 deg F.
 3. Color: White.

2.7 SEALANTS

- A. FSK and Metal Jacket Flashing Sealants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Eagle Bridges - Marathon Industries.
 - c. Foster Brand; H. B. Fuller Construction Products.
 - d. Mon-Eco Industries, Inc.
2. Materials are 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.

B. ASJ Flashing Sealants, and Vinyl and PVC Jacket Flashing Sealants:

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. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller Construction Products.
2. Materials are compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.

2.8 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
 3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.
 4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type II.
 5. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested in accordance with ASTM E96/E96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

6. ASJ+: All-service jacket composed of aluminum foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film leaving no paper exposed; complying with ASTM C1136, Types I, II, III, IV, and VII.
7. PSK Jacket: Aluminum foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type II.

2.9 FIELD-APPLIED JACKETS

- A. Field-applied jackets comply with ASTM C921, 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 D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Johns Manville; a Berkshire Hathaway company.
 - b. P.I.C. Plastics, Inc.
 - c. Proto Corporation.
 - d. Speedline Corporation.
 2. Adhesive: As recommended by jacket material manufacturer.
 3. Color: White.
- D. Metal Jacket:
 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. Johns Manville; a Berkshire Hathaway company.
 - b. RPR Products, Inc.
 2. Aluminum Jacket: Comply with ASTM B209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 - a. Factory cut and rolled to size.
 - b. Finish and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier: 3-mil- thick polysurlyn.

2.10 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Woven Glass-Fiber Mesh: Approximately 6 oz./sq. yd. with a thread count of 5 strands by 5 strands/sq. in. for covering ducts.
 - 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. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller Construction Products.
- B. Woven Polyester Mesh: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for ducts.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller Construction Products.
 - c. Vimasco Corporation.

2.11 FIELD-APPLIED CLOTHS

- A. Woven Glass-Fiber Cloth: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd..
 - 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. Alpha Associates, Inc.

2.12 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. 3M Industrial Adhesives and Tapes Division.
 - b. Avery Dennison Corporation, Specialty Tapes Division.

- c. [Ideal Tape Co., Inc., an American Biltrite Company.](#)
 - d. [Knauf Insulation.](#)
 2. Width: 3 inches.
 3. Thickness: 11.5 mils.
 4. Adhesion: 90 ounces force/inch in width.
 5. Elongation: 2 percent.
 6. Tensile Strength: 40 lbf/inch in width.
 7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.
1. [Manufacturers:](#) Subject to compliance with requirements, provide products by one of the following:
 - a. [3M Industrial Adhesives and Tapes Division.](#)
 - b. [Avery Dennison Corporation, Specialty Tapes Division.](#)
 - c. [Ideal Tape Co., Inc., an American Biltrite Company.](#)
 - d. [Knauf Insulation.](#)
 2. Width: 3 inches75 mm.
 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.
- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
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. [3M Industrial Adhesives and Tapes Division.](#)
 - b. [Ideal Tape Co., Inc., an American Biltrite Company.](#)
 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.
- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. 3M Industrial Adhesives and Tapes Division.
 - b. Avery Dennison Corporation, Specialty Tapes Division.
 - c. Ideal Tape Co., Inc., an American Biltrite Company.
 - d. Knauf Insulation.
 2. Width: 2 inches50 mm.
 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.

2.13 SECUREMENTS

- A. Bands:
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. Johns Manville; a Berkshire Hathaway company.
 - b. RPR Products, Inc.
 2. Aluminum: ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal or closed seal.
- B. Insulation Pins and Hangers:
1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- or larger diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) AGM Industries, Inc.
 - 2) CL WARD & Family Inc.
 - 3) Gemco.

- 4) [Midwest Fasteners, Inc.](#)
 - 5) [Nelson Stud Welding.](#)
 2. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. [Manufacturers:](#) Subject to compliance with requirements, provide products by one of the following:
 - 1) [AGM Industries, Inc.](#)
 - 2) [Gemco.](#)
 - 3) [Midwest Fasteners, Inc.](#)
 - b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - c. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
 - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
 3. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
 - 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) [Gemco.](#)
 - 2) [Midwest Fasteners, Inc.](#)
- C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.
- D. Wire: 0.062-inch soft-annealed, stainless steel.
 1. [Manufacturers:](#) Subject to compliance with requirements, provide products by one of the following:
 - a. [C & F Wire.](#)
 - b. [Johns Manville; a Berkshire Hathaway company.](#)

- c. [RPR Products, Inc.](#)

2.14 CORNER ANGLES

- A. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum in accordance with ASTM B209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.

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 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, compress, or otherwise damage insulation or jacket.
- 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. Replace insulation materials that get wet during storage or in the installation process before being properly covered and sealed in accordance with Contract Documents.
- 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, but not to the extent of creating wrinkles or areas of compression in the insulation.
 - 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.

- 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.

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 - 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at 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."

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.

3.5 INSTALLATION OF FLEXIBLE ELASTOMERIC AND POLYOLEFIN INSULATION

- A. Comply with manufacturer's written installation instructions and ASTM C1710.
- B. 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.
- C. Square and Rectangular Ducts and Plenums:
1. Provide 1/4 inch more per side for a tight, compression fit.
 2. Cut sheet insulation with the following dimensions:
 - a. Width of duct plus 1/4 inch, one piece.
 - b. Height of duct plus 1/4 inch, plus thickness of insulation, two pieces.
 - c. Width of duct plus 1/4 inch, plus two times the thickness of insulation, one piece.
 3. Insulate the bottom of the duct with the sheet from (a) above, then the sides with the two sheets from (b) above, and finally the top of the duct with the sheet from (c) above.
 4. Insulation without self-adhering backing:
 - a. Apply 100 percent coverage of manufacturer adhesive on the metal surface, then the insulation, except for the last 1/4 inch where sheets will butt together.
 - b. Roll sheet down into position.
 - c. Press two sheets together under compression and apply adhesive at the butt joint to seal the two sheets together.
 5. Insulation with self-adhering backing:
 - a. Peel back release paper in 6- to 8-inch increments and line up sheet.
 - b. Press firmly to activate adhesive.
 - c. Align material and continue to line up correctly, pressing firmly while slowly removing release paper.

- d. Allow 1/4-inch overlap for compression at butt joints.
 - e. Apply adhesive at the butt joint to seal the two sheets together.
- 6. Insulate duct brackets following manufacturer's written installation instructions.
- D. Circular Ducts:
 - 1. Determine the circumference of the duct, using a strip of insulation the same thickness as to be used.
 - 2. Cut the sheet to the required size.
 - 3. Apply 100 percent coverage of manufacturer adhesive on the metal surface then the insulation.
 - 4. Apply manufacturer adhesive to the cut surfaces along 100 percent of the longitudinal seam. Press together the seam at the ends and then the middle. Close the entire seam starting from the middle.

3.6 INSTALLATION OF GLASS-FIBER AND MINERAL-WOOL INSULATION

- A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
- B. Comply with manufacturer's written installation instructions.
 - 1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
 - 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 - 3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not overcompress insulation during installation.
 - e. Impale insulation over pins and attach speed washers.

- f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 - 4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches 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 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. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
 - 6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
 - 7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.
- C. 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 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 glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
 - 1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
 - 2. Embed glass cloth between two 0.062-inch- thick coats of lagging adhesive.
 - 3. Completely encapsulate insulation with coating, leaving no exposed insulation.

- B. Where FSK jackets are indicated, install as follows:
 - 1. Draw jacket material smooth and tight.
 - 2. Install lap or joint strips with same material as jacket.
 - 3. Secure jacket to insulation with manufacturer's recommended adhesive.
 - 4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
 - 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
 - 1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless steel bands 12 inches o.c. and at end joints.

3.8 FIRE-RATED INSULATION SYSTEM INSTALLATION

- A. Comply with manufacturer's written installation instructions.
- B. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.
- C. Insulate duct access panels and doors to achieve same fire rating as duct.
- D. Install firestopping at penetrations through fire-rated assemblies.

3.9 DUCT AND PLENUM INSULATION SCHEDULE

- A. Interior supply air ductwork.
 - 1. Concealed Locations: Mineral-Fiber Blanket; R-6.
 - 2. Exposed Locations: Mineral-Fiber Board; R-6.
 - 3. Exception: Supply air ductwork exposed to view in conditioned spaces served by ductwork shall not be insulated.
- B. Interior outdoor air ductwork and plenums.

1. Concealed Locations: Mineral-Fiber Blanket; R-12
 2. Exposed Locations: Mineral-Fiber Board; R-12
- C. Interior exhaust air ductwork and plenums (3 feet from penetration of building exterior or isolation damper, whichever is longer).
1. Concealed Locations: Mineral-Fiber Blanket; R-12
 2. Exposed Locations: Mineral-Fiber Board; R-12
- D. Items Not Insulated:
1. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
 2. Factory-insulated flexible ducts.
 3. Factory-insulated plenums and casings.
 4. Flexible connectors.
 5. Vibration-control devices.
 6. Factory-insulated access panels and doors.
- E. Type I, Commercial, Kitchen Hood Exhaust Duct and Plenum Insulation: Fire-rated blanket or board; thickness as required to achieve 2-hour fire rating.

END OF SECTION 230713

SECTION 230716 - EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes insulating the following HVAC equipment that is not factory insulated:
 - 1. Chilled-water pumps.
 - 2. Hot water pumps
 - 3. Air separators.
 - 4. Expansion tanks
 - 5. Piping system filtration unit housings.

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- C. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM 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.

1.5 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. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- B. 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.
- C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- D. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. Provide insulation without factory-applied jacket.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. CertainTeed Corp.; CertaPro Commercial Board.
 - b. Johns Manville; 800 Series Spin-Glas.
 - c. Knauf Insulation; Insulation Board.
 - d. Manson Insulation Inc.; AK Board.
 - e. Owens Corning; Fiberglas 700 Series.

2.2 INSULATING CEMENTS

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
 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. Ramco Insulation, Inc.; Super-Stik.
- B. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.
 - 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. Ramco Insulation, Inc.; Ramcote 1200 and Quik-Cote.

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, 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-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).
 - 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 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.
- C. Vapor-Barrier Mastic: Solvent 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. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-30.
 - b. Eagle Bridges - Marathon Industries; 501.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-35.
 - d. Mon-Eco Industries, Inc.; 55-10.
 2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
 3. Service Temperature Range: 0 to 180 deg F.
 4. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
 5. Color: White.
- D. Breather Mastic: Water based; suitable for indoor and outdoor use on above 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. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
 - b. Eagle Bridges - Marathon Industries; 550.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.
 - d. Mon-Eco Industries, Inc.; 55-50.
 - e. Vimasco Corporation; WC-1/WC-5.

2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: 60 percent by volume and 66 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. 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.
 - b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-36.
 - c. Vimasco Corporation; 713 and 714.
 2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over equipment insulation.
 3. Service Temperature Range: 0 to plus 180 deg F.
 4. Color: White.

2.6 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Woven Glass-Fiber Fabric: Approximately 6 oz./sq. yd. with a thread count of 5 strands by 5 strands/sq. in. for covering equipment.
 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.
- B. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for equipment.
 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; Mast-A-Fab.
 - b. Vimasco Corporation; Elastafab 894.

2.7 FIELD-APPLIED CLOTHS

- A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd..
 - 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. Alpha Associates, Inc.; Alpha-Maritex 84215 and 84217/9485RW, Luben 59.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
 - 1. Verify that systems and equipment to be insulated have been tested and are free of defects.
 - 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
 - 1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
 - 2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that 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.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item 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. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- L. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

- M. 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.
- N. For above ambient services, do not install insulation to the following:
 - 1. Vibration-control devices.
 - 2. Testing agency labels and stamps.
 - 3. Nameplates and data plates.
 - 4. Manholes.
 - 5. Handholes.
 - 6. Cleanouts.

3.4 INSTALLATION OF EQUIPMENT, TANK, AND VESSEL INSULATION

- A. Mineral-Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.
 - 1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.
 - 2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
 - 3. Protect exposed corners with secured corner angles.
 - 4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
 - a. Do not weld anchor pins to ASME-labeled pressure vessels.
 - b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
 - c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
 - d. Do not overcompress insulation during installation.
 - e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
 - f. Impale insulation over anchor pins and attach speed washers.
 - g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.
7. Stagger joints between insulation layers at least 3 inches.
8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

B. 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 0.060 inch thick.
3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

3.5 FIELD-APPLIED JACKET INSTALLATION

- A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
 2. Embed glass cloth between two 0.062-inch- thick coats of lagging adhesive.

3. Completely encapsulate insulation with coating, leaving no exposed insulation.

3.6 EQUIPMENT INSULATION SCHEDULE

- A. Chilled-water pump insulation shall be the following:
 1. Mineral-Fiber Board: 2 inches thick and 2-lb/cu. ft. nominal density.
- B. Chilled-water air-separator insulation shall be the following:
 1. Mineral-Fiber Pipe and Tank: 1 inch thick.
- C. Chilled-water strainer insulation shall be the following:
 1. Mineral-Fiber Pipe and Tank: 1 inch thick.
- D. Heating-hot-water air-separator insulation shall be the following:
 1. Mineral-Fiber Pipe and Tank: 2 inches thick.
- E. Heating-hot-water expansion tank insulation shall be the following:
 1. Mineral-Fiber Pipe and Tank: 2 inches thick.

END OF SECTION 230716

SECTION 230719 - HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes insulation for HVAC piping systems.

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- C. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

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 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.

1.7 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in "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 into contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable in accordance with ASTM C795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C534/C534M, Type I for tubular materials, Type II for sheet materials.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Aeroflex USA.
 - b. Airex Manufacturing.
 - c. Armacell LLC.
 - d. K-Flex USA.
- G. Mineral-Fiber, Preformed Pipe: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C547.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Johns Manville; a Berkshire Hathaway company.
 - b. Knauf Insulation.
 - c. Manson Insulation Inc.

- d. [Owens Corning.](#)
2. Preformed Pipe Insulation: Type I, Grade A with factory-applied ASJ.
3. [850 deg F \(454 deg C\).](#)
4. Factory fabricate shapes in accordance with ASTM C450 and ASTM C585.
5. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 INSULATING CEMENTS

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C195.
 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. [Ramco Insulation, Inc.](#)
- B. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C449.
 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. [Ramco Insulation, Inc.](#)

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. Flexible Elastomeric and Polyolefin Adhesive: Solvent-based adhesive.
 1. [Manufacturers:](#) Subject to compliance with requirements, provide products by one of the following:
 - a. [Aeroflex USA.](#)
 - b. [Armacell LLC.](#)
 - c. [K-Flex USA.](#)

2. Flame-spread index shall be 25 or less and smoke-developed index shall be 50 or less as tested in accordance with ASTM E84.
 3. Wet Flash Point: Below 0 deg F (minus 18 deg C).
 4. Service Temperature Range: 40 to 200 deg F (4 to plus 93 deg C).
 5. Color: Black.
- C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller Construction Products.
 - c. Mon-Eco Industries, Inc.
- 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller Construction Products.
 - c. Mon-Eco Industries, Inc.
- E. PVC Jacket Adhesive: Compatible with PVC jacket.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Johns Manville; a Berkshire Hathaway company.
 - b. P.I.C. Plastics, Inc.
 - c. Speedline Corporation.
 - d. The Dow Chemical Company.

2.4 MASTICS AND COATINGS

- A. Materials shall be compatible with insulation materials, jackets, and substrates.
- B. Vapor-Retarder Mastic, Water Based: Suitable for indoor use on below-ambient services.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. [Childers Brand; H. B. Fuller Construction Products.](#)
 - b. [Foster Brand; H. B. Fuller Construction Products.](#)
 - c. [Knauf Insulation.](#)
 - d. [Vimasco Corporation.](#)
2. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
 3. Service Temperature Range: **0 to plus 180 deg F** (Minus 18 to plus 82 deg C).
 4. Comply with MIL-PRF-19565C, Type II, for permeance requirements, with supplier listing on DOD QPD - Qualified Products Database.
 5. Color: White.
- C. Vapor-Retarder Mastic, Solvent Based, Outdoor Use: Suitable for outdoor use on below-ambient services.
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. [Childers Brand; H. B. Fuller Construction Products.](#)
 - b. [Foster Brand; H. B. Fuller Construction Products.](#)
 2. Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.
 3. Service Temperature Range: **Minus 50 to plus 220 deg F** (Minus 46 to plus 104 deg C).
 4. Color: White.

2.5 LAGGING ADHESIVES

- A. Adhesives shall comply with MIL-A-3316C, Class I, Grade A, and shall be compatible with insulation materials, jackets, and substrates.
1. [Manufacturers:](#) Subject to compliance with requirements, provide products by one of the following:
 - a. [Childers Brand; H. B. Fuller Construction Products.](#)
 - b. [Foster Brand; H. B. Fuller Construction Products.](#)
 - c. [Vimasco Corporation.](#)
 2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
 3. Service Temperature Range: **0 to plus 180 deg F** (Minus 18 to plus 82 deg C).
 4. Color: White.

2.6 SEALANTS

- A. Materials shall be as recommended by the insulation manufacturer and shall be compatible with insulation materials, jackets, and substrates.
- B. Joint Sealants:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller Construction Products.
 - c. Mon-Eco Industries, Inc.
 - 2. Permanently flexible, elastomeric sealant.
 - a. Service Temperature Range: **Minus 150 to plus 250 deg F** (Minus 101 to plus 121 deg C).
 - b. Color: White or gray.
- C. FSK and Metal Jacket Flashing Sealants:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller Construction Products.
 - c. Mon-Eco Industries, Inc.
 - 2. Fire- and water-resistant, flexible, elastomeric sealant.
 - 3. Service Temperature Range: **Minus 40 to plus 250 deg F** (Minus 40 to plus 121 deg C).
 - 4. Color: Aluminum.
- D. ASJ Flashing Sealants and PVDC and PVC Jacket Flashing Sealants:
 - 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. Childers Brand; H. B. Fuller Construction Products.
 - 2. Fire- and water-resistant, flexible, elastomeric sealant.
 - 3. Service Temperature Range: **Minus 40 to plus 250 deg F** (Minus 40 to plus 121 deg C).

4. Color: White.

2.7 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
 1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
 3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.

2.8 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C1136, 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 D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Johns Manville; a Berkshire Hathaway company.
 - b. P.I.C. Plastics, Inc.
 - c. Proto Corporation.
 - d. Speedline Corporation.
 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.
- D. Metal Jacket:

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. RPR Products, Inc.
2. Aluminum Jacket: Comply with **ASTM B209** (**ASTM B209M**), Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 - a. Factory cut and rolled to size.
 - b. Finish and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier for Indoor Applications: **3-mil-** (**0.075-mm-**) thick, heat-bonded polyethylene and kraft paper.
 - d. Moisture Barrier for Outdoor Applications: **3-mil-** (**0.075-mm-**) 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.
- E. Self-Adhesive Outdoor Jacket: **60-mil-** (**1.5-mm-**) thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a cross-laminated polyethylene film covered with white aluminum-foil facing.
 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. Polyguard Products, Inc.

2.9 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. 3M Industrial Adhesives and Tapes Division.
 - b. Avery Dennison Corporation, Specialty Tapes Division.
 - c. Ideal Tape Co., Inc., an American Biltrite Company.
 - d. Knauf Insulation.
 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.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. 3M Industrial Adhesives and Tapes Division.
 - b. Avery Dennison Corporation, Specialty Tapes Division.
 - c. Ideal Tape Co., Inc., an American Biltrite Company.
 - d. Knauf Insulation.
 2. Width: 3 inches (75 mm).
 3. Thickness: 6.5 mils (0.16 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. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
1. 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. 3M Industrial Adhesives and Tapes Division.
 - b. Ideal Tape Co., Inc., an American Biltrite Company.
 2. Width: 2 inches (50 mm).

3. Thickness: 6 mils (0.15 mm).
4. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. 3M Industrial Adhesives and Tapes Division.
 - b. Avery Dennison Corporation, Specialty Tapes Division.
 - c. Ideal Tape Co., Inc., an American Biltrite Company.
 - d. Knauf Insulation.
2. Width: 2 inches (50 mm).
3. Thickness: 3.7 mils (0.093 mm).
4. Adhesion: 100 ounces force/inch (1.1 N/mm) in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch (6.2 N/mm) in width.

2.10 SECUREMENTS

A. Bands:

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. RPR Products, Inc.
2. Stainless Steel: ASTM A240/A240M, Type 304 or Type 316; 0.015 inch (0.38 mm) thick, 1/2 inch (13 mm) wide with wing seal or closed seal.
3. Aluminum: ASTM B209 (ASTM B209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, 1/2 inch (13 mm) wide with wing seal or closed seal.
4. Springs: Twin spring set constructed of stainless steel, with ends flat and slotted to accept metal bands. Spring size is determined by manufacturer for application.

B. Staples: Outward-clinching insulation staples, nominal 3/4 inch (19 mm) wide, stainless steel or Monel.

C. Wire: 0.062-inch (1.6-mm) soft-annealed, galvanized steel.

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. C & F Wire.

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. Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Clean and prepare surfaces to be insulated.
- C. Coordinate insulation installation with the tradesman 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.

3.3 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 of 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 storage, application, and finishing. Replace insulation materials that get wet.
- 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 attached to structure with vapor-barrier mastic.
 - 3. Install insert materials and 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- (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)** o.c.

- a. For below-ambient services, apply vapor-barrier mastic over staples.
- 4. Cover joints and seams with tape, in accordance with 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 25 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 (100 mm)** beyond damaged areas. Adhere, staple, and seal patches in similar fashion 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.

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside roof flashing at least **2 inches (50 mm)** 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 (50 mm)**.
 - 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.
- F. Insulation Installation at Floor Penetrations:
 - 1. Pipe: Install insulation continuously through floor penetrations.

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, Mechanical Couplings, and Unions:
 - 1. Install insulation over fittings, valves, strainers, flanges, mechanical couplings, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
 - 2. Insulate pipe elbows using preformed fitting insulation made from same material and density as that of 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 of same material and thickness as that 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 that used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 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 that used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 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, mechanical couplings, and unions using a section of oversized preformed pipe insulation to fit. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Stencil or label the outside insulation jacket of each union with the word "union" matching size and color of pipe labels.
 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.
- 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 all serviceable locations such as unions, gauges, petes plugs control valves, strainers, and equipment connections. 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 that of adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least 2 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 (50 mm)** 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.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- 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 that of 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 that of 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.
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 that of 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 that of 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 FIELD-APPLIED JACKET INSTALLATION

- A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
1. Draw jacket smooth and tight to surface with **2-inch (50-mm)** overlap at seams and joints.
 2. Embed glass cloth between two **0.062-inch- (1.6-mm-)** thick coats of lagging adhesive.
 3. Completely encapsulate insulation with coating, leaving no exposed insulation.
- B. Where FSK jackets are indicated, install as follows:
1. Draw jacket material smooth and tight.
 2. Install lap or joint strips with same material as jacket.
 3. Secure jacket to insulation with manufacturer's recommended adhesive.
 4. Install jacket with **1-1/2-inch (38-mm)** laps at longitudinal seams and **3-inch- (75-mm-)** wide joint strips at end joints.
 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- C. Where PVC jackets are indicated and for horizontal applications, install with **1-inch (25-mm)** overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.
1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- D. Where metal jackets are indicated, install with **2-inch (50-mm)** 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 (300 mm)** o.c. and at end joints.
- E. Where PVDC jackets are indicated, install as follows:

1. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
2. Wrap factory-presizes jackets around individual pipe insulation sections, with one end overlapping the previously installed sheet. Install presized jacket with an approximate overlap at butt joint of **2 inches (50 mm)** over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.
3. Continuous jacket can be spiral-wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.
4. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of **33-1/2 inches (850 mm)** or less. The **33-1/2-inch- (850-mm-)** circumference limit allows for **2-inch- (50-mm-)** overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
5. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

3.9 FINISHES

- A. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating on exterior insulation.

3.10 PIPING INSULATION SCHEDULE, GENERAL

- A. Insulation conductivity and thickness per pipe size shall comply with schedules in this Section or with requirements of authorities having jurisdiction, whichever is more stringent.
- B. 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.
- C. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 1. Underground piping.
 2. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.11 INDOOR PIPING INSULATION SCHEDULE

MINIMUM PIPE INSULATION THICKNESS (in inches)

FLUID OPERATING TEMPERATURE RANGE AND USAGE (°F)	INSULATION CONDUCTIVITY	NOMINAL PIPE OR TUBE SIZE (inches)					
	Conductivity Btu • in./ (h • ft ² • °F) ^b	Mean Rating Tem- perature, °F	< 1	1 to < 1 1/2	1 1/2 to < 4	4 to < 8	≥ 8
> 350	0.32 - 0.34	250	4.5	5.0	5.0	5.0	5.0
251 — 350	0.29 — 0.32	200	3.0	4.0	4.5	4.5	4.5
201 — 250	0.27 — 0.30	150	2.5	2.5	2.5	3.0	3.0
141 — 200	0.25 — 0.29	125	1.5	1.5	2.0	2.0	2.0
105 — 140	0.21 — 0.28	100	1.0	1.0	1.5	1.5	1.5
40 — 60	0.21 — 0.27	75	0.5	0.5	1.0	1.0	1.0
< 40	0.20 — 0.26	50	0.5	1.0	1.0	1.0	1.5

3.12 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.

INSULATION MATERIAL AND JACKETING SCHEDULE THICKNESS SHALL BE DETERMINED BASED UPON THE R VALUE SPECIFIED AND THE INSULATION TYPE SCHEDULED						
EQUIPMENT OR SYSTEM SERVED	TYPE ①			JACKETING CLASS ②		
	INTERIOR GENERAL	EQUIPMENT ROOMS	EXTERIOR	INTERIOR GENERAL	EQUIPMENT ROOMS	EXTERIOR
REFRIGERANT SUCTION, RS	FE	FE	FE	0	0	4
REFRIGERANT HOT GAS, RHG	FE	FE	FE	0	0	4
CHILLED WATER, CHWS/R	FG	FG	UR	1	3/4	4&5
HOT WATER, HWS/R	FG	FG	CS	1	3/4	7
DUAL TEMP, DTS/DTR	FG	FG	CS	1	3/4	7

- ① INSULATION TYPE:
 FG--FIBROUS GLASS
 FE--FLEXIBLE ELASTOMERIC
 JR--URETHANE
 CS--CALCIUM SILICATE

THICKNESS SHALL BE DETERMINED
 BASED UPON THE R VALUE SPECIFIED
 AND THE INSULATION TYPE SCHEDULED.
 DUAL TEMP PIPING INSULATION SHALL
 BE SAME AS HOT WATER

- ② JACKET TYPE:
 0--NONE
 1--ALL SERVICE JACKET
 2--ALUMINUM FOIL
 3--CANVAS
 4--POLYVINYL CHLORIDE
 5--ALUMINUM FOIL/MYLAR LAMINATE
 6--STAINLESS STEEL
 7--ALUMINUM
 8--EPDM

END OF SECTION 230719

SECTION 230800 - COMMISSIONING OF HVAC SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. The requirements of this section are supplementary to the General Commissioning Requirements for the project and do not negate or supersede the commissioning requirements specified elsewhere.
- B. This section defines the commissioning responsibilities of the Division 23 Contractor (referred to herein as either "MC" or "the Contractor") and all other subcontractors or factory-authorized service representatives responsible for the systems to be commissioned. The responsibilities of other parties, including the Commissioning Agent (CxA), Owner, and Design Team (A/E) are referenced for clarification purposes only.
- C. The final list of Systems to be Commissioned will be included in the Commissioning Plan provided by the CxA.
- D. Related Requirements:
 - 1. Section 019113 "General Commissioning Requirements" describes the overall commissioning process and responsibilities for which this contract is responsible.
- E. Abbreviations: The following are common abbreviations used in the Specifications. For additional definitions refer to Section 019113.
 - 1. A/E: Architects and Engineers
 - 2. Cx: Commissioning
 - 3. CxA: Commissioning Authority
 - 4. Cx Plan: Commissioning Plan Document
 - 5. CC: Controls Contractor
 - 6. CM: Construction Manager
 - 7. EC: Electrical Contractor
 - 8. FT: Functional Performance Test
 - 9. MC: Mechanical Contractor
 - 10. PFI: Pre-Functional Inspection
 - 11. TAB: Test and Balance Contractor

1.2 INFORMATIONAL SUBMITTALS

- A. Prefunctional Checklists

1. Submit according to the procedures defined in the Commissioning Plan and as agreed at the commissioning scoping meeting.
- B. Startup and Manufacturer Test Reports
 1. Obtain copies of all startup reports as well as any test reports prepared by factory authorized service representatives as required by the specification section for each commissioned system. Promptly provide copies of reports to the CxA, as requested.
- C. Requests for Clarification
 1. The CxA may request supplemental written clarification for items which are not clearly indicated in equipment submittal documentation. Where such requests are made, the MC shall provide written responses to the CxA within 5 business days. Examples of such requests may include, but are not limited to, clarification of equipment operating sequences, performance data, startup requirements, selected options or accessories, etc.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 MEETINGS

- A. Attend commissioning meetings as described in the General Commissioning Requirements.
- B. Commissioning meetings may be scheduled separately from regular construction progress meetings, at the discretion of the CM and CxA.

3.2 COORDINATION AND SCHEDULING

- A. MC shall coordinate schedule for prefunctional checklists and equipment startup with CxA.
- B. CxA shall review and approve prefunctional checklists and equipment startup reports prior to scheduling functional testing.

3.3 PREFUNCTIONAL CHECKLISTS

- A. Blank copies of the required checklists will be provided by the CxA for use by the MC.

- B. Completed copies of checklists shall be submitted to the CxA according to the procedures defined in the Commissioning Plan and as agreed at the commissioning scoping meeting.
- C. Where checklists require sign-off by multiple parties (e.g. checking of electrical connections by the EC on equipment provided by the MC) each party shall complete their respective portions of the checklist and shall organize all documentation into a single, comprehensive checklist record. Responsible parties shall be indicated by the CxA on each checklist.
- D. The MC shall submit any requests for direction on completion of checklists in writing to the CM and CxA.

3.4 FUNCTIONAL PERFORMANCE TESTING

- A. The objective of functional performance testing is to demonstrate that each commissioned system is installed and operating in accordance with the documented design intent. Functional testing shall commence only after all prefunctional inspections, manufacturer testing and startup activities are complete.
- B. The detailed functional testing requirements for each commissioned system will be established in the Commissioning Plan and the Functional Testing Procedures to be developed by the CxA.
- C. Before test procedures are written, the CxA shall obtain all requested documentation related to the intended functional performance of the commissioned systems. This includes submittal documentation, change orders, requests for information, design clarifications, and updated controls system programming information (points lists, control sequences, etc).
- D. MC shall provide assistance to the CxA by reviewing the procedures and responding to questions and concerns posed by the CxA.
- E. General testing requirements:
 - 1. Certify that HVAC systems, subsystems, and equipment have been installed, calibrated, and started and are operating in accordance with the Contract Documents and approved Shop Drawings and submittals.
 - 2. Certify that HVAC instrumentation and control systems have been completed and calibrated, that they are operating in accordance with the Contract Documents and approved Shop Drawings and submittals, and that pretest set points have been recorded.
 - 3. Set systems, subsystems, and equipment into operating mode to be tested in accordance with approved test procedures (e.g., normal shutdown, normal auto

position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

4. Measure capacities and effectiveness of systems, assemblies, subsystems, equipment, and components, including operational and control functions to verify compliance with acceptance criteria.
5. Test systems, assemblies, subsystems, equipment, and components operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and response in accordance with commissioning and acceptance test criteria.

3.5 SEASONAL TESTING

- A. Where seasonal tests are specified, scheduled, or otherwise required by the CxA, the MC shall provide qualified personnel to assist with execution of tests. Where required, the MC shall also secure the services of factory-authorized personnel who are fully capable of executing the required tests.

3.6 MANUFACTURER'S FIELD SERVICE

- A. Where required in these specifications, the MC shall retain the services of a factory-authorized representative, vendor's representative, or third-party testing service to carry out equipment startup and testing services (hereby referred to as "Manufacturer's Field Service").
- B. The MC shall ensure that the contract for Manufacturer's Field Service contains sufficient time, in addition to normal startup activities, for the representative to assist the commissioning team in completing functional performance tests. The scope and schedule of testing will be directed by the CxA. This requirement applies to service contracts for each of the commissioned system identified in these specifications.
- C. It shall be the responsibility of the Contractor to specifically request and secure all Manufacturer's Field Services necessary for the startup and commissioning activities specified in the contract documents. Where the standard Manufacturer's Field Service proposed by a vendor or third party service representative may otherwise be insufficient, the necessary services shall be secured during the equipment procurement process.
- D. Following correction of deficiencies, the MC shall arrange for Manufacturer's Field Service required to re-test previously deficient systems, as directed by the CxA.

3.7 DEFICIENCIES, NON-CONFORMANCE AND APPROVAL OF TESTS

- A. MC shall be responsible for responding to deficiencies or items of non-conformance related to the system.
- B. Where deficiencies are identified during the commissioning process, the MC shall issue a written response.
- C. Deficiencies shall be corrected in a timely manner. Once corrections are made, notify the CxA that the system(s) are ready for re-inspection and/or re-testing.
- D. Items which are not corrected, require multiple inspections by the CxA to resolve, or which result in scheduling delays may result in back charges to the responsible party. Refer to the section entitled "Documentation, Non-Conformance and Approval of Tests" in section 019113 for additional information on deficiency resolution.
- E. Upon successful completion of testing for each system, the CxA will document the results of testing in the functional testing record. A copy of the test record shall be included in the commissioning documentation to be provided to the Owner upon completion of commissioning.

3.8 OWNER TRAINING

- A. Training shall be provided by the MC in coordination with the Owner, CM and CxA. Adequacy of training shall be verified by the CxA, though the CxA may opt not attend all portions of training. For detailed training requirements, refer to section 019113 "General Commissioning Requirements" as well as the requirements contained within the individual equipment specifications.

3.9 PERSONNEL

- A. Provide qualified technicians, instrumentation, tools and equipment during the startup, functional testing, and seasonal testing of the commissioned systems. Ensure the availability of at least one individual on site during commissioning tests.

END OF SECTION 230800

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SECTION 232113 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Copper tube and fittings.
2. Steel pipe and fittings.
3. Plastic pipe and fittings.
4. Joining materials.
5. Transition fittings.
6. Dielectric fittings.
7. Bypass chemical feeder.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of the following:

1. Pipe and tube.
2. Fittings.
3. Joining materials.
4. Transition fittings.

1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Piping layout, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.
- B. Qualification Data: For Installer.
- C. Welding certificates.
- D. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installers of Pressure-Sealed Joints: Installers shall be certified by pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.
- B. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- C. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
 1. Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.
 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

1.5 WARRANTY

- A. PP-R Manufacturer's Warranty: Manufacturer agrees to repair or replace PP-R pipe and fittings that fail in materials or workmanship within 10 years from date of Substantial Completion.
 1. Warranty is to cover labor and material costs of repairing and/or replacing defective materials and repairing any incidental damage caused by failure of the piping system due to defects in materials or manufacturing.
 2. Warranty is to be in effect only upon submission by the Contractor to the manufacturer of valid pressure/leak documentation indicating that the system was tested and passed the manufacturer's pressure/leak test.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:
 1. Hot-Water Heating Piping: 100 psig at 200 deg F.
 2. Chilled-Water Piping: 150 psig at 73 deg F.
 3. Dual-Temperature Heating and Cooling Water Piping: 100 psig at 200 deg F..
 4. Condenser-Water Piping: 150 psig at 150 deg F.
 5. Glycol Cooling-Water Piping: 150 psig at 150 deg F.
 6. Makeup-Water Piping: 150 psig at 150 deg F.
 7. Condensate-Drain Piping: 180 deg F.

8. Blowdown-Drain Piping: 200 deg F.
9. Air-Vent Piping: 200 deg F.
10. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

2.2 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tube: ASTM B88, Type L.
- B. DWV Copper Tube: ASTM B306, Type DWV.
- C. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, pressure fittings.
- D. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
- E. Wrought Copper Unions: ASME B16.22.
- F. Grooved, Mechanical-Joint, Copper Tube Appurtenances:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International.
 - b. Victaulic Company.
 2. Grooved-End Copper Fittings: ASTM B75, copper tube or ASTM B584, bronze castings.
 3. Grooved-End-Tube Couplings: To fit copper-tube dimensions; rigid pattern unless otherwise indicated; gasketed fitting EPDM-rubber gasket rated for minimum 230 deg F for use with ferrous housing, and steel bolts and nuts; 300 psig minimum CWP pressure rating.
- G. Copper-Tube, 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 LLC.
 2. Fittings: Cast-brass, cast-bronze, or wrought-copper with EPDM O-ring seal in each end.
 3. Minimum 200-psig working-pressure rating at 250 deg F.

2.3 STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A53/A53M, black steel with plain ends; welded and seamless, Grade B, and wall thickness as indicated in "Piping Applications" Article.
- B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in "Piping Applications" Article.
- C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in "Piping Applications" Article.
- D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in "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 "Piping Applications" Article.
- F. Wrought-Steel Fittings: ASTM A234/A234M, 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. Grooved Mechanical-Joint Fittings and Couplings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International.
 - b. Gustin Bacon Company.
 - c. Victaulic Company.
 - 2. Joint Fittings: ASTM A536, Grade 65-45-12 ductile iron; ASTM A47/A47M, Grade 32510 malleable iron; ASTM A53/A53M, Type F, E, or S, Grade B fabricated steel; or ASTM A106/A106M, Grade B steel fittings with grooves or shoulders constructed to accept grooved-end couplings; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
 - 3. Couplings: Ductile- or malleable-iron housing and EPDM gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.

I. Plain-End Mechanical-Joint Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Anvil International.
 - b. Shurjoint-Apollo Piping Products USA Inc.
 - c. Victaulic Company.
2. Housing: ASTM A536 Grade 65-45-12 segmented ductile iron or type 304 stainless steel.
3. Housing coating: None.
4. Gasket: EPDM.
5. Sealing Mechanism: Double-lip sealing system or carbon steel case-hardened jaws.
6. Bolts, hex nuts, washers, or lock bars based on manufacturer's design.
7. Minimum Pressure Rating: Equal to that of the joined pipes.

J. Steel Pressure-Seal 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. Victaulic Company.
 - b. Viega LLC.
2. Housing: Steel.
3. O-Rings and Pipe Stop: EPDM.
4. Tools: Manufacturer's special tool.
5. Minimum 300-psig working-pressure rating at 230 deg F.

K. Steel Pipe Nipples: ASTM A733, made of same materials and wall thicknesses as pipe in which they are installed.

2.4 PLASTIC PIPE AND FITTINGS

A. PVC Plastic Pipe: ASTM D1785, with wall thickness as indicated in "Piping Applications" Article.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Charlotte Pipe and Foundry Company.

- b. [IPEX USA LLC.](#)
 - c. [Spears Manufacturing Company.](#)
- 2. PVC Plastic Pipe Fittings: Socket-type pipe fittings, ASTM D2466 for Schedule 40 pipe; ASTM D2467 for Schedule 80 pipe.

2.5 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 otherwise indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
- B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- C. Solder Filler Metals: ASTM B32, lead-free alloys. Include water-flushable flux according to ASTM B813.
- D. Brazing Filler Metals: AWS A5.8/A5.8M, 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 D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.6 TRANSITION FITTINGS

- A. Plastic-to-Metal Transition Fittings:
 - 1. [Manufacturers:](#) Subject to compliance with requirements, provide products by one of the following:
 - a. [Charlotte Pipe and Foundry Company.](#)
 - b. [IPEX USA LLC.](#)
 - c. [Uponor.](#)
 - d. [Viega LLC.](#)
 - 2. One-piece fitting with one threaded brass or copper insert and one solvent-cement-joint end of material and wall thickness to match plastic pipe material.

B. Plastic-to-Metal Transition Unions:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Charlotte Pipe and Foundry Company.
 - b. IPEX USA LLC.
 - c. NIBCO INC.
 - d. Spears Manufacturing Company.
2. Brass or copper end, solvent-cement-joint end of material and wall thickness to match plastic pipe material, rubber gasket, and threaded union.

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. A.Y. McDonald Mfg. Co.
 - b. Capitol Manufacturing Company.
 - c. HART Industrial Unions, LLC.
 - d. Jomar Valve.
 - e. Zurn Industries, LLC.
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. Matco-Norca.
 - c. Zurn Industries, LLC.

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. [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.

E. Dielectric Nipples:

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

- a. [Elster Perfection Corporation.](#)
- b. [Precision Plumbing Products.](#)
- c. [Victaulic Company.](#)

2. Description:

- a. Standard: IAPMO PS 66.
- b. Electroplated steel nipple, complying with ASTM F1545.
- c. Pressure Rating: 300 psig at 225 deg F.
- d. End Connections: Male threaded or grooved.
- e. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Piping, aboveground, NPS 2.5 and smaller, shall be the following:
 - 1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered pressure-seal joints.
- B. Piping, aboveground, NPS 3 and larger, shall be any of the following:
 - 1. Type L, drawn-temper copper tubing, wrought-copper fittings, and grooved joints.
 - 2. Schedule 40 steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints, **or welded**.
- C. Condensate-Drain Piping, Copper: Type DWV, drawn-temper copper tubing, wrought-copper fittings, and soldered joints in plenums and Schedule 40 PVC plastic pipe and fittings and solvent-welded joints in all other locations.
- D. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.
- E. Air-Vent Piping:
 - 1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.
 - 2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.
- F. 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 piping manufacturer's written instructions.

3.2 INSTALLATION OF PIPING

- A. 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.
- 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 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 unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- Q. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.
- R. Install shutoff valve immediately upstream of each dielectric fitting.
- S. Install sleeves for piping penetrations of walls, ceilings, and floors.

- T. Install sleeve seals for piping penetrations of concrete walls and slabs.
- U. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.3 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Soldered Joints: Apply ASTM B813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B32.
- 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 D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
- F. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- G. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid, grooved-end-pipe couplings.
- H. Plain-End Mechanical-Coupled Joints: Prepare, assemble, and test joints in accordance with manufacturer's written installation instructions.
- I. Mechanically Formed, Copper-Tube-Outlet Joints: Use manufacturer-recommended tools and procedure, and brazed joints.
- J. Pressure-Sealed Joints: Use manufacturer-recommended tools and procedure. Leave insertion marks on pipe after assembly.

3.4 INSTALLATION OF DIELECTRIC FITTINGS

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.
- D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.5 INSTALLATION OF HANGERS AND SUPPORTS

- A. Install hangers for copper tubing and steel piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- B. Install hangers for plastic piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- C. Support horizontal piping within 12 inches of each fitting and coupling.
- D. Support vertical runs of copper tubing and steel piping to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- E. Support vertical runs of PP-R piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.6 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 ports for pressure gauges and thermometers at coil inlet and outlet connections.

3.7 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, and to sustain the following water characteristics:
1. pH: 9.0 to 10.5.
 2. "P" Alkalinity: 100 to 500 ppm.
 3. Boron: 100 to 200 ppm.
 4. Chemical Oxygen Demand: Maximum of 100 ppm.
 5. Corrosion Inhibitor:
 - a. Sodium Nitrate: 1000 to 1500 ppm.
 - b. Molybdate: 200 to 300 ppm.
 - c. Chromate: 200 to 300 ppm.
 - d. Sodium Nitrate Plus Molybdate: 100 to 200 ppm each.
 - e. Chromate Plus Molybdate: 50 to 100 ppm each.
 6. Soluble Copper: Maximum of 0.20 ppm.
 7. Tolyriazole Copper and Yellow Metal Corrosion Inhibitor: Minimum of 10 ppm.
 8. Total Suspended Solids: Maximum of 10 ppm.
 9. Ammonia: Maximum of 20 ppm.
 10. Free Caustic Alkalinity: Maximum of 20 ppm.
 11. Microbiological Limits:
 - a. Total Aerobic Plate Count: Maximum of 1000 organisms/mL.
 - b. Total Anaerobic Plate Count: Maximum of 100 organisms/mL.
 - c. Nitrate Reducers: 100 organisms/mL.
 - d. Sulfate Reducers: Maximum of zero organisms/mL.
 - e. Iron Bacteria: Maximum of zero organisms/mL.
- B. Install bypass chemical feeders in each hydronic system where indicated.
1. Install in upright position with top of funnel not more than 48 inches above the floor.
 2. Install feeder in minimum NPS 3/4 bypass line, from main with full-size, full-port, ball valve in the main between bypass connections.
 3. Install NPS 3/4 pipe from chemical feeder drain to nearest equipment drain and include a full-size, full-port, ball valve.
- C. 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.

- D. Add initial chemical treatment and maintain water quality in ranges noted above for the first year of operation.

3.8 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 the "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 232113

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SECTION 232116 - HYDRONIC PIPING SPECIALTIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Hydronic specialty valves.
2. Air-control devices.
3. Strainers.
4. Connectors.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product:

1. Include construction details and material descriptions for hydronic piping specialties.
2. Include rated capacities, operating characteristics, and furnished specialties and accessories.
3. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For hydronic piping specialties to include in emergency, operation, and maintenance manuals.

1.4 MAINTENANCE MATERIAL SUBMITTALS

A. Differential Pressure Meter: For each type of balancing valve and automatic flow control valve, include flowmeter, probes, hoses, flow charts, and carrying case.

1.5 QUALITY ASSURANCE

A. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

- B. 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 HYDRONIC SPECIALTY VALVES

A. Bronze, Calibrated-Orifice, Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Bell & Gossett; a Xylem brand.
 - b. NIBCO INC.
 - c. TACO Comfort Solutions, Inc.
 - d. Victaulic Company.
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.

B. Diaphragm-Operated, Pressure-Reducing Valves: ASME labeled.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AMTROL, Inc.
 - b. Apollo Flow Controls; Conbraco Industries, Inc.
 - c. Armstrong Pumps, Inc.
 - d. Bell & Gossett; a Xylem brand.
 - e. Victaulic Company.
 - f. 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. Inlet Strainer: Stainless Steel, removable without system shutdown.
9. Valve Seat and Stem: Noncorrosive.
10. Valve Size, Capacity, and Operating Pressure: Selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

C. Diaphragm-Operated Safety Valves: ASME labeled.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AMTROL, Inc.
 - b. Apollo Flow Controls; Conbraco Industries, Inc.
 - c. Armstrong Pumps, Inc.
 - d. Bell & Gossett; a Xylem brand.
 - e. 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. Inlet Strainer: Stainless Steel, removable without system shutdown.
9. Valve Seat and Stem: Noncorrosive.
10. 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.

2.2 AIR-CONTROL DEVICES

A. Manual Air Vents:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AMTROL, Inc.
 - b. Apollo Flow Controls; Conbraco Industries, Inc.
 - c. Armstrong Pumps, Inc.
 - d. Bell & Gossett; a Xylem brand.
 - e. TACO Comfort Solutions, Inc.

2. Body: Bronze.
3. Internal Parts: Nonferrous.
4. Operator: Screwdriver or thumbscrew.
5. Inlet Connection: NPS 1/2.
6. Discharge Connection: NPS 1/8.
7. CWP Rating: 150 psig.
8. Maximum Operating Temperature: 225 deg F.

B. Automatic Air Vents:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AMTROL, Inc.
 - b. Bell & Gossett; a Xylem brand.
 - c. Spirotherm, Inc.
 - d. TACO Comfort Solutions, Inc.
2. Body: Bronze or cast iron.
3. Internal Parts: Nonferrous.
4. Operator: Noncorrosive metal float.
5. Inlet Connection: NPS 1/2.
6. Discharge Connection: NPS 1/4.
7. CWP Rating: 150 psig.
8. Maximum Operating Temperature: 240 deg F.

C. Bladder-Type ASME Expansion Tanks:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AMTROL, Inc.
 - b. Armstrong Pumps, Inc.
 - c. Bell & Gossett; a Xylem brand.
 - d. TACO Comfort Solutions, Inc.
2. Tank: Welded steel, rated for 125-psig working pressure and 240 deg F maximum operating temperature. Factory test after taps are fabricated and supports installed and are labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
3. Bladder: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
4. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.

- D. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.
- E. Coalescing-Type Air and Dirt Separators:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Armstrong Pumps, Inc.
 - b. Bell & Gossett; a Xylem brand.
 - c. Spirotherm, Inc.
 - 2. Tank: Fabricated steel tank; ASME constructed and stamped for 125-psig (862-kPa) working pressure and 270 deg F (130 deg C) maximum operating temperature.
 - 3. Coalescing Medium: [Copper].
 - 4. Air Vent: Threaded to the top of the separator.
 - 5. Inline Inlet and Outlet Connections: Threaded for NPS 2 (DN 50) and smaller; Class 150 flanged connections for NPS 2-1/2 (DN 65) and larger.
 - 6. Blowdown Connection: Threaded to the bottom of the separator.
 - 7. Size: Match system flow capacity.

2.3 STRAINERS

- A. Y-Pattern Strainers:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Keckley Company.
 - b. Metraflex Company (The).
 - c. Titan Flow Control, Inc.
 - d. WATTS.
 - 2. Body: ASTM A126, Class B, cast iron or bronze with bolted cover and bottom drain connection.
 - 3. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
 - 4. Strainer Screen: Stainless-steel, 40-mesh strainer, or perforated stainless-steel basket.
 - 5. CWP Rating: 125 psig.

2.4 CONNECTORS

A. Stainless-Steel Bellow, Flexible Connectors:

1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
2. End Connections: Threaded or flanged to match equipment connected.
3. Performance: Capable of 3/4-inch misalignment.
4. CWP Rating: 150 psig.
5. Maximum Operating Temperature: 250 deg F.

B. 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.

PART 3 - EXECUTION

3.1 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 check valves at each pump discharge and elsewhere as required to control flow direction
- C. 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; 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.
- D. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

3.2 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. Install 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 tangential air separator in pump suction. Install blowdown piping with gate or full-port ball valve; extend full size to nearest floor drain.
- F. Install expansion tanks on the floor. Vent and purge air from hydronic system, and ensure that tank is properly charged with air to suit system Project requirements.

END OF SECTION 232116

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SECTION 232123 - HYDRONIC PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Close-coupled, in-line centrifugal pumps.
2. Separately coupled, vertically mounted, in-line centrifugal pumps.
3. Separately coupled, base-mounted, end-suction centrifugal pumps.

1.2 DEFINITIONS

- A. ECM: Electronically commutated motor.
- B. EPDM: Ethylene propylene diene monomer.
- C. EPR: Ethylene propylene rubber.
- D. FKM: Fluoroelastomer polymer.
- E. HI: Hydraulic Institute.
- F. NBR: Nitrile rubber or Buna-N.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of pump.
1. Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated.
 2. Indicate pump's operating point on curves.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

- B. Field quality-control reports.

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 that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Mechanical Seals: One (1) mechanical seal(s) for each pump.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS

- 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. Bell & Gossett; a Xylem brand
 - 2. Grundfos Pumps Corporation
 - 3. TACO Comfort Solutions, Inc.
- B. Source Limitations: Obtain pumps from single source from single manufacturer.
- C. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally or vertically.
- D. Pump Construction:

1. Casing: Radially split, cast iron, with threaded gauge tappings at inlet and outlet, replaceable bronze wear rings, and threaded companion-flange connections.
 2. Impeller: ASTM B584, 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 Sleeve: Type 304 stainless steel.
 4. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless steel spring, and EPDM rubber bellows and gasket. Include water slinger on shaft between motor and seal.
 5. Seal Flushing: Flush, cool, and lubricate pump seal by directing pump discharge water to flow over the seal.
- E. Shaft Coupling: Rigid, axially-split spacer coupling to allow service of pump seal without disturbing pump or motor.
- F. Motor: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
1. Enclosure : Open drip proof.
 2. NEMA Premium 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. Variable-speed motor.
 6. Provide integral pump motor variable-speed controller.

2.3 SEPARATELY COUPLED, VERTICALLY MOUNTED, IN-LINE CENTRIFUGAL PUMPS

- 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. Bell & Gossett; a Xylem brand
 2. TACO Comfort Solutions, Inc.
- B. Source Limitations: Obtain pumps from single source from single manufacturer.
- C. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted vertically.

D. Pump Construction:

1. Casing: Radially split, cast iron, with threaded gauge tapings at inlet and outlet, replaceable bronze wear rings, and threaded companion-flange connections.
2. Impeller: ASTM B584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For pumps that are not frequency-drive controlled, trim impeller to match specified performance.
3. Pump Shaft: Carbon steel, Type 304 stainless steel shaft sleeve.
4. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless steel spring, and EPDM bellows and gasket.

E. Shaft Coupling: Interlocking frame with interconnecting springs capable of absorbing vibration.

F. Motor: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

1. Enclosure: Open drip proof
2. NEMA Premium 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. Variable-speed motor.
6. Provide integral pump motor variable-speed controller.

2.4 SEPARATELY COUPLED, BASE-MOUNTED, END-SUCTION CENTRIFUGAL PUMPS

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. Bell & Gossett; a Xylem brand
2. TACO Comfort Solutions, Inc.

B. Source Limitations: Obtain pumps from single source from single manufacturer.

C. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, end-suction pump with flexible shaft coupling as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal.

D. Pump Construction:

1. Casing: Radially split, cast iron, with threaded gauge tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and threaded companion-flange connections.
 2. Impeller: ASTM B584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For pumps that are not frequency-drive controlled, trim impeller to match specified performance.
 3. Pump Shaft: Type 304 stainless steel.
 4. Seal, Mechanical Type: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless steel spring, and EPDM bellows and gasket.
 5. Seal, Packing Type: Packing seal consisting of stuffing box with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.
 6. Pump Bearings: Grease-lubricated ball bearings in cast-iron housing with grease fittings.
- E. Shaft Coupling: Molded-rubber insert and interlocking spider capable of absorbing vibration. Couplings shall be drop-out type to allow disassembly and removal without removing pump shaft or motor.
- F. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.
- G. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A36/A36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.
- H. Motor: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
1. Enclosure: Open drip proof.
 2. NEMA Premium 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. Variable-speed motor.
 6. Provide integral pump motor variable-speed controller.

2.5 PUMP SPECIALTY FITTINGS

- A. Suction Diffuser:

1. Angle pattern.
2. 175-psig pressure rating, cast-iron body and end cap, pump-inlet fitting.
3. Bronze 16-mesh wire startup and Type 304 stainless steel permanent strainers with 3/16-inch.
4. Carbon steel straightening vanes.
5. Drain plug.
6. Factory-fabricated support.

2.6 INTEGRAL PUMP MOTOR VARIABLE-SPEED CONTROLLERS

- A. Where specified or scheduled, provide pumps with an integral pump motor speed controller.
1. Motor: Operates as constant- or variable-speed pump with speed regulated by an integrated variable-speed drive.
 2. Integrated Pump Controller: Supports direct communication with the building management system (BMS) with built-in support for the following protocols: BACnet MS/TP.
 3. Commissioning and pump set up access to pump controls via the following:
 - a. A web interface (data exchange).
 - b. A user interface located on the face of speed controller to adjust modes and mode values.
 - c. An electronic display that reads real-time mode set values, flow, head, speed, and power and that locks out unauthorized adjustment of pump.
 4. Provide electronics with "Auto" as factory default but slope of the proportional curve will automatically match the required system curve, constant pressure control ($\Delta p/c$), variable differential pressure control ($\Delta p/v$), constant curve duty (uncontrolled pump), and rpm regulation. RPM (speed) regulation can be accomplished by the following:
 - a. Manual (via user interface or HTML).
 - b. Remote via 0 to 10 V dc.
 - c. Data protocol communications with the BMS.
 5. Pump Electronics: Standard with multiple digital inputs and one external digital output to be available for additional mechanical room control and pump status monitoring.
 6. Controller: Mounted on or adjacent to the motor. Provide enclosure rated to UL Type 12.

7. Electronically Protected Pumps: Rated for continuous duty and with built-in startup circuit. Provide overcurrent, line surge and current limit protection, thermal monitoring, heat sink status and over temperature protection.
8. Pump capable of being monitored continuously via integrated Internet link.

2.7 ELECTRONICALLY COMMUTATED MOTOR (ECM)

- A. Provide pumps so they are specified or scheduled with ECM.
 1. Synchronous, constant torque, ECM with permanent magnet rotor. Rotor magnets to be time-stable, nontoxic ceramic magnets (Sr-Fe).
 2. Driven by a frequency converter with an integrated power factor correction filter. Conventional induction motors will not be acceptable.
 3. Each motor with an integrated variable-frequency drive, tested as one unit by manufacturer.
 4. Motor speed adjustable over full range from 0 rpm to maximum scheduled speed.
 5. Variable motor speed to be controlled by a 0- to 10 V-dc or 4- to 20-mA input.
 6. Integrated motor protection verified by UL to protect the pump against over-/undervoltage, overtemperature of motor and/or electronics, overcurrent, locked rotor, and dry run (no-load condition).

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of 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 will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PUMP INSTALLATION

- A. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.
- B. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.
- C. Equipment Mounting:
 - 1. Install base-mounted pumps on cast-in-place concrete equipment bases.

3.3 ALIGNMENT

- A. Engage a factory-authorized service representative to perform alignment service.
- B. Comply with requirements in HI 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.

3.4 PIPING 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.
 - 1. Use startup strainer for initial system startup. Install permanent strainer element before turnover of system to Owner.

- F. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.
- G. Install pressure gauges on pump suction and discharge or at integral pressure-gauge tapping, or install single gauge with multiple-input selector valve.
- H. Install check valve on each condensate pump unit discharge unless unit has a factory-installed check valve.

3.5 ELECTRICAL CONNECTIONS

- A. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.
- B. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
 - 1. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.6 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.

3.7 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks in accordance with manufacturer's written instructions.
 - 2. Check piping connections for tightness.
 - 3. Clean strainers on suction piping. Use startup strainer for initial startup.
 - 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 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.

3.8 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections with the assistance of a factory-authorized service representative.
- C. Hydronic pumps will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

3.9 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps.

END OF SECTION 232123

SECTION 232300 - REFRIGERANT PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Copper tube and fittings.
2. Valves and specialties.
3. Refrigerants.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of valve, refrigerant piping, and piping specialty.

1. Include pressure drop, based on manufacturer's test data, for the following:
 - a. Thermostatic expansion valves.
 - b. Solenoid valves.
 - c. Hot-gas bypass valves.
 - d. Filter dryers.
 - e. Strainers.
 - f. Pressure-regulating valves.

B. Shop Drawings:

1. Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes; flow capacities; valve arrangements and locations; slopes of horizontal runs; oil traps; double risers; wall and floor penetrations; and equipment connection details.
2. Show piping size and piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.
3. Show interface and spatial relationships between piping and equipment.
4. Shop Drawing Scale: 1/4 inch equals 1 foot.

1.3 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
- B. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to 2010 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."

1.6 PRODUCT STORAGE AND HANDLING

- A. Store piping with end caps in place to ensure that piping interior and exterior are clean when installed.

PART 2 - PRODUCTS

2.1 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.

D. Line Test Pressure for Refrigerant R-454B:

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.

2.2 COPPER TUBE AND FITTINGS

A. Copper Tube: ASTM B 88, Type K or L ASTM B 280, Type ACR.

B. Wrought-Copper Fittings, Brazed-Joint: ASME B16.50.

C. Wrought-Copper Unions: ASME B16.22.

D. Brazing Filler Metals: AWS A5.8/A5.8M.

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. Working Pressure Rating: Factory test at minimum 500 psig.
5. Maximum Operating Temperature: 250 deg F.

2.3 VALVES AND SPECIALTIES

A. Diaphragm Packless Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Danfoss Inc.
 - b. Henry Technologies Inc.; The Henry Group.
 - c. Parker Hannifin Corp.
 - d. Paul Mueller Company.

2. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
3. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
4. Operator: Rising stem and hand wheel.
5. Seat: Nylon.
6. End Connections: Socket, union, or flanged.
7. Working Pressure Rating: 500 psig.
8. Maximum Operating Temperature: 275 deg F.

B. Packed-Angle Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Danfoss Inc.
 - b. Henry Technologies Inc.; The Henry Group.
 - c. Parker Hannifin Corp.
 - d. Paul Mueller Company.
 - e.
2. Body and Bonnet: Forged brass or cast bronze.
3. Packing: Molded stem, back seating, and replaceable under pressure.
4. Operator: Rising stem.
5. Seat: Nonrotating, self-aligning polytetrafluoroethylene.
6. Seal Cap: Forged-brass or valox hex cap.
7. End Connections: Socket, union, threaded, or flanged.
8. Working Pressure Rating: 500 psig.
9. Maximum Operating Temperature: 275 deg F.

C. Check Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; a part of Aalberts Integrated Piping Systems.
 - b. Danfoss Inc.
 - c. Emerson Climate Technologies; Emerson Electric Co.
 - d. Parker Hannifin Corp.
 - e. Paul Mueller Company.
2. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
3. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
4. Piston: Removable polytetrafluoroethylene seat.
5. Closing Spring: Stainless steel.

6. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
7. End Connections: Socket, union, threaded, or flanged.
8. Maximum Opening Pressure: 0.50 psig.
9. Working Pressure Rating: 500 psig.
10. Maximum Operating Temperature: 275 deg F.

D. Service Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Danfoss Inc.
 - b. Emerson Climate Technologies; Emerson Electric Co.
 - c. Parker Hannifin Corp.
 - d. Paul Mueller Company.
 - e. RectorSeal HVAC; a CSW Industrials Company.
2. Body: Forged brass with brass cap including key end to remove core.
3. Core: Removable ball-type check valve with stainless-steel spring.
4. Seat: Polytetrafluoroethylene.
5. End Connections: Copper spring.
6. Working Pressure Rating: 500 psig.

E. Refrigerant Locking Caps:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. C & D Valve, LLC.
 - b. JB Industries.
 - c. RectorSeal HVAC; a CSW Industrials Company.
2. Description: Locking-type, tamper-resistant, threaded caps to protect refrigerant charging ports from unauthorized refrigerant access and leakage.
3. Material: Brass, with protective shroud or sleeve.
4. Refrigerant Identification: Color-coded, refrigerant specific or Universal design.
5. Special Tool: For installing and unlocking.

F. Solenoid Valves: Comply with AHRI 760 and UL 429; listed and labeled by a National Recognized Testing Laboratory (NRTL).

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

- a. [Danfoss Inc.](#)
 - b. [Emerson Climate Technologies; Emerson Electric Co.](#)
 - c. [Henry Technologies Inc.; The Henry Group.](#)
 - d. [Parker Hannifin Corp.](#)
 - e. [Paul Mueller Company.](#)
 2. Body and Bonnet: Plated steel.
 3. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
 4. Seat: Polytetrafluoroethylene.
 5. End Connections: Threaded.
 6. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and ac coil.
 7. Working Pressure Rating: 400 psig.
 8. Maximum Operating Temperature: 240 deg F.
- G. Safety Relief Valves: Comply with 2010 ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
1. [Manufacturers:](#) Subject to compliance with requirements, provide products by one of the following:
 - a. [Danfoss Inc.](#)
 - b. [Henry Technologies Inc.; The Henry Group.](#)
 - c. [Parker Hannifin Corp.](#)
 - d. [Paul Mueller Company.](#)
 2. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
 3. Piston, Closing Spring, and Seat Insert: Stainless steel.
 4. Seat: Polytetrafluoroethylene.
 5. End Connections: Threaded.
 6. Working Pressure Rating: 400 psig.
 7. Maximum Operating Temperature: 240 deg F.
- H. Thermostatic Expansion Valves: Comply with AHRI 750.
1. [Manufacturers:](#) Subject to compliance with requirements, provide products by one of the following:
 - a. [Danfoss Inc.](#)
 - b. [Emerson Climate Technologies; Emerson Electric Co.](#)
 - c. [Henry Technologies Inc.; The Henry Group.](#)
 - d. [Paul Mueller Company.](#)
 2. Body, Bonnet, and Seal Cap: Forged brass or steel.

3. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
 4. Packing and Gaskets: Non-asbestos.
 5. Capillary and Bulb: Copper tubing filled with refrigerant charge.
 6. Suction Temperature: 40 deg F.
 7. Superheat: Adjustable.
 8. Reverse-flow option (for heat-pump applications).
 9. End Connections: Socket, flare, or threaded union.
 10. Working Pressure Rating: 700 psig.
- I. Hot-Gas Bypass Valves: Comply with UL 429; listed and labeled by an NRTL.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Danfoss Inc.
 - b. Henry Technologies Inc.; The Henry Group.
 - c. Parker Hannifin Corp.
 2. Body, Bonnet, and Seal Cap: Ductile iron or steel.
 3. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
 4. Packing and Gaskets: Non-asbestos.
 5. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
 6. Seat: Polytetrafluoroethylene.
 7. Equalizer: Internal or External.
 8. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit.
 9. End Connections: Socket.
 10. Throttling Range: Maximum 5 psig.
 11. Working Pressure Rating: 500 psig.
 12. Maximum Operating Temperature: 240 deg F.
- J. Straight-Type Strainers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Danfoss Inc.
 - b. Henry Technologies Inc.; The Henry Group.
 - c. Parker Hannifin Corp.
 2. Body: Welded steel with corrosion-resistant coating.
 3. Screen: 100-mesh stainless steel.
 4. End Connections: Socket or flare.
 5. Working Pressure Rating: 500 psig.

6. Maximum Operating Temperature: 275 deg F.

K. Angle-Type Strainers:

- a. [Danfoss, Inc.](#)
- b. [Henry Technologies Inc.; The Henry Group.](#)
- c. [Parker Hannifin Corporation.](#)

2. Body: Forged brass or cast bronze.

3. Drain Plug: Brass hex plug.

4. Screen: 100-mesh monel.

5. End Connections: Socket or flare.

6. Working Pressure Rating: 500 psig.

7. Maximum Operating Temperature: 275 deg F.

L. Moisture/Liquid Indicators:

1. [Manufacturers:](#) Subject to compliance with requirements, provide products by one of the following:

- a. [Danfoss Inc.](#)
- b. [Emerson Climate Technologies; Emerson Electric Co.](#)
- c. [Henry Technologies Inc.; The Henry Group.](#)
- d. [Parker Hannifin Corp.](#)

2. Body: Forged brass.

3. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.

4. Indicator: Color coded to show moisture content in parts per million (ppm).

5. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.

6. End Connections: Socket or flare.

7. Working Pressure Rating: 500 psig.

8. Maximum Operating Temperature: 240 deg F.

M. Replaceable-Core Filter Dryers: Comply with AHRI 730.

1. [Manufacturers:](#) Subject to compliance with requirements, provide products by one of the following:

- a. [Danfoss Inc.](#)
- b. [Emerson Climate Technologies; Emerson Electric Co.](#)
- c. [Henry Technologies Inc.; The Henry Group.](#)
- d. [Parker Hannifin Corp.](#)

2. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
3. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
4. Desiccant Media: Activated charcoal.
5. Designed for reverse flow (for heat-pump applications).
6. End Connections: Socket.
7. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
8. Maximum Pressure Loss: 2 psig.
9. Working Pressure Rating: 500 psig.
10. Maximum Operating Temperature: 240 deg F.

N. Permanent Filter Dryers: Comply with AHRI 730.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Danfoss Inc.
 - b. Emerson Climate Technologies; Emerson Electric Co.
 - c. Henry Technologies Inc.; The Henry Group.
 - d. Parker Hannifin Corp.
2. Body and Cover: Painted-steel shell.
3. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
4. Desiccant Media: Activated charcoal.
5. Designed for reverse flow (for heat-pump applications).
6. End Connections: Socket.
7. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
8. Maximum Pressure Loss: 2 psig.
9. Working Pressure Rating: 500 psig.
10. Maximum Operating Temperature: 240 deg F.

O. Mufflers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Danfoss Inc.
 - b. Emerson Climate Technologies; Emerson Electric Co.
 - c. Henry Technologies Inc.; The Henry Group.
2. Body: Welded steel with corrosion-resistant coating.

3. End Connections: Socket or flare.
4. Working Pressure Rating: 500 psig.
5. Maximum Operating Temperature: 275 deg F.

P. Receivers: Comply with AHRI 495.

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. Henry Technologies Inc.; The Henry Group.
2. Comply with 2010 ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
3. Comply with UL 207; listed and labeled by an NRTL.
4. Body: Welded steel with corrosion-resistant coating.
5. Tappings: Inlet, outlet, liquid level indicator, and safety relief valve.
6. End Connections: Socket or threaded.
7. Working Pressure Rating: 500 psig.
8. Maximum Operating Temperature: 275 deg F.

Q. Liquid Accumulators: Comply with AHRI 495.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Emerson Climate Technologies; Emerson Electric Co.
 - b. Henry Technologies Inc.; The Henry Group.
 - c. Parker Hannifin Corp.
2. Body: Welded steel with corrosion-resistant coating.
3. End Connections: Socket or threaded.
4. Working Pressure Rating: 500 psig.
5. Maximum Operating Temperature: 275 deg F.

2.4 REFRIGERANTS

A. ASHRAE 34, R-134a: Tetrafluoroethane.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Arkema Inc.
 - b. DuPont Fluorochemicals Div.
 - c. Genetron Refrigerants; Honeywell International Inc.

- d. [Mexichem Fluor Inc.](#)
- B. ASHRAE 34, R-407C: Difluoromethane/Pentafluoroethane/1,1,1,2-Tetrafluoroethane.
 - 1. [Manufacturers:](#) Subject to compliance with requirements, provide products by one of the following:
 - a. [Arkema Inc.](#)
 - b. [DuPont Fluorochemicals Div.](#)
 - c. [Genetron Refrigerants; Honeywell International Inc.](#)
 - d. [Mexichem Fluor Inc.](#)
- C. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.
 - 1. [Manufacturers:](#) Subject to compliance with requirements, provide products by one of the following:
 - a. [Arkema Inc.](#)
 - b. [DuPont Fluorochemicals Div.](#)
 - c. [Genetron Refrigerants; Honeywell International Inc.](#)
 - d. [Mexichem Fluor Inc.](#)

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS FOR REFRIGERANT R-134a

- A. Suction Lines NPS 4 and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed joints.
- B. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications:
 - 1. Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.
- C. Safety-Relief-Valve Discharge Piping, Copper: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with soldered joints.

3.2 PIPING APPLICATIONS FOR REFRIGERANT R-407C

- A. Suction Lines NPS 4 and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed joints.

- B. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications:
 - 1. Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.
- C. Safety-Relief-Valve Discharge Piping, Copper: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with soldered joints.

3.3 PIPING APPLICATIONS FOR REFRIGERANT R-410A

- A. Suction Lines NPS 4 and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with soldered joints.
- B. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications:
 - 1. Copper, Type ACR, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.
- C. Safety-Relief-Valve Discharge Piping:
 - 1. Copper, Type ACR, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.

3.4 VALVE AND SPECIALTY APPLICATIONS

- A. Install diaphragm packless valves in suction and discharge lines of compressor.
- B. Install service valves for gauge 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-size, 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 2010 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 the 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, and in the suction line at the compressor.
- L. Install receivers sized to accommodate pump-down charge.
- M. Install flexible connectors at compressors.
- N. Provide refrigerant locking caps on refrigerant charging ports that are located outdoors unless otherwise protected from unauthorized access by a means acceptable to the authority having jurisdiction.

3.5 INSTALLATION OF PIPING, GENERAL

- 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. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
- K. 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 if valves or equipment requiring maintenance is concealed behind finished surfaces.
- L. Install refrigerant piping in protective conduit where installed belowground.
- M. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
- N. 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.
- O. 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.
- P. Before installation of steel refrigerant piping, clean pipe and fittings using the following procedures:
 - 1. Shot blast the interior of piping.

2. Remove coarse particles of dirt and dust by drawing a clean, lintless cloth through tubing by means of a wire or electrician's tape.
3. Draw a clean, lintless cloth saturated with trichloroethylene through the tube or pipe. Continue this procedure until cloth is not discolored by dirt.
4. Draw a clean, lintless cloth, saturated with compressor oil, squeezed dry, through the tube or pipe to remove remaining lint. Inspect tube or pipe visually for remaining dirt and lint.
5. Finally, draw a clean, dry, lintless cloth through the tube or pipe.
6. Safety-relief-valve discharge piping is not required to be cleaned but is required to be open to allow unrestricted flow.

- 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.
- T. Install sleeve seals for piping penetrations of concrete walls and slabs.
- U. Install escutcheons for piping penetrations of walls, ceilings, and 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. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.
- D. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."
- E. 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.

- F. Threaded Joints: Thread steel 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 to 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. Steel pipe can be threaded, but threaded joints must be seal brazed or seal welded.
- H. Welded Joints: Construct joints according to AWS D10.12M/D10.12.
- I. 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 INSTALLATION OF HANGERS AND SUPPORTS

- A. 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.
- B. Install hangers for copper tubing, with maximum horizontal spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- C. Support horizontal piping within 12 inches of each fitting.
- D. Support vertical runs of copper tubing to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.8 FIELD QUALITY CONTROL

- A. Perform the following 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 "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.

B. Prepare test and inspection reports.

3.9 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.

3.10 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 232300

SECTION 232513 - WATER TREATMENT FOR CLOSED-LOOP HYDRONIC SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This section specifies cleaning and treatment of circulating HVAC water systems, including the following.
 - 1. Cleaning compounds.
 - 2. Chemical treatment for closed loop hydronic systems.
 - 3. Water treatment equipment.

1.2 PERFORMANCE REQUIREMENTS

- A. Minimize corrosion, scale buildup, and biological growth for optimum efficiency of mechanical equipment without creating a hazard to operating personnel or the environment.
- B. Base water treatment program 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. Chemically treat and maintain closed-loop hydronic system water to meet following standards:
 - 1. Suspended solids: None.
 - 2. Iron Corrosion Rate: stable rate, 0.5 mils per year maximum, no pitting.
 - 3. Copper Corrosion Rate: stable rate, 0.2 mils per year maximum, no pitting.
 - 4. Total Iron Concentration: 0.5 mg/L Fe maximum.
 - 5. Total Copper Concentration: 0.2 mg/L Cu maximum.
 - 6. pH: 8.5 – 9.5, accuracy ± 0.1
 - 7. Conductivity <2500 $\mu\text{S}/\text{cm}$ (micro siemens/cm)
 - 8. "P" Alkalinity: Maintain a value within 100 to 500 ppm.
 - 9. Boron: Maintain a value within 100 to 200 ppm.
 - 10. Chemical Oxygen Demand: Maintain a maximum value of 100 ppm.
 - 11. TDS: Maintain a maximum value of 10 ppm.

12. 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.

1.3 ACTION SUBMITTALS

- A. Product data for each type of chemical supplied. Include manufacturer's technical product data, material safety data sheets and manufacturer's instructions for proper application of chemicals.
 1. Bypass feeders.
 2. Water meters.
 3. Inhibitor injection timers.
 4. pH controllers.
 5. Chemical solution tanks.
 6. Injection pumps.
 7. Chemical-treatment test equipment.
 8. Chemical material safety data sheets.
 9. Inhibited propylene glycol.
- B. Shop Drawings: Pretreatment and chemical-treatment equipment, showing tanks, maintenance space required, and piping connections to hydronic systems.
 1. Include plans, elevations, sections, and attachment details.
 2. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Water-Analysis Provider Qualifications: Verification of experience and capability of HVAC water-treatment service provider.
- B. Water-Treatment Program: Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in "Performance Requirements" Article.
- C. Water Analysis: Illustrate water quality available at Project site.

- D. Field test reports indicating and interpreting test results relative to compliance with specified requirements.

1.5 CLOSEOUT SUBMITTALS

- A. Operations and Maintenance Manual: Include the following:
 - 1. Material Safety Data Sheets for chemical supplied.
 - 2. Manufacturer's instructions for proper application of chemicals.
 - 3. Maintenance schedules for application and testing.
 - 4. System volume(s).
 - 5. Water Analysis Report
 - 6. Operations and Maintenance Manuals for equipment and systems

1.6 QUALITY ASSURANCE

- A. Supplier Qualifications: A recognized chemical water treatment supplier with warehousing facilities in the Project's vicinity and that is or employs an experienced consultant, available at reasonable times during the course of the Work to consult with Contractor, Architect, and Owner about water treatment.
- B. Chemical Standards: Meet state and local environmental regulations.

1.7 QUALIFICATIONS

- A. Water treatment company specializing in performing the work specified in this Section with minimum five years experience. Company shall be capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.

1.8 REGULATORY REQUIREMENTS

- A. Conform to applicable code for addition of non-potable chemicals to building mechanical systems, and to public sewage systems.

1.9 MAINTENANCE SERVICE

- A. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions for a period of one year from date of Substantial Completion.

1. Provide technical service visits to perform field inspections and make water analysis on site six months and eleven months after completion. Detail findings in writing on proper practices, chemical treating requirements, and corrective actions needed. Submit two copies of field service report after each visit.
2. Provide laboratory and technical assistance services during this maintenance period.
3. Include two hour training course for operating personnel, instructing them on installation, care, maintenance, testing, and operation of water treatment systems. Arrange course at start up of systems.
4. Provide on-site inspections of equipment during scheduled or emergency shutdown to properly evaluate success of water treatment program, and make recommendations in writing based upon these inspections.

PART 2 - PRODUCTS

2.1 CLEANING CHEMICALS

- A. Cleaning Solution: neutral pH cleaning solution which is capable of removing oil, grease, and rust from metal surfaces of system and passivating cleaned metal surfaces of system. Cleaning solution shall include:
 1. Low foaming non-ionic surfactant for penetrating oily and greasy deposit surfaces.
 2. Solvent for dissolving oil and grease.
 3. Dispersant for dissolving rust.
 4. Reducing agent for corrosion control.
 5. Ferrous and non-ferrous metal corrosion inhibitors.
- B. All chemicals to be acceptable for discharge to sanitary sewer.

2.2 TREATMENT CHEMICALS

- A. Furnish chemicals recommended by water treatment system manufacturer for treating water to meet specified water quality. Provide only chemicals that are compatible with piping materials, seals, and accessories.

2.3 MANUAL CHEMICAL-FEED EQUIPMENT

- A. Bypass Feeders: Steel, with corrosion-resistant exterior coating, minimum 3-1/2-inch fill opening in the top, and NPS 3/4 bottom inlet and top side outlet. Quarter turn or threaded fill cap with gasket seal and diaphragm to lock the top on the feeder when exposed to system pressure in the vessel.

1. Capacity: 2 gal.
 2. Minimum Working Pressure: 175 psig.
- B. Provide test kits for all treatment programs.

2.4 AUTOMATIC GLYCOL FEEDER

- A. Manufacturer: subject to compliance with requirements, provide products by one of the following:
1. Wessels Company
 2. Neptune
- B. General: provide and install a completely pre-fabricated/preassembled package glycol feeder system with: single point power connection, injection pump, fluid holding tank, interconnecting piping and wiring, and control panel.
- C. Pump
1. Material: Bronze
 2. Fluid flow rate: per scheduled data
 3. Discharge pressure: per scheduled data
- D. Tank: shall be constructed of polyethylene with a four-leg steel stand with attachment bolts at each leg. Tank shall have upper and lower steel support banding. Steel support stand to be painted with corrosion resistant enamel.
- E. Piping
1. Piping to be rated for system pressure and use within a pressurized system.
 2. Pump suction piping: to be constructed of PVC tubing and fittings. PVC shutoff valve and strainer to be furnished.
 3. Pump discharge piping: constructed of schedule 40 brass and brass fittings. Discharge to come equipped with pressure switch, pressure gage, isolation valve, check valve, and relief valve. Relief valve to be piped back to the holding tank.
- F. Control Panel
1. 115 volt, single phase power connection
 2. NEMA 4X enclosure
 3. HOA switch with running light and starter.
- G. Level switch: low level switch shall engage a low level alarm. Alarm shall be issued to the central BAS system as well as a local, audible, alarm.

2.5 STAINLESS-STEEL PIPES AND FITTINGS

1. Stainless-Steel Tubing: Comply with ASTM A 269, Type 316.
2. Stainless-Steel Fittings: Complying with ASTM A 815/A 815M, Type 316, Grade WP-S.
3. 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.

2.6 CHEMICAL TREATMENT TEST EQUIPMENT

- A. Provide white enamel test cabinet with local and fluorescent light, capable of accommodating 4 - 10 ml zeroing titrating burettes and associated reagents.
 1. Provide test kits for all treatment programs.
- B. Corrosion Test-Coupon Assembly: Two station rack constructed of corrosive-resistant material, complete with piping, valves, and mild steel and copper coupons. Locate copper coupon downstream from mild steel coupon in the test-coupon assembly.

PART 3 - EXECUTION

3.1 WATER ANALYSIS

- A. Perform an analysis of supply water to determine the type and quantities of chemical treatment needed to maintain the water quality as specified in "Performance Requirements" Article. Submit analysis report to owner for review and include in Operations and Maintenance Manual submission.

3.2 INSTALLATION

- A. Install treatment equipment level and plumb, in accordance with manufacturer's instructions.
- B. Provide one bypass feeder on each system. Install isolating and drain valves and necessary piping. Install around balancing valve downstream of circulating pumps unless indicated otherwise.
- C. Provide 3/4 inch water coupon rack around circulating pumps. Maintain access to coupon rack.
- D. Install piping adjacent to equipment to allow service and maintenance.

3.3 CLEANING - GENERAL

- A. Systems shall be operational, filled, started, and vented prior to cleaning. Use water meter to record capacity in each system.
- B. Place terminal control valves in open position during cleaning.
- C. Manual and automatic valves are in full open position.
- D. By-pass valves are operated to ensure full flow through entire system.
- E. Safety devices, including pressure relief valves, flow switches, and pressure switches are functioning.
- F. Temporary fine mesh strainers for system pump and control valve strainer baskets are installed and cleaned as required.

3.4 CLEANING PROCEDURE

- A. Step 1: Fill system with domestic water, establish circulation, and heat system contents to a temperature of 140°F.
- B. Step 2: After two hours of circulation, collect water samples from at least three different locations in system. If these samples contain suspended solids, clean out strainer baskets, drain system, and repeat steps 1 & 2.
- C. Step 3: Blend in prepared concentrated cleaning solution, establish circulation, and maintain system temperature at 140°F for at least three days.
- D. Step 4: Dump spent cleaning solution to disposal, fill system with domestic water, circulate system contents for at least two hours, and dump spent rinse water to disposal.
- E. Step 5: Fill system with domestic water and repeat step 4 until water samples collected from system are free of oil, grease, and suspended solids.
- F. Step 6: Drain system completely, including all system low points and perform visual inspections of metal surfaces at three different locations.
- G. Complete steps 4, 5 & 6 within a 24 hour period.
- H. If metal surfaces contain oil/grease or silt, fill the system with domestic water and repeat steps 3, 4, 5 & 6.
- I. Immediately after inspection is completed, install strainers, fill system with glycol solution, blend in concentrated corrosion inhibitor solution until its concentration in system is at an acceptable level for film formation, and pass system water through corrosion coupon rack.

3.5 ADJUSTING

- A. Sample water at two-week intervals after each system startup for a period of three months, and prepare certified test report for each required water performance characteristic. Where applicable, comply with industry standard test procedures.

3.6 DEMONSTRATION

- A. Provide services of water treatment firm's representative for half a day to instruct Owner's personnel in operation, maintenance, and testing procedures of chemical water treatment system.
- B. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.
 - 1. Review manufacturer's safety data sheets for handling of chemicals.
 - 2. Review data in maintenance manuals, especially data on recommended parts inventory and supply sources and on availability of parts and service. Refer to Division 01 Section Closeout Procedures.

END OF SECTION 232513

SECTION 233113 - METAL DUCTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Single-wall round ducts and fittings.
3. Double-wall exterior located rectangular ducts and fittings.
4. Sheet metal materials.
5. Duct liner.
6. Sealants and gaskets.
7. Hangers and supports.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.
3. Seismic-restraint devices.

B. 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. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.

12. Hangers and supports, including methods for duct and building attachment and vibration isolation.

1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: A single set of plans or BIM model, drawn to scale, showing the items described in this Section
- B. , and coordinated with all building trades.

1.4 QUALITY ASSURANCE

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and with performance requirements and design crit
- B. eria indicated in "Duct Schedule" Article.
- C. Structural Performance: Duct hangers and supports are to withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible".
- D. Wind Performance: Ducts are to withstand the effects of wind determined in accordance with to ASCE/SEI 7.
- E. Airstream Surfaces: Surfaces in contact with airstream comply with requirements in ASHRAE 62.1.
- F. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment," and Section 7 - "Construction and System Startup."
- G. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."
- H. Duct Dimensions: Unless otherwise indicated, all duct dimensions indicated on Drawings are inside clear dimensions and do not include insulation or duct wall thickness.

2.2 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.
 - 1. Construct ducts of galvanized sheet steel unless otherwise indicated.
 - 2. For ducts exposed to weather, construct of stainless steel indicated by manufacturer to be suitable for outdoor installation.
 - 3. For ducts serving or exposed to natatoriums, construct of aluminum indicated by manufacturer to be suitable for natatorium installation.
- B. Transverse Joints: Fabricate joints in accordance with 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."
 - 1. For ducts with longest side less than 36 inches, select joint types in accordance with Figure 2-1.
 - 2. For ducts with longest side 36 inches or greater, use flange joint connector Type T-22, T-24, T-24A, T-25a, or T-25b. Factory-fabricated flanged duct connection system may be used if submitted and approved by engineer of record.
- C. Longitudinal Seams: Select seam types and fabricate in accordance with 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 SMAC
- D. NA's "HVAC Duct Construction Standards - Metal and Flexible."
- E. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 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."

2.3 SINGLE-WALL ROUND DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

1. Construct ducts of galvanized sheet steel unless otherwise indicated.
 2. For ducts exposed to weather, construct of stainless steel indicated by manufacturer to be suitable for outdoor installation.
 3. For ducts serving or exposed to natatoriums, construct of aluminum indicated by manufacturer to be suitable for natatorium installation.
 4. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Linx Industries; a DMI company (formerly Lindab).
 - b. MKT Metal Manufacturing.
 - c. SEMCO, LLC; part of FlaktGroup.
 - d. Sheet Metal Connectors, Inc.
 - e. Spiral Manufacturing Co., Inc.
- B. Source Limitations: Obtain single-wall round ducts and fittings from single manufacturer.
- C. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).
- D. Transverse Joints: Select joint types and fabricate in accordance with 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."
- E. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.
1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.
- F. Longitudinal Seams: Select seam types and fabricate in accordance with 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.
 2. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.
- G. Tees and Laterals: Select types and fabricate in accordance with 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."

2.4 DOUBLE-WALL EXTERIOR LOCATED RECTANGULAR DUCTS AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- a. [Linx Industries; a DMI company \(formerly Lindab\).](#)
 - b. Tuff Duct
 - c. [MKT Metal Manufacturing.](#)
 - d. [SEMCO, LLC; part of FlaktGroup.](#)
 - e. [Sheet Metal Connectors, Inc.](#)
 - f. [Spiral Manufacturing Co., Inc.](#)
- B. Source Limitations: Obtain double-wall rectangular ducts and fittings from single manufacturer.
- C. Inner Liner: System shall incorporate a fortified inner liner with included testing and passing the following:
1. ASTM C 423 noise reduction
 2. ASTM C 518: 2004, Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
 3. ASTM C 1071 for erosion
 4. ASTM E 84 tested, Tunnel Test, Does not exceed 25 flame spread, 50 smoke developed.
 5. ASTM E 96/E 96M Procedure A for permeability
 6. ASTM E2257 Standard Test Method for Room Fire Test of Wall and Ceiling Materials and Assemblies
 7. NFPA Compliance:
 8. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems"
 9. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems"
 10. NFPA 255, "Standard Method of Test of Surface Burning Characteristics of Building Materials
 11. NRTL product approval, (Subpart S of 29 CFR Part 1910, OSHA)
 12. UL 181 Standard for Factory-Made Air Ducts and Air Connectors
 13. UL 723 Test for Surface Burning Characteristics of Building Materials
- D. Exterior Shell: System shall incorporate a UV stable, pre-coated galvanized exterior shell.
1. .20-.30 mill primer baked on finish
 2. .70-.80 mill polyester top coat

- E. The inner liner panel shall be manufactured of CFC-free closed cell rigid thermoset resin thermally bonded on both sides to a factory applied minimum 0.001" (25 micron) aluminum foil facing reinforced with a fiberglass scrim. The outer panel shall be a per-coated galvanized sheet metal jacket, with a .20-.30 mil primer baked on finish with a .70-.80 mill polyester UV stable top coat.
- F. Duct schedule:
 - 1. Minimum Panel Thickness: 22 mm
 - 2. Galvanized Steel Outer Shell: 0.0336 inch
- G. Materials:
 - 1. The density of the inner foam liner shall not be less than 3.43 pcf (55 Kg/m3) with a minimum compressive strength of 28 psi.
 - 2. Maximum Temperature: Continuous rating of 185 degF to -15 degF inside ducts or ambient temperature surrounding ducts.
 - 3. Maximum Thermal Conductivity: 0.146 Btu-in./h-sqft.-degF at 75 degF mean temperature.
 - 4. Antimicrobial Agent: Additive for antimicrobial shall not be used but instead, raw product must pass UL bacteria growth testing
 - 5. Required Markings: All interior duct liner shall bear UL label and other markings required by UL 181 on each full sheet of duct panel.
 - 6. All insulation materials shall be closed cell with a closed cell content of >90%.
 - 7. Internal Tape: 3M high temperature, high strength, UL181A-P foil tape with coated cold weather acrylic adhesive.
 - 8. Outer Sealant: Novagard, NovaFlex Metal Roof Adhesive Sealant.
 - 9. Outer Jacket: galvanized steel pre-coated with a UV stable 20-.30 mil primer baked on finish with a .70-.80 mill polyester top coat.
 - 10. Standard white finish with custom colors available
 - 11. Duct Connections: TDC (SMACNA Figure 2-1, Page 2.9, T-25a)
 - 12. Connection Cover: covers and corners are manufactured using high-impact PVC with UV stabilizers added for sun protection.
 - 13. Connection are field sealed airtight before the cover is installed
- H. Fabrication:
 - 1. Pre-fabricated joints, seams, transitions, taps, elbows, tees, and access doors according to Manufacturer's instructions.
 - 2. Pre-fabricated radius heel 45 degree throat elbow (SMACNA Figure 4-2, page 4.4).
 - 3. Pre-fabricated ductwork shall include 5 inches of straight on the end of each connecting piece, leaving room to install the connection cover.
 - 4. Fabricated duct segments utilizing internal and external sealed Pittsburgh seams. Internal seams will be sealed with VOC silicone. Each duct segment will be factory

- supplied with either 4-bolt TDC or slip-on flange in accordance with manufacturer's submittal package.
5. Applied internal and external duct reinforcement to prevent swelling and narrowing of duct based on positive and negative pressure guidelines provided by the manufacturer.
 6. Designed and fabricated duct segments and fittings will be in compliance with latest edition SMACNA HVAC Duct Construction Standards.
 7. Both positive and negative ductwork and fittings shall be constructed to incorporate a UL Listed – Class 1 air duct to Standard for Safety UL 181 liner with an exterior pre-coated galvanized shell—with options for aluminum and stainless—for permanent protection against water intrusion.
 8. Duct shall be constructed to exceed requirements for rain, snow and wind load.
- I. Installation:
1. Duct segments shall be installed per the Installation Instructions provided by the Manufacturer.
 2. Duct air leakage to comply with the latest version of "SMACNA HVAC Air Duct Leakage Test Manual" in accordance with the applicable pressure class.

2.5 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 are to be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A653/A653M.
1. Galvanized Coating Designation: G90.
 2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. Aluminum Sheets: Comply with ASTM B209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.
- D. 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.

2.6 DUCT LINER

- A. Fibrous-Glass Duct Liner: Comply with ASTM C1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Johns Manville; a Berkshire Hathaway company.
 - b. Knauf Insulation.
 - c. Owens Corning.
 2. Source Limitations: Obtain fibrous-glass duct liner from single manufacturer.
 3. Maximum Thermal Conductivity:
 - a. Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
 - b. Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
 4. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound is to be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
 5. Solvent-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C916.
- B. Flexible Elastomeric Duct Liner: Preformed, cellular, closed-cell, sheet materials complying with ASTM C534/C534M, Type II, Grade 1; and with NFPA 90A or NFPA 90B.
1. Source Limitations: Obtain flexible elastomeric duct liner from single manufacturer.
 2. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.
 3. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
- C. Insulation Pins and Washers:
1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
 2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick galvanized steel; with beveled edge sized as required to hold insulation securely in place, but not less than 1-1/2 inches in diameter.

- D. 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 or greater.
 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.

2.7 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets are to be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested in accordance with UL 723; certified by an NRTL.
- B. Solvent-Based Joint and Seam Sealant:
 - 1. Application Method: Brush on.
 - 2. Base: Synthetic rubber resin.
 - 3. Solvent: Toluene and heptane.
 - 4. Solids Content: Minimum 60 percent.
 - 5. Shore A Hardness: Minimum 60.
 - 6. Water resistant.
 - 7. Mold and mildew resistant.
 - 8. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
 - 9. Service: Indoor or outdoor.
 - 10. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
- C. Flanged Joint Sealant: Comply with ASTM C920.
 - 1. General: Single-component, acid-curing, silicone, elastomeric.
 - 2. Type: S.
 - 3. Grade: NS.
 - 4. Class: 25.
 - 5. Use: O.
- D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.
- E. Round Duct Joint O-Ring Seals:
 - 1. Seal is to provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and is to be rated for 10-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.

2.8 HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Galvanized-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 A603.
- E. Steel Cables for Stainless Steel Ducts: Stainless steel complying with ASTM A492.
- F. Steel Cable End Connections: Galvanized-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 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 in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- C. e indicated.
- D. Install ducts in maximum practical lengths 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. Install fire, combination fire/smoke, and smoke dampers where indicated on Drawings and as required by code, and by local authorities having jurisdiction.
- L. Install heating coils, cooling coils, air filters, dampers, and all other duct-mounted accessories in air ducts where indicated on Drawings.
- M. Protect duct interiors from moisture, construction debris and dust, and other foreign materials both before and after installation. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."
- N. Elbows: Use long-radius elbows wherever they fit.
 - 1. Fabricate 90-degree rectangular mitered elbows to include turning vanes.
 - 2. Fabricate 90-degree round elbows with a minimum of three segments for 12 inches and smaller and a minimum of five segments for 14 inches and larger.
- O. Branch Connections: Use lateral or conical branch connections.

3.2 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 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.

3.3 DUCT SEALING

- A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

3.4 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. Coordinate with Section 230548 "Vibration and Seismic Controls for HVAC."
- 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.

3.5 DUCTWORK CONNECTIONS

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 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.

3.7 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. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
 - 3. Testing of each duct section is to be performed with access doors, coils, filters, dampers, and other duct-mounted devices in place as designed. No devices are to be removed or blanked off so as to reduce or prevent additional leakage.
 - 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 in accordance with "Description of Method 3 - NADCA 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 is to 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.

3.8 DUCT CLEANING

A. Clean new duct system(s) before testing, adjusting, and balancing.

B. Use duct cleaning methodology as indicated in NADCA ACR.

C. Use service openings for entry and inspection.

1. Provide openings with access panels appropriate for duct static-pressure and leakage class at dampers, coils, and any other locations where required for inspection and 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.

D. 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.

E. 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.

F. 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 in accordance with NADCA ACR. 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 in accordance with manufacturer's written instructions after removal of surface deposits and debris.

3.9 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:

1. Fabricate all ducts to achieve SMACNA pressure class, seal class, and leakage class as indicated below.

B. Supply Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
 - a. Pressure Class: Positive 2-inch wg.
 - b. Minimum SMACNA Seal Class: B.

2. Ducts Connected to Constant-Volume Air-Handling Units:
 - a. Pressure Class: Positive 3-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 3. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive 2-inch wg.
 - b. Minimum SMACNA Seal Class: A.
- C. Return Ducts:
1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: B.
 2. Ducts Connected to Air-Handling Units:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: B.
 3. Ducts Connected to Equipment Not Listed above:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: A.
- D. Exhaust Ducts:
1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
 - a. Pressure Class: Negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
 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.
 3. Ducts Connected to Equipment Not Listed above:
 - a. Pressure Class: Positive or negative 3-inch wg.
 - b. Minimum SMACNA Seal Class: B if negative pressure; A if positive pressure.

- E. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:
 - 1. Ducts Connected to Air-Handling Units:
 - a. Pressure Class: Positive or negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: A.
- F. Intermediate Reinforcement:
 - 1. Galvanized-Steel Ducts: Galvanized steel.
 - 2. Stainless Steel Ducts:
 - a. Exposed to Airstream: Match duct material.
 - b. Not Exposed to Airstream: Match duct material.
 - 3. Aluminum Ducts: Aluminum.
- G. Liner:
 - 1. Supply-Air Ducts: Flexible elastomeric, 1 inch thick.
 - 2. Return-Air Ducts: Flexible elastomeric, 1 inch thick.
 - 3. Exhaust-Air Ducts: Flexible elastomeric, 1 inch thick.
 - 4. Supply Fan Plenums: Flexible elastomeric, 1 inch thick.
 - 5. Return- and Exhaust-Fan Plenums: Flexible elastomeric, 1 inches thick.
 - 6. Transfer Ducts: Flexible elastomeric, 1 inch thick.
- H. Double-Wall Duct Interstitial Insulation:
 - 1. Supply-Air Ducts: 1 inch thick.
 - 2. Return-Air Ducts: 1 inch thick.
 - 3. Exhaust-Air Ducts: 1 inch thick.
- I. Elbow Configuration:
 - 1. Rectangular Duct - Requirements for Different Velocities: 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 - Requirements for All Velocities: 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: Welded.

J. 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: Conical 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 233113

SECTION 233300 - 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. Section Includes:
 - 1. Backdraft and pressure relief dampers.
 - 2. Manual volume dampers.
 - 3. Fire dampers.
 - 4. Smoke dampers.
 - 5. Combination fire and smoke dampers.
 - 6. Flange connectors.
 - 7. Duct silencers.
 - 8. Turning vanes.
 - 9. Remote damper operators.
 - 10. Duct-mounted access doors.
 - 11. Flexible connectors.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. For duct silencers, include pressure drop, dynamic insertion loss, and self-generated noise data. Include breakout noise calculations for high-transmission-loss casings.
- B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail duct accessories' fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:

- a. Special fittings.
- b. Manual volume damper installations.
- c. Control-damper installations.
- d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor-damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
- e. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, or BIM model, 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 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air duct accessories to include in 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. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Comply with NFPA 90A and NFPA 90B.
- 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 BACKDRAFT AND PRESSURE RELIEF DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. American Warming and Ventilating; a Mestek Architectural Group company.
 2. Cesco Products; a division of MESTEK, Inc.
 3. Greenheck Fan Corporation.
 4. Nailor Industries Inc.
 5. Pottorff.
 6. Ruskin Company.
 7. Safe Air - Dowco Products.
 8. United Enertech.
 9. Vent Products Co., Inc.
- B. Description: Gravity balanced.
- C. Performance:
1. Maximum Air Velocity: 1250 fpm.
 2. Maximum System Pressure: 2 inches wg.
 3. AMCA Certification: Test and rate in accordance with AMCA 511.
 4. Leakage:
 - a. Class I: Leakage shall not exceed 4 cfm/sq. ft. against 1-inch wg differential static pressure.
- D. Construction:
1. Frame:
 - a. Hat shaped.
 - b. 16-gauge- thick, galvanized sheet steel, with welded or mechanically attached corners and mounting flange.
 2. Blades:
 - a. Multiple single-piece blades.
 - b. Off-center pivoted, maximum 6-inch width, 16-gauge- thick, with sealed edges.
 3. Blade Action: Parallel.
- E. Blade Seals: Neoprene, mechanically locked.
- F. Blade Axles:

1. Material: Galvanized steel.
 2. Diameter: 0.20 inch.
- G. Tie Bars and Brackets: Galvanized steel.
- H. Return Spring: Adjustable tension.
- I. Bearings: Steel ball Brass sleeve or synthetic pivot bushings.
- J. Accessories:
1. Adjustment device to permit setting for varying differential static pressure.
 2. Counterweights and spring-assist kits for vertical airflow installations.
 3. Chain pulls.
 4. Screen Mounting:
 - a. Front mounted in sleeve.
 - 1) Sleeve Thickness: 20 gauge minimum.
 - 2) Sleeve Length: 6 inches minimum.
 5. Screen Material: Aluminum.
 6. Screen Type: Bird.
 7. 90-degree stops.

2.3 MANUAL VOLUME DAMPERS

- A. Standard, Steel, Manual Volume Dampers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Air Balance; a division of MESTEK, Inc.
 - b. Aire Technologies, Inc.; a DMI company.
 - c. Greenheck Fan Corporation.
 - d. Lloyd Industries, Inc.
 - e. McGill AirFlow LLC.
 - f. Nailor Industries Inc.
 - g. Ruskin Company.
 2. Performance:
 - a. Leakage Rating Class III: Leakage not exceeding 40 cfm/sq. ft. against 1-inch wg differential static pressure.

3. Construction:
 - a. Linkage out of airstream.
 - b. Suitable for horizontal or vertical airflow applications.
4. Frames:
 - a. Hat-shaped, 16-gauge- thick, galvanized sheet steel.
 - b. Mitered and welded corners.
 - c. Flanges for attaching to walls and flangeless frames for installing in ducts.
5. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Stiffen damper blades for stability.
 - d. Galvanized steel; 16 gauge thick.
6. Blade Axles: Galvanized steel.
7. Bearings:
 - a. Oil-impregnated stainless steel sleeve.
 - b. Dampers mounted with vertical blades to have thrust bearing at each end of every blade.
8. Tie Bars and Brackets: Galvanized steel.
9. Locking device with offset handle to hold damper blades in a fixed position without vibration.

B. Standard, Aluminum, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Warming and Ventilating; a Mestek Architectural Group company.
 - b. Arrow United Industries.
 - c. Cesco Products; a division of MESTEK, Inc.
 - d. McGill AirFlow LLC.
 - e. Nailor Industries Inc.
 - f. Pottorff.
 - g. Ruskin Company.
 - h. Safe Air - Dowco Products.
 - i. United Enertech.

- j. [Vent Products Co., Inc.](#)
- 2. Performance:
 - a. Leakage Rating Class III: Leakage not exceeding 40 cfm/sq. ft. against 1-inch wg differential static pressure.
- 3. Construction:
 - a. Linkage out of airstream.
 - b. Suitable for horizontal or vertical airflow applications.
- 4. Frames:
 - a. Hat-shaped, 0.10-inch- thick, aluminum sheet channels.
 - b. Flanges for attaching to walls and flangeless frames for installing in ducts.
- 5. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Stiffen damper blades for stability.
 - d. Roll-Formed Aluminum Blades: 0.10-inch- thick aluminum sheet.
 - e. Extruded-Aluminum Blades: 0.050-inch- thick extruded aluminum.
- 6. Blade Axles: Galvanized steel.
- 7. Bearings:
 - a. Oil-impregnated bronze Molded synthetic Stainless steel sleeve.
 - b. Dampers mounted with vertical blades to have thrust bearing at each end of every blade.
- 8. Tie Bars and Brackets: Aluminum.
- 9. Locking device with offset handle to hold damper blades in a fixed position without vibration.
- C. Low-Leakage, Steel, Manual Volume Dampers:
 - 1. [Manufacturers:](#) Subject to compliance with requirements, provide products by one of the following:
 - a. [Air Balance; a division of MESTEK, Inc.](#)
 - b. [American Warming and Ventilating; a Mestek Architectural Group company.](#)
 - c. [Arrow United Industries.](#)
 - d. [Cesco Products; a division of MESTEK, Inc.](#)

- e. [Greenheck Fan Corporation.](#)
- f. [McGill AirFlow LLC.](#)
- g. [Nailor Industries Inc.](#)
- h. [Pottorff.](#)
- i. [Ruskin Company.](#)
- j. [Safe Air – Dowco Products.](#)
- k. [United Enertech.](#)
- l. [Vent Products Co., Inc.](#)
- 2. Performance:
 - a. AMCA Certification: Test and rate in accordance with AMCA 511.
 - b. Leakage:
 - 1) Class I: Leakage shall not exceed 4 cfm/sq. ft. against 1-inch wg differential static pressure.
- 3. Construction:
 - a. Linkage: Out of airstream.
 - b. Suitable for horizontal or vertical airflow applications.
- 4. Frames:
 - a. Hat, U, or angle shaped.
 - b. Thickness: 16-gauge galvanized sheet steel.
 - c. Mitered and welded corners.
 - d. Flanges for attaching to walls and flangeless frames for installing in ducts.
- 5. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Stiffen damper blades for stability.
 - d. Galvanized, roll-formed steel; 16 gauge thick.
- 6. Blade Edging Seals:
 - a. Closed-cell neoprene.
 - b. Inflatable seal blade edging or replaceable rubber seals.
- 7. Blade Jamb Seals: Neoprene.
- 8. Blade Axles: Galvanized steel.
- 9. Bearings:
 - a. Oil-impregnated stainless steel sleeve.

- b. Dampers mounted with vertical blades to have thrust bearing at each end of every blade.
- 10. Tie Bars and Brackets: Galvanized steel.
- 11. Locking device with offset handle to hold damper blades in a fixed position without vibration.
- D. Low-Leakage, Aluminum, Manual Volume Dampers:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Air Balance; a division of MESTEK, Inc.
 - b. American Warming and Ventilating; a Mestek Architectural Group company.
 - c. Arrow United Industries.
 - d. Cesco Products; a division of MESTEK, Inc.
 - e. McGill AirFlow LLC.
 - f. Nailor Industries Inc.
 - g. Pottorff.
 - h. Ruskin Company.
 - i. Safe Air - Dowco Products.
 - j. United Enertech.
 - k. Vent Products Co., Inc.
 - 2. Performance:
 - a. Leakage:
 - 1) Class I: Leakage shall not exceed 4 cfm/sq. ft. against 1-inch wg differential static pressure.
 - 3. Construction:
 - a. Linkage out of airstream.
 - b. Suitable for horizontal or vertical airflow applications.
 - 4. Frames:
 - a. Hat, U, or angle shaped.
 - b. Thickness: 0.08-inch aluminum sheet channels.
 - c. Flanges for attaching to walls and flangeless frames for installing in ducts.
 - 5. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.

- c. Roll-Formed Aluminum Blades: 0.072-inch thick aluminum sheet.
 - d. Extruded-Aluminum Blades: 0.050-inch- thick extruded aluminum.
 - 6. Blade Edging Seals:
 - a. Closed-cell neoprene.
 - b. Inflatable seal blade edging or replaceable rubber seals.
 - 7. Blade Jamb Seals: Neoprene.
 - 8. Blade Axles: Nonferrous metal.
 - 9. Bearings:
 - a. Molded synthetic Stainless steel sleeve.
 - b. Dampers mounted with vertical blades to have thrust bearings at each end of every blade.
 - 10. Tie Bars and Brackets: Aluminum.
 - 11. Locking device with offset handle to hold damper blades in a fixed position without vibration.
- E. Jackshaft:
- 1. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
 - 2. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.
- F. 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 FIRE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- 1. [Air Balance; a division of MESTEK, Inc.](#)
 - 2. [Arrow United Industries.](#)
 - 3. [Cesco Products; a division of MESTEK, Inc.](#)
 - 4. [Greenheck Fan Corporation.](#)
 - 5. [NCA Manufacturing, Inc.](#)
 - 6. [Pottorff.](#)

7. [Ruskin Company.](#)
8. [Safe Air - Dowco Products.](#)
9. [United Enertech.](#)
10. [Vent Products Co., Inc.](#)

- B. Type: dynamic; rated and labeled in accordance with 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 except when located behind grille where blades may be inside airstream; fabricated with roll-formed galvanized steel; with mitered and interlocking corners; gauge in accordance with UL listing.
- F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel; gauge in accordance with UL listing.
- G. Mounting Orientation: Vertical or horizontal as indicated.
- H. Blades: Roll-formed galvanized sheet steel, interlocking. Material gauge is to be in accordance with UL listing.
- I. Horizontal Dampers: Include blade lock and stainless steel closure spring.
- J. Heat-Responsive Device:
1. Replaceable, 165 deg F rated, fusible links.

2.5 SMOKE DAMPERS

- A. [Manufacturers:](#) Subject to compliance with requirements, provide products by one of the following:
1. [Air Balance; a division of MESTEK, Inc.](#)
 2. [Arrow United Industries.](#)
 3. [Cesco Products; a division of MESTEK, Inc.](#)
 4. [Greenheck Fan Corporation.](#)
 5. [Pottorff.](#)
 6. [Ruskin Company.](#)
 7. [Safe Air - Dowco Products.](#)
 8. [United Enertech.](#)

B. General Requirements:

1. Label to indicate conformance to UL 555 and UL 555S by an NRTL.
2. Label to indicate conformance to NFPA 80 and NFPA 90A by an NRTL.
3. Unless otherwise indicated, use parallel-blade configuration.
4. Factory or field assemble multiple damper sections to provide a single damper assembly of size required by the application.
5. Factory install damper actuator by damper manufacturer as integral part of damper assembly. Coordinate actuator location, mounting, and electrical requirements with damper manufacturer.

C. Performance:

1. Leakage:
 - a. Class I: Leakage shall not exceed 4 cfm/sq. ft. against 1-inch wg differential static pressure.
2. Pressure Drop: 0.05 inch wg at 1500 fpm across a 24-by-24-inch damper when tested in accordance with AMCA 500-D, Figure 5.3.
3. Velocity: Up to 3000 fpm.
4. Temperature: Minus 25 to plus 180 deg F.
5. Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/200 of blade length.

D. Construction:

1. Suitable for horizontal or vertical airflow applications.
2. Linkage out of airstream.
3. Frame:
 - a. Hat shaped.
 - b. Galvanized sheet steel, with welded or mechanically attached corners and mounting flange.
 - c. Gauge in accordance with UL listing.
4. Blades:
 - a. Roll-formed, horizontal, airfoil, galvanized sheet steel.
 - b. Maximum width and gauge in accordance with UL listing.
5. Blade Edging Seals:
 - a. Silicone rubber.
6. Blade Jamb Seal: Flexible stainless steel, compression type.

7. Blade Axles: 1/2-inch diameter; galvanized steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings. Linkage is to be mounted out of airstream.
8. Bearings:
 - a. Oil-impregnated stainless steel sleeve.
- E. Mounting Sleeve: Factory-installed, galvanized sheet steel; length to suit wall or floor application; gauge in accordance with UL listing.
- F. Damper Actuator - Electric:
 1. Electric - 120 V ac.
 2. UL 873, plenum rated.
 3. Designed to operate in smoke-control systems complying with UL 555S requirements.
 4. Two position with fail-safe spring return.
 - a. Sufficient motor torque and spring torque to drive damper fully open and fully closed with adequate force to achieve required damper seal.
 - b. Maximum 15-second full-stroke closure.
 - c. Minimum 90-degree drive rotation.
 5. Clockwise or counterclockwise drive rotation as required for application.
 6. Environmental Operating Range:
 - a. Temperature: Minus 40 to plus 130 deg F.
 - b. Humidity: 5 to 95 percent relative humidity noncondensing.
 7. Environmental Enclosure: NEMA 2.
 8. Actuator to be factory mounted and provided with single-point wiring connection.
- G. Controllers, Electrical Devices, and Wiring:
 1. Electrical Connection: 115 V, single phase, 60 Hz.
- H. Accessories:
 1. Auxiliary switches for signaling or position indication.
 2. Test and reset switches, damper mounted.
 3. Smoke Detector: Integral, factory wired for single-point connection.

2.6 COMBINATION FIRE AND SMOKE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Air Balance; a division of MESTEK, Inc.
 2. Arrow United Industries.
 3. Cesco Products; a division of MESTEK, Inc.
 4. Greenheck Fan Corporation.
 5. Pottorff.
 6. Ruskin Company.
 7. Safe Air - Dowco Products.
 8. United Enertech.
- B. General Requirements:
1. Label to indicate conformance to UL 555 and UL 555S by an NRTL.
 2. Label to indicate conformance to NFPA 80 and NFPA 90A by an NRTL.
 3. Unless otherwise indicated, use parallel-blade configuration.
- C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000 fpm velocity.
- D. Fire Rating: 1-1/2 and 3 hours.
- E. Performance:
1. Leakage:
 - a. Class IA: Leakage shall not exceed 3 cfm/sq. ft. against 1-inch wg differential static pressure.
 - b. Class I: Leakage shall not exceed 4 cfm/sq. ft. against 1-inch wg differential static pressure.
 - c. Class II: Leakage shall not exceed 10 cfm/sq. ft. against 1-inch wg differential static pressure.
 2. Pressure Drop: 0.05 in. wg at 1500 fpm across a 24-by-24-inch damper when tested in accordance with AMCA 500-D, Figure 5.3.
 3. Velocity: Up to 3000 fpm.
 4. Temperature: Minus 25 to plus 180 deg F.
 5. Pressure Rating: Damper close-off pressure equal to fan shutoff pressure with a maximum blade deflection of 1/200 of blade length.
- F. Construction:

1. Suitable or horizontal or vertical airflow applications.
2. Linkage out of airstream.
3. Frame:
 - a. Hat shaped.
 - b. Galvanized sheet steel, with welded or mechanically attached corners and mounting flange.
 - c. Gauge is to be in accordance with UL listing.
4. Blades:
 - a. Roll-formed, horizontal, airfoil, galvanized sheet steel.
 - b. Maximum width and gauge in accordance with UL listing.
5. Blade Edging Seals:
 - a. Silicone rubber.
6. Blade Jamb Seal: Flexible stainless steel, compression type.
7. Blade Axles: 1/2-inch- diameter; galvanized steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings. Linkage mounted out of airstream.
8. Bearings:
 - a. Oil-impregnated stainless steel sleeve.
- G. Mounting Sleeve:
 1. Factory installed, galvanized sheet steel.
 2. Length to suit wall or floor application.
 3. Gauge in accordance with UL listing.
- H. Heat-Responsive Device:
 1. Replaceable, 165 deg F rated, fusible links.
- I. Master control panel for use in dynamic smoke-management systems.
- J. Damper Actuator - Electric:
 1. Electric - 120 V ac.
 2. UL 873, plenum rated.
 3. Designed to operate in smoke-control systems complying with UL 555S requirements.
 4. Two position with fail-safe spring return.

- a. Sufficient motor torque and spring torque to drive damper fully open and fully closed with adequate force to achieve required damper seal.
 - b. Maximum 15-second full-stroke closure.
 - c. Minimum 90-degree drive rotation.
 5. Clockwise or counterclockwise drive rotation as required for application.
 6. Environmental Operating Range:
 - a. Temperature: Minus 40 to plus 130 deg F.
 - b. Humidity: 5 to 95 percent relative humidity noncondensing.
 7. Environmental Enclosure: NEMA 2.
 8. Actuator to be factory mounted and provided with single-point wiring connection.
- K. Controllers, Electrical Devices, and Wiring:
1. Comply with requirements for electrical devices and connections specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."
 2. Electrical Connection: 115 V, single phase, 60 Hz.
- L. Accessories:
1. Auxiliary switches for signaling or position indication.
 2. Test and reset switches, damper mounted.
 3. Smoke Detector: Integral, factory wired for single-point connection.

2.7 FLANGE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ductmate Industries, Inc.
 2. DynAir; a Carlisle Company.
 3. Elgen Manufacturing.
- B. Description: Add-on or roll-formed, factory fabricated, slide-on transverse flange connectors, gaskets, and components.
- C. Material: Galvanized steel.
- D. Gauge and Shape: Match connecting ductwork.

2.8 DUCT SILENCERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. FläktGroup.
 2. Flexmaster U.S.A., Inc.
 3. McGill AirFlow LLC.
 4. Pottorff.
 5. Ruskin Company.
- B. General Requirements:
1. Factory fabricated.
 2. Fire-Performance Characteristics: Adhesives, sealants, packing materials, and accessory materials shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested in accordance with ASTM E84.
 3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
 4. Bearing AMCA's Certified Ratings Seal for prefabricated silencer sound and air performance.
- 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 Silencer Outer Casing: ASTM A653/A653M, G90, galvanized sheet steel, 0.034 inch thick.
- E. Round Silencer Outer Casing: ASTM A653/A653M, G90, galvanized sheet steel.
1. Sheet Metal Thickness for Units up to 24 Inches in Diameter: 22 gauge thick.
 2. Sheet Metal Thickness for Units 26 through 40 Inches in Diameter: 20 gauge thick.
 3. Sheet Metal Thickness for Units 42 through 52 Inches in Diameter: 18 gauge thick.
 4. Sheet Metal Thickness for Units 54 through 60 Inches in Diameter: 16 gauge thick.

- F. Inner Casing and Baffles: ASTM A653/A653M, G90 galvanized sheet metal, 22 gauge thick, and with 1/8-inch- diameter perforations.
- G. Special Construction:
 - 1. Suitable for outdoor use.
 - 2. High transmission loss.
- H. Connection Sizes: Match connecting ductwork unless otherwise indicated.
- I. Principal Sound-Absorbing Mechanism:
 - 1. Controlled impedance membranes and broadly tuned resonators without absorptive media.
 - 2. Dissipative type with fill material.
 - a. Fill Material: Inert and vermin-proof fibrous material, packed under not less than 15 percent compression.
 - b. Erosion Barrier: Polymer bag enclosing fill, heat-sealed before assembly.
 - 3. Lining: Fiberglass cloth.
- J. 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 or flanged connections.
 - 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.
- K. Source Quality Control:
 - 1. Test in accordance with ASTM E477.
 - 2. Record acoustic ratings, including dynamic insertion loss and generated-noise power levels with an airflow of at least 2000 fpm face velocity.
 - 3. Leak Test: Test units for airtightness at 200 percent of associated fan static pressure or 6-inch wg static pressure, whichever is greater.

2.9 TURNING VANES

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

1. [Aero-Dyne Sound Control Co.](#)
 2. [Duro Dyne Inc.](#)
 3. [DynAir; a Carlisle Company.](#)
 4. [Elgen Manufacturing.](#)
- B. Manufactured Turning Vanes for Metal Ducts: Fabricate 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"; Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
- E. Vane Construction:
1. Single wall for ducts up to 48 inches wide and double wall for larger dimensions.
- 2.10 REMOTE DAMPER OPERATORS
- A. [Manufacturers](#): Subject to compliance with requirements, provide products by one of the following:
1. [DynAir; a Carlisle Company.](#)
 2. [METALAIRE, Inc.](#)
 3. [United Enertech.](#)
- B. Description: Cable system designed for remote manual damper adjustment.
- C. Tubing: Aluminum.
- D. Cable: Steel.
- E. Wall-Box Mounting: Recessed.
- F. Wall-Box Cover-Plate Material: Stainless steel.

2.11 DUCT-MOUNTED ACCESS DOORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Aire Technologies.
 2. Arrow United Industries.
 3. Cesco Products; a division of MESTEK, Inc.
 4. Duro Dyne Inc.
 5. McGill AirFlow LLC.
 6. Ruskin Company.
 7. United Enertech.
- B. Duct-Mounted Access Doors: Fabricate access panels in accordance with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figure 7-2 (7-2M), "Duct Access Doors and Panels," and Figure 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. 24-gauge- thick galvanized steel door panel.
 - d. Vision panel.
 - e. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
 - f. Fabricate doors airtight and suitable for duct pressure class.
 2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
 - a. 24-gauge- thick galvanized steel or 0.032-inch- thick aluminum Insert value frame.
 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: Two hinges 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.

2.12 DUCT ACCESS PANEL ASSEMBLIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. CL WARD & Family Inc.
 - 2. Ductmate Industries, Inc.
 - 3. Flame Gard, Inc.
- B. Access panels used in cooking applications:
 - 1. Labeled compliant to NFPA 96 for grease duct access doors.
 - 2. Labeled in accordance with UL 1978 by an NRTL.
- C. Panel and Frame: Minimum thickness 16-gauge 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 inches wg positive or negative.

2.13 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ductmate Industries, Inc.
 - 2. Duro Dyne Inc.
 - 3. DynAir; a Carlisle Company.
 - 4. Elgen Manufacturing.
- B. Fire-Performance Characteristics: Adhesives, sealants, fabric materials, and accessory materials shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested in accordance with ASTM E84.
- C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- D. Materials: Flame-retardant or noncombustible fabrics.
- E. Coatings and Adhesives: Comply with UL 181, Class 1.
- F. 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.
- G. 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.

2.14 DUCT ACCESSORY HARDWARE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. CL WARD & Family Inc.
 2. Ductmate Industries, Inc.
 3. Duro Dyne Inc.
 4. Elgen Manufacturing.
 5. United Enertech.
- B. 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.
- C. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

2.15 MATERIALS

- A. Galvanized Sheet Steel: Comply with ASTM A653/A653M.
1. Galvanized Coating Designation: G90.
 2. Exposed-Surface Finish: Mill phosphatized.
- B. Stainless Steel Sheets: Comply with ASTM A480/A480M, Type 304, and having a No. 2 finish for concealed ducts and finish for exposed ducts.
- C. Aluminum Sheets: Comply with ASTM B209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, one-side bright finish for exposed ducts.
- D. Extruded Aluminum: Comply with ASTM B221, 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.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install duct accessories in accordance with applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116 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 backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- D. Where multiple damper sections are necessary to achieve required dimensions, provide reinforcement to fully support damper assembly when fully closed at full system design static pressure.
- E. 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.
- F. Set dampers to fully open position before testing, adjusting, and balancing.
- G. Install test holes at fan inlets and outlets and elsewhere as indicated and as needed for testing and balancing.
- H. Install fire and smoke dampers in accordance with UL listing.
- I. Connect ducts to duct silencers with flexible duct connectors.

- J. 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-ft. spacing.
 - 8. Upstream from turning vanes.
 - 9. Upstream or downstream from duct silencers.
 - 10. For grease ducts, install at locations and spacing as required by NFPA 96.
 - 11. Control devices requiring inspection.
 - 12. Elsewhere as indicated.
- K. Install access doors with swing against duct static pressure.
- L. 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.
- M. Install flexible connectors to connect ducts to equipment.
- N. For fans developing static pressures of 5 inches wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
- O. Install duct test holes where required for testing and balancing purposes.
- P. 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.

3.2 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 size and location of access doors are adequate to perform required operation.
3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation, and verify that vanes do not move or rattle.
5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 233300

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SECTION 233346 - FLEXIBLE 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. Section Includes:
 - 1. Non-insulated flexible ducts.
 - 2. Insulated flexible ducts.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For flexible ducts.
 - 1. Include plans showing locations and mounting and attachment details.

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.

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.
- C. Comply with the Air Diffusion Council's "ADC Flexible Air Duct Test Code FD 72-R1."
- D. Comply with ASTM E96/E96M, "Test Methods for Water Vapor Transmission of Materials."

2.2 INSULATED FLEXIBLE DUCTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Flexmaster U.S.A., Inc.
 - 2. McGill AirFlow LLC.
 - 3. Ward Industries; a brand of Hart & Cooley, Inc.
- B. Insulated, Flexible Duct: UL 181, Class 1, two-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier film.
 - 1. Pressure Rating: 10-inch wg positive and 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: R6.

2.3 FLEXIBLE DUCT CONNECTORS

- A. 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.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install flexible ducts 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 in indoor applications only. Flexible ductwork should not be exposed to UV lighting.

- C. Connect terminal units to supply ducts with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.
- D. Connect diffusers or light troffer boots to ducts with maximum 60-inch lengths of flexible duct clamped or strapped in place.
- E. Connect flexible ducts to metal ducts with adhesive plus sheet metal screws.
- F. Install duct test holes where required for testing and balancing purposes.
- G. Installation:
 - 1. Install ducts fully extended.
 - 2. Do not bend ducts across sharp corners.
 - 3. Bends of flexible ducting shall not exceed a minimum of one duct diameter.
 - 4. Avoid contact with metal fixtures, water lines, pipes, or conduits.
 - 5. Install flexible ducts in a direct line, without sags, twists, or turns.
- H. Supporting Flexible Ducts:
 - 1. Suspend flexible ducts with bands 1-1/2 inches wide or wider and spaced a maximum of 48 inches apart. Maximum centerline sag between supports shall not exceed 1/2 inch per 12 inches.
 - 2. Install extra supports at bends placed approximately one duct diameter from center line of the bend.
 - 3. Ducts may rest on ceiling joists or truss supports. Spacing between supports shall not exceed the maximum spacing per manufacturer's written installation instructions.
 - 4. Vertically installed ducts shall be stabilized by support straps at a maximum of 72 inches o.c.

END OF SECTION 233346

SECTION 233423 - 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. Section Includes:
 - 1. Ceiling-mounted ventilators.
 - 2. Centrifugal ventilators - roof downblast.
 - 3. Centrifugal ventilators - roof upblast and sidewall.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes for fans.
 - 2. Rated capacities, operating characteristics, and furnished specialties and accessories.
 - 3. Certified fan performance curves with system operating conditions indicated.
 - 4. Certified fan sound-power ratings.
 - 5. Motor ratings and electrical characteristics, plus motor and electrical accessories.
 - 6. Material thickness and finishes, including color charts.
 - 7. Dampers, including housings, linkages, and operators.
 - 8. Prefabricated roof curbs.
 - 9. Fan speed controllers.
- B. 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. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans, reflect
- B. ed ceiling plans, and other details, or BIM model, drawn to scale, showing the items described in this Section and coordinated with all building trades.
- C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For HVAC power ventilators to include in normal and 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.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

2.2 CEILING-MOUNTED VENTILATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Greenheck Fan Corporation.
 - 2. Loren Cook Company.
 - 3. PennBarry.
- B. Housing: Steel, lined with acoustical insulation.
- C. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel removable for service.
- D. Back-draft damper: Integral.

- E. Grille: Plastic, louvered grille with flange on intake and thumbscrew or spring retainer attachment to fan housing.
- F. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.
- G. Accessories:
 - 1. Variable-Frequency Motor Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
 - 2. Manual Starter Switch: Single-pole rocker switch assembly with cover and pilot light.
 - 3. Time-Delay Switch: Assembly with single-pole rocker switch, timer, and cover plate.
 - 4. Motion Sensor: Motion detector with adjustable shutoff timer.
 - 5. Ceiling Radiation Damper: Fire-rated assembly with ceramic blanket, stainless steel springs, and fusible link.
 - 6. Filter: Washable aluminum to fit between fan and grille.
 - 7. Isolation: Rubber-in-shear vibration isolators.
 - 8. Manufacturer's standard roof jack or wall cap, and transition fittings.

2.3 IN-LINE CENTRIFUGAL VENTILATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following :
 - 1. Loren Cook Company.
 - 2. Greenheck
 - 3. PennBarry.
 - 4. Stanley Fans.
- B. Housing:
 - 1. Tubular fan housing shall be completely welded and coated with a minimum of 2-4 mils of Polyester Urethane, electrostatically applied and baked. Finish color shall be RAL 7023, concrete grey. No uncoated steel parts will be allowed.
 - 2. Housing and bearing support shall be constructed of welded structural steel members to prevent vibration and rigidly support the shaft and bearings.
 - 3. All mixed flow housings shall include vanes to straighten airflow prior to exiting the fan discharge.
 - 4. Units shall incorporate mounting system that allows for field rotation of the motor position. Bearing life shall not be reduced below specified level in different configurations. Units shall accommodate base mount or ceiling hung mounting without structural modifications to the fan.

5. An access door shall be supplied for impeller inspection and service.
 6. OSHA compliant belt guard or motor cover to be included to completely cover the motor pulley and belt(s).
- C. Fan Wheel: Fan wheel shall be of the backward inclined centrifugal type with an inlet venturi for maximum performance. Impellers shall be molded of high impact polypropylene
- D. Fan Drive: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing.
- E. Accessories:
1. Accessories listed in subparagraphs below are optional features.
 2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
 3. Vibration Isolation: Sized to match the weight of each fan
 4. Spark-resistant per schedule.
- F. Motors:
1. Motorized impeller shall be an external rotor type, class B insulation, enclosed with permanent split capacitor. Motor shall be a permanently sealed self-lubricating ball bearing type. Motor shall be equipped with automatic reset thermal overload protection. Motor shall be acceptable for continuous duty. Motorized impeller shall be both statically and dynamically balanced as one integral unit to provide for vibration free performance.

2.4 Dryer Exhaust Duct Power Ventilator

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following :
1. Loren Cook Company.
 2. Greenheck
 3. Fantech.
- B. Galvanized, sheet metal inline duct fan with Alternating Current (AC) motor
1. HVI 916 certified
 2. cULus Listed
 3. Conforms to UL standard 507
 4. Conforms to CSA standard C22.2-113
 5. Supports dryer exhaust runs up to 125 linear feet

C. Casing

1. Constructed of galvanized, sheet metal material
2. Inlet/outlet: 4-inch inlet and outlet

D. Electrical

1. Completely enclosed, electrical wiring box with pre-wired terminal strip connections
2. Equipped with a 5-foot power cord

E. Indicator Panel

1. Equipped with a 50-foot cable
2. LED flashes indicate proper operation and/or troubleshooting issues

F. Motor

1. Alternating Current (AC), external-rotor motor
2. Permanently sealed, self-lubricating, ball-bearing type
3. Equipped with automatic reset thermal overload protection

G. Wheel

1. Mixed flow, centrifugal type
2. Motorized impeller statically and dynamically balanced as one integral unit

H. Pressure-sensing switch

1. Constructed of galvanized sheet metal
2. Integral delay-on-break timer cycles fan on for intervals of 10 minutes
 - a. Activates after sensing positive pressure

I. Accessories:

1. Secondary Lint Trap
 - b. Model: DBLT-4W
 - c. Constructed of galvanized, sheet metal
 - d. 4-inch inlet and outlet
 - e. Internal screen to filter dryer lint

2.5 CENTRIFUGAL VENTILATORS - ROOF DOWNBLAST

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

1. [Greenheck Fan Corporation.](#)
 2. [Loren Cook Company.](#)
 3. [PennBarry.](#)
- B. Housing: Downblast; removable spun-aluminum dome top and outlet baffle; square, one-piece aluminum base with venturi inlet cone.
- 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. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
 5. Motor Pulleys: Adjustable pitch for use with motors through 5 hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch for use with motors larger than 5 hp.
 6. Fan and motor isolated from exhaust airstream.
- E. Accessories:
1. Variable-Frequency Motor Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
 2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside 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.
 6. Spark-resistant, all-aluminum wheel construction.
 7. Mounting Pedestal: Galvanized steel with removable access panel.
- F. Prefabricated 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: Self-flashing without a cant strip, with mounting flange.
 2. Overall Height: 24 inches.
 3. Sound Curb: Curb with sound-absorbing insulation.

4. Hinged sub-base to provide access to damper or as cleanout for grease applications.
5. Pitch Mounting: Manufacture curb for roof slope.
6. Metal Liner: Galvanized steel.
7. Mounting Pedestal: Galvanized steel with removable access panel.

2.6 SOURCE QUALITY CONTROL

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- B. AMCA Certification: Fans shall comply with AMCA 11 and bear the AMCA-Certified Ratings Seal.
- C. Fan Sound Ratings: Comply with AMCA 311, and label fans with the AMCA-Certified Ratings Seal. Sound ratings shall comply with AMCA 301. The fans shall be tested according to AMCA 300.
- D. Fan Performance Ratings: Comply with AMCA 211 and label fans with AMCA-Certified Rating Seal. The fans shall be tested for air performance - flow rate, fan pressure, power, fan efficiency, air density, speed of rotation, and fan efficiency - according to AMCA 210/ASHRAE 51.
- E. Operating Limits: Classify according to AMCA 99.
- F. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

PART 3 - EXECUTION

3.1 INSTALLATION OF HVAC POWER VENTILATORS

- A. Install power ventilators level and plumb.
- B. Secure roof-mounted fans to roof curbs with zinc-plated hardware.
- C. Ceiling Units: Suspend units from structure; use steel wire or metal straps.
- D. Support suspended units from structure using threaded steel rods and elastomeric hangers having a static deflection of 1 inch.
- E. Install units with clearances for service and maintenance.

- F. Install and secure roof mounted units in accordance with local wind loading requirements.

3.2 DUCTWORK CONNECTIONS

- A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors.

3.3 ELECTRICAL CONNECTIONS

- A. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.
 - 1. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.4 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections.
- E. 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 there is adequate maintenance and access space.
 - 4. Verify that cleaning and adjusting are complete.

5. 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.
 6. Adjust belt tension.
 7. Adjust damper linkages for proper damper operation.
 8. Verify lubrication for bearings and other moving parts.
 9. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
 10. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
 11. Shut unit down and reconnect automatic temperature-control operators.
 12. Remove and replace malfunctioning units and retest as specified above.
- F. Test and adjust controls and safeties. Controls and equipment will be considered defective if they do not pass tests and inspections.
- G. Prepare test and inspection reports.

3.6 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.
- C. Replace fan and motor pulleys as required to achieve design airflow.
- D. Lubricate bearings.

3.7 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain centrifugal fans.

END OF SECTION 233423

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SECTION 233433.13 - COMMERCIAL AIR CURTAINS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes commercial air-curtain unit.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For air curtains.
 - 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. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

- A. Sample Warranties: For special warranties.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air curtains to include in operation and 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. Furnish one set of filters for each unit installed.

PART 2 - PRODUCTS

2.1 COMMERCIAL AIR-CURTAIN UNIT

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Berner International.
 - 2. Mars Air Doors; Mars Air Systems.
 - 3. Powered Aire Inc.
- B. Source Limitations: Obtain air curtain from single source from single manufacturer.
- C. Housing:
 - 1. Galvanized Steel: Galvanized steel with electrostatically applied, epoxy-enamel, powder-coat finish.
 - 2. Discharge Nozzle: Integral to housing, containing adjustable air-directional vanes with 40-degree sweep front to back.
- D. Mounting Brackets: Galvanized steel, for wall mounting.
- E. Air-Intake Grilles:
 - 1. Grilles: Integral to, and same material as, housing.
- F. Fans:
 - 1. Centrifugal, forward curved, double width, double inlet.
 - 2. Galvanized steel.
 - 3. Statically and dynamically balanced.
 - 4. Direct drive.
- G. Motors: 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.
 - 2. Variable speed.
 - 3. Resiliently mounted.
 - 4. Continuous duty.
 - 5. Totally enclosed, air over.
 - 6. Integral thermal-overload protection.

7. Bearings: Permanently sealed, lifetime, prelubricated, ball bearings.
8. Disconnect: Internal power cord with plug and receptacle Lockable disconnect.

H. Filters:

1. Washable Panel Filters: Removable, aluminum, baffle-type filters with spring-loaded fastening; with minimum 0.0781-inch thick, stainless steel filter frame.
2. Mounting Frames: Welded, galvanized steel with gaskets and fasteners and suitable for bolting together into built-up filter banks.

I. Controls:

1. Automatic Double Door Switch: Magnetic, installed in door area to activate air curtain when either door opens and to deactivate air curtain when both doors are closed.
2. Time-Delay Relay: Factory installed and adjustable to allow air curtain to operate from 0.5 seconds to 10 hours.

J. Accessories:

1. Mounting Brackets: Adjustable mounting brackets for wall mounting.

2.2 SOURCE QUALITY CONTROL

- A. Source Quality Control: Test to 300 and 200 psig underwater.
- B. Comply with AMCA 220, "Laboratory Methods of Testing Air Curtains for Aerodynamic Performance Ratings," for airflow, outlet velocity, and power consumption.
- C. Comply with AHRI 410, "Forced-Circulation Air-Cooling and Air-Heating Coils," for components, construction, and rating.
- D. UL and cUL listed to comply with applicable United States and Canadian standards.
- E. Comply with NSF 37, "Air Curtains for Entranceways in Food and Food Service Establishments."
- F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and use.
- G. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine work areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Install air curtains with clearance for equipment service and maintenance.

3.3 ELECTRICAL CONNECTIONS

- A. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

3.4 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections with the assistance of a factory-authorized service representative.
- E. Tests and Inspections:
 - 1. After installing air curtains completely, perform visual and mechanical check of individual components.

2. After electrical circuitry has been energized, start unit to confirm motor rotation and unit operation. Certify compliance with test parameters.
 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- F. Air-curtain unit will be considered defective if it does not pass tests and inspections.
- G. Prepare test and inspection reports.

3.6 ADJUSTING

- A. Adjust motor speed to achieve specified airflow.
- B. Adjust discharge louver and dampers to regulate airflow.
- C. Adjust air-directional vanes.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial air curtains.

END OF SECTION 233433

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SECTION 233713.13 - AIR DIFFUSERS

PART 1 - GENERAL

1.1 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 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 Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.
- B. Samples: For each exposed product and for each color and texture specified. Actual size of smallest diffuser indicated.
- C. Samples for Initial Selection: For diffusers with factory-applied color finishes. Actual size of smallest diffuser indicated.
- D. Samples for Verification: For diffusers, in manufacturer's standard sizes to verify color selected. Actual size of smallest diffuser indicated.

1.2 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 Refer to schedules on drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas where diffusers are installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install diffusers 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 with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

- A. After installation, adjust diffusers to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713.13

SECTION 233713.23 - REGISTERS AND GRILLES

PART 1 - GENERAL

1.1 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 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. Register and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.
- B. Samples: For each exposed product and for each color and texture specified. Smallest size register and grille indicated.
- C. Samples for Initial Selection: For registers and grilles with factory-applied color finishes. Smallest size register and grille indicated.
- D. Samples for Verification: For registers and grilles, in manufacturer's standard sizes to verify color selected. Smallest size register and grille indicated.

1.2 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 Refer to schedules on drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas where registers and grilles are installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install registers and grilles level and plumb.
- B. Outlets and Inlets Locations: 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 registers and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

- A. After installation, adjust registers and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713.23

SECTION 235216 - CONDENSING BOILERS

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 gas-fired, fire-tube floor-mounted wall-hung condensing boilers, trim, and accessories for generating hot water.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for boilers.
 - 2. Include rated capacities, operating characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For boilers, boiler trim, and accessories.
 - 1. Include plans, elevations, sections, and mounting attachment details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For boilers to include in emergency, operation, and maintenance manuals.

1.5 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period. Where "prorated" is indicated, the boiler manufacturer will cover the indicated percentage of cost of replacement parts. With "prorated" type, covered cost decreases as age of equipment increases.

1. Warranty Period for Floor-Mounted Fire-Tube Condensing Boilers:

- a. Heat Exchanger and Tank: Free from defects in material and workmanship.
- b. Warranty Coverage: Prorated Year 0 to 5 - 100 percent; Year 6 to 7 - 50 percent; Year 8 to 9 - 30 percent; Year 10 - 10 percent for years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.
- C. ASHRAE/IES 90.1 Compliance: Boilers shall have minimum efficiency in accordance with Table 6.8.1-6 and other requirements in Ch. 6 of ASHRAE/IES 90.1.
- D. ASHRAE 90.2 Compliance: Boilers shall have minimum efficiency in accordance with Ch. 6 of ASHRAE 90.2.
- E. DOE Compliance: Minimum efficiency shall comply with 10 CFR 431, Subpart E, Appendix N.
- F. Mounting Base: For securing boiler to concrete base For securing boiler to structural wall.
- G. A.ASME CSD-1 Controls and Safety Devices for Automatically Fired Boilers.
- H. B.NYS Industrial Code Rule 4; New York Codes, Rules & Regulations, Title 12, Part 4 - Low pressure Boilers.

2.2 FLOOR-MOUNTED, FORCED-DRAFT, FIRE-TUBE CONDENSING BOILERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. AERCO; A WATTS Brand.
 2. Fulton Boiler Works, Inc.
 3. Laars Heating Systems Company; a subsidiary of Bradford White Corporation.
 4. Lochinvar, LLC.
 5. Viessmann Manufacturing Company, Inc.
- B. Description: Factory-fabricated, -assembled, and -tested, fire-tube, forced-draft, condensing boiler with heat exchanger sealed pressure tight, built on a steel base, including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls. Units are to be for water-heating service only.
- C. Primary Heat Exchanger: Corrosion-resistant Type 316 stainless steel.
- D. Secondary Heat Exchanger: Corrosion-resistant Type 316 stainless steel.
- E. Combustion Chamber and Flue Pipes: Corrosion-resistant stainless steel.
- F. Pressure Vessel: Carbon steel with welded heads and tube connections.
- G. Burner: Propane, forced draft.
- H. Blower: Centrifugal fan to operate during each burner-firing sequence and to prepurge and postpurge the combustion chamber.
1. Motors: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - a. Motor Sizes: Large enough so driven load will not require motor to operate in service factor range above 1.0.
- I. Gas Train: Combination gas valve with manual shutoff and pressure regulator.
- J. Ignition: Direct-spark ignition or silicone carbide hot-surface ignition with 100 percent main-valve shutoff and electronic flame supervision.
- K. Casing:
1. Jacket: Sheet metal, with snap-in or interlocking closures.

2. Control Compartment Enclosures: NEMA 250, Type 1A.
3. Finish: Baked-enamel protective finish.
4. Insulation: Minimum 2-inch- thick, polyurethane-foam insulation surrounding the heat exchanger.
5. Combustion-Air Connections: Inlet and vent duct collars.

2.3 TTRIM - FOR HOT-WATER BOILERS

- A. Include devices sized to comply with ASME B31.1.
- B. Aquastat Controllers: Operating, firing rate, and high limit with automatic reset.
- C. Safety Relief Valve: ASME rated.
- D. Pressure and Temperature Gauge: Minimum 3-1/2-inch- diameter, combination water-pressure and -temperature gauge. Gauges shall have operating-pressure and -temperature ranges, so normal operating range is about 50 percent of full range.
- E. High and low gas-pressure switches.
- F. Alarm bell with silence switch.
- G. Boiler Air Vent: Automatic.
- H. Drain Valve: Minimum NPS 3/4 hose-end gate valve.
- I. Circulation Pump: Nonoverloading, in-line pump with split-capacitor motor having thermal-overload protection and lubricated bearings; designed to operate at specified boiler pressures and temperatures.

2.4 CONTROLS

- A. Boiler operating controls shall include the following devices and features:
 1. Control transformer.
 2. Set-Point Adjust: All set points shall be adjustable.
 3. Electric, factory-fabricated and factory-installed panel to modulate burner and control burner-firing rate to maintain space temperature in response to thermostat with heat anticipator located in heated space.
 - a. Include automatic, alternating-firing sequence for multiple boilers to ensure maximum system efficiency throughout the load range and to provide equal runtime for boilers.

4. Electric, factory-fabricated and factory-installed panel to control burner-firing rate, to reset supply-water temperature inversely with outside-air temperature. At 0 deg F (adjustable) outside-air temperature, set supply-water temperature at 160 deg F (adjustable) at 60 deg F (adjustable) outside-air temperature, set supply-water temperature at 130 deg F (adjustable).
 - a. Include automatic, alternating-firing sequence for multiple boilers to ensure maximum system efficiency throughout the load range and to provide equal runtime for boilers.
- B. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.
 1. High Cutoff: Manual reset stops burner if operating conditions rise above maximum boiler design temperature.
 2. Low-Water Cutoff Switch: Electronic probe shall prevent burner operation on low water. Cutoff switch shall be manual-reset type.
 3. Blocked Inlet Safety Switch: Manual-reset pressure switch factory mounted on boiler combustion-air inlet.
 4. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.
- C. Building Automation System Interface: Factory install hardware and software to enable building automation system to monitor, control, and display boiler status and alarms.
 1. Hardwired Points:
 - a. Monitoring: On/off status, common trouble alarm low-water-level alarm.
 - b. Control: On/off operation, hot-water-supply temperature set-point adjustment.
 2. A BACnet communication interface with building automation system shall enable building automation system operator to remotely control and monitor the boiler from an operator workstation. All monitoring and control features, which are available at the local boiler control panel, shall also be available at the remote operator workstation through the building automation system.
 3. Provide electronic flame safeguard controls which, upon flame failure, respond in 2-4 seconds to cut fuel supply through the burner and main fuel valve.

2.5 ELECTRICAL POWER

- A. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are shown on Drawings and specified in electrical Sections.
- B. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.
 - 1. House in NEMA 250, Type 1 enclosure.
 - 2. Wiring shall be numbered and color coded to match wiring diagram.
 - 3. Install factory wiring outside of an enclosure in araceway.
 - 4. Field power interface shall be to fused disconnect switch.
 - 5. Provide branch power circuit to each motor and to controls with a disconnect switch or circuit breaker.
 - 6. Provide each motor with overcurrent protection.

2.6 VENTING KITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Centrotherm Eco Systems.
 - 2. Duravent (M & G Group).
- B. Vent: Complete system, polypropylene pipe, vent terminal, thimble, indoor plate, condensate trap and dilution tank, and sealant.
- C. Combustion-Air Intake: Complete system, polypropylene pipe, thimble, indoor plate, and sealant.

2.7 CONDENSATE-NEUTRALIZATION UNITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. SFA Saniflo USA.
 - 2. Skidmore Pump.
 - 3. Wessels Company.
- B. Description: Factory-fabricated and -assembled condensate-neutralizing tank assembly of corrosion-resistant plastic material with threaded or flanged inlet and outlet pipe connections. Device functions to prevent acidic condensate from damaging grain

system. It is to be piped to receive acidic condensate discharged from condensing boiler and neutralize it by chemical reaction with replaceable neutralizing agent. Neutralized condensate is then piped to suitable drain.

C. Capsule features:

1. All corrosion-resistant material.
2. Suitable for use on all natural gas and propane boilers.
3. Includes initial charge of neutralizing agent.
4. Neutralizing agent to be easily replaceable when exhausted.
5. Inlet and outlet pipe connections.

D. Capsule Configuration:

1. Low-profile design for applications where boiler condensate drain is close to the floor.
2. Easily removed and opened for neutralizing agent replacement.
3. Multiple units may be used for larger capacity.

2.8 SOURCE QUALITY CONTROL

- A. UL Compliance: Test gas-fired boilers having input of more than 400,000 Btu/h for compliance with UL 795. Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.
- B. UL Compliance, Oil-Fired: Test oil-fired boilers for compliance with UL 726. Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.
- C. UL Compliance, Gas-Fired: Test gas-fired boilers for compliance with UL 2764. Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.
- D. CSA Compliance: Test boilers for compliance with ANSI Z21.13-2017/CSA 4.9.
- E. Performance Testing: Test and label boilers for efficiency to comply with AHRI 1500.
- F. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.
- G. Test and inspect factory-assembled boilers, before shipping, in accordance with 2017 ASME Boiler and Pressure Vessel Code. Factory test boilers for safety and functionality; fill boiler with water, and fire throughout firing range, to prove operation of all safety components.

- H. Allow Owner access to source quality-control testing of boilers. Notify Architect 14 days in advance of testing.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting performance of the Work.
 - 1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.
- B. Examine mechanical spaces for suitable conditions where boilers will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 BOILER INSTALLATION

- A. Equipment Mounting:
 - 1. Install floor-mounted boilers on cast-in-place concrete equipment base(s).
 - 2. Install wall-hung boilers where indicated on Drawings using suitable hangers. Comply with manufacturer's mounting instructions.
- B. Install gas-fired boilers according to NYS Fuel Gas Code.
- C. Assemble and install boiler trim.
- D. Install electrical devices furnished with boiler but not specified to be factory mounted.
- E. Install control wiring to field-mounted electrical devices.

3.3 PIPING CONNECTIONS

- A. Connect piping to boilers, except safety relief valve connections, with flexible connectors of materials suitable for service.
- B. Drawings indicate general arrangement of piping, fittings, and specialties.

- C. When installing piping adjacent to boiler, allow space for service and maintenance of condensing boilers. Arrange piping for easy removal of condensing boilers.
- D. Install condensate drain piping to condensate-neutralization unit and from neutralization unit to nearest floor drain. Piping shall be at least full size of connection. Install piping with a minimum of 2 percent downward slope in direction of flow.
- E. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas-train connection. Provide a reducer if required.
- F. Connect hot-water piping to supply- and return-boiler tapplings with shutoff valve, and union or flange at each connection.
- G. Install piping from safety relief valves to nearest floor drain.

3.4 DUCT CONNECTIONS

- A. Boiler Venting:
 - 1. Install flue-venting kit and combustion-air intake.
 - 2. Comply with all boiler manufacturer's installation instructions.
 - 3. Field fabricate and install boiler vent and combustion-air intake.
 - 4. Utilize vent and intake duct material, size, and configuration as indicated in boiler manufacturer's instructions and to comply with UL 1738.
 - 5. Comply with all boiler manufacturer's installation instructions.
 - 6. Connect boiler vent full size to boiler connections.
 - 7. Comply with all boiler manufacturer's installation instructions.

3.5 ELECTRICAL CONNECTIONS

- A. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.
- B. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
 - 1. Nameplate shall be laminated acrylic or melamine plastic signs.
 - 2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.6 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Install nameplate for each control connection, indicating field control panel designation and I/O control designation feeding connection.
 - 1. Nameplate shall be laminated acrylic or melamine plastic signs.
 - 2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.7 FIELD QUALITY CONTROL

- A. Testing Agency, Owner: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency, Contractor: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections with the assistance of a factory-authorized service representative:
- E. Tests and Inspections:
 - 1. Perform installation and startup checks in accordance with manufacturer's written instructions.
 - 2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level, and water temperature.
 - b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- F. Boiler will be considered defective if it does not pass tests and inspections.
- G. Prepare test and inspection reports.

- H. 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.

3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain boilers.
 - 1. Instructor shall be factory trained and certified.
 - 2. Provide not less than two hours of training.
 - 3. Train personnel in operation and maintenance and to obtain maximum efficiency in plant operation.
 - 4. Provide instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
 - 5. Obtain Owner sign-off that training is complete.
 - 6. Owner training shall be held at Project site.

END OF SECTION 235216

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SECTION 236423 – AIR-COOLED MODULAR CHILLER

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

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

1.02 REFERENCES

- A. ANSI/ASHRAE STANDARD 15-1992 - Safety Code for Mechanical Refrigeration.
- B. ANSI/ARI 550/590-98 - Standard for Water Chilling Packages using the Vapor Compression Cycle.

1.03 SUBMITTALS

- A. Submit unit performance data including: capacity, nominal and operating performance.
- B. Submit Mechanical Specifications for unit and accessories describing construction, components and options.
- C. Submit shop drawings indicating overall dimensions as well as installation, operation and service clearances. Indicate lift points and recommendations and center of gravity. Indicate unit shipping, installation and operating weights including dimensions.
- D. Submit data on electrical requirements and connection points. Include recommended wire and fuse sizes or MCA, sequence of operation, safety and start-up instructions.
- E. Submit manufacturer's standard IOM manual in PDF format.

1.04 STORAGE AND HANDLING

- A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.

- B. Protect units from physical damage. Leave factory shipping covers in place until installation.

1.05 WARRANTY

- A. Provide a full warranty for one year from start-up or 18 months from shipment, whichever occurs first.
- B. Provide five year warranty for replacement compressors including material only.

PART 2 - PRODUCTS

2.01 OPERATING CONDITIONS

- A. Provide air-cooled liquid chiller with the capacity as scheduled on drawings.
- B. Chiller shall be designed to operate using R-410a Refrigerant.

2.02 AIR-COOLED PACKAGED CHILLER

- A. System Description: Chiller shall incorporate Scroll-type compressors and consist of multiple refrigerant circuits. Each refrigerant circuit shall consist of an individual compressor, condenser, evaporator, thermal expansion valve, and control system. Each circuit shall be constructed to be independent of other circuits from a refrigeration and electrical stand-point. The multi-circuit chiller must be able to produce chilled water even in the event of a failure of one or more refrigerant circuits.
- B. General
 - 1. Chiller Modules shall be ETL listed in accordance with UL Standard 465, CSA certified per Standard C22.2#119, and bear the ASME UM stamp on all heat exchangers.
 - 2. Modules shall ship wired and charged with refrigerant. All modules shall be factory run tested prior to shipment.
 - 3. Compressors, heat exchangers, piping and controls shall be mounted on a heavy gauge steel frame. Electrical controls, contactors, and relays for each module shall be mounted within that module.
- C. Chilled Water Mains: Each module shall include supply and return mains for chilled water. Grooved end connections are provided for interconnection to six inch standard piping with Victaulic type couplings.

- D. Evaporators: Brazed plate heat exchangers constructed of 316 stainless steel; designed, tested, and stamped in accordance with ASME code for 360 psig working pressure. Heat exchanger shall be mounted below the compressor, to eliminate the effect of migration of refrigerant to the cold evaporator with consequent liquid slugging on start-up.
- E. Compressor: Each module shall contain two hermetic scroll compressors independently circuited and with internal spring isolation mounted to the module with rubber-in-shear isolators. Each system also includes high discharge pressure and low suction pressure manual reset safety cut-outs.
- F. Air Cooled Condensers
 - 1. Condensers shall be furnished by unit manufacturer. The condenser coil shall be divided into individual refrigerant circuits, each sized for its own specific application.
- G. Central Control System.
 - 1. Scheduling of the various compressors shall be performed by a microprocessor based control system (Master Controller). The Heat Recovery Chiller shall have the capability to operate in response to either heating water or cooling water set points. A new lead compressor is selected every 24 hours to assure even distribution of compressor run time.
 - 2. The Master Controller shall monitor and report the following on each refrigeration system:
 - a. Discharge Pressure Fault
 - b. Suction Pressure Fault
 - c. Compressor Winding Temperature
 - d. Suction Temperature
 - e. Evaporator Leaving Chilled Water Temp.
 - 3. The Master Controller shall monitor and report the following system parameters:
 - a. Chilled Water Entering and Leaving Temperature
 - b. Condenser Water Entering and Leaving Temperature
 - c. Chilled Water and Condenser Water Flow
 - 4. An out of tolerance indication from these controls or sensors shall cause a "fault" indication at the Master Controller and shutdown of that compressor with the transfer of load requirements to the next available compressor. In the case of a System Fault the entire chiller will be shut down. When a fault occurs, the Master Controller shall record conditions at the time of the fault and store the data for recall. This information shall be capable of being recalled through the keypad of the Master Controller and displayed on the Master Controller's 2

- line by 40 character back-lit LCD. A history of faults shall be maintained including date and time of day of each fault (up to the last 20 occurrences).
5. Individual monitoring of leaving chilled water temperatures from each refrigeration system shall be programmed to protect against freeze-up.
 6. The control system shall monitor entering and leaving chilled water temperatures to determine system load and select the number of compressor circuits required to operate. Response times and set points shall be adjustable. The system shall provide for variable time between compressor sequencing and temperature sensing, so as to fine tune the chiller to different existing building conditions.
 7. The Chiller shall be capable of interfacing to a building automation system. Interface shall be accomplished using an Interoperability Web Portal and shall be capable of communication over BACNet, Modbus or LON. Coordinate interface with temperature controls installer.
- H. Chiller shall have a single point power connection and external inputs and outputs to be compatible with the building management system.

2.03 SAFETIES, CONTROLS AND OPERATION

- A. Chiller safety controls system shall be provided with the unit (minimum) as follows:
1. Low evaporator refrigerant pressure.
 2. Loss of flow through the evaporator.
 3. Loss of flow through the condenser.
 4. High condenser refrigerant pressure.
 5. High compressor motor temperature.
 6. Low suction gas temperature.
 7. Low leaving evaporator water temperature.
- B. Failure of chiller to start or chiller shutdown due to any of the above safety cutouts shall be enunciated by display of the appropriate diagnostic description at the unit control panel. This annunciation will be in plain English. Alphanumeric codes shall be unacceptable.
- C. The chiller shall be furnished with a Master Controller as an integral portion of the chiller control circuitry to provide the following functions:
1. Provide automatic chiller shutdown during periods when the load level decreases below the normal operating requirements of the chiller. Upon an increase in load, the chiller shall automatically restart.
 2. Provisions for connection to automatically enable the chiller from a remote energy management system.

3. The control panel shall provide alphanumeric display
4. showing all system parameters in the English language with numeric data in English units.

D. Normal Chiller Operation

1. When chiller is enabled, the factory supplied Master Controller modulates the chiller capacity from minimum to maximum as required by building load.
2. The Chiller control system shall respond to Entering Water
3. Temperature and will have an integral reset based on entering water temperature to provide for efficient operation at part-load conditions.

E. Power Phase Monitor

1. Provide a Power Phase Monitor on the incoming power supply to the chiller. This device shall prevent the chiller from operating during periods when the incoming power is unsuitable for proper operation.
2. The Power Phase Monitor shall provide protection against the following conditions:
 - a. Low Voltage (Brown-Out).
 - b. Phase Rotation.
 - c. Loss of Phase.
 - d. Phase Imbalance.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install units on neoprene vibration isolators.
- C. Connect to chilled water piping.
- D. Maintain recommended clearances for service and maintenance.

3.02 MANUFACTURER'S FIELD SERVICES

- A. Supply service of factory trained representative to supervise testing, start- up, and instruction on operation and maintenance to Owner.

3.03 PIPING SYSTEM FLUSHING PROCEDURE

- A. Prior to connecting the chiller to the chilled water loop, the piping loops shall be flushed with a detergent and hot water (110-130° F) mixture.
- B. During the flushing 30 mesh (max.) Y-strainers (or acceptable equivalent) shall be in place in the system piping and examined periodically as necessary to remove collected residue. The flushing process shall take no less than 6 hours or until the strainers when examined after each flushing are clean. Detergent and acid concentrations shall be used in strict accordance with the respective chemical manufacturer's instructions. After flushing with the detergent and/or dilute acid concentrations the system loop shall be purged with clean water for at least one hour to ensure that all residual cleaning chemicals have been flushed out.

END OF SECTION 236423

SECTION 237343 - AIR HANDLING UNITS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Indoor modular air handling units.

1.2 ACTION SUBMITTALS

- A. Product Data: Include manufacturer's technical data for each unit, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.
 - 1. Dimensioned arrangement drawings for each AHU including a plan and elevation view of the assembled unit with overall dimensions, lift points, unit shipping split locations and dimensions, installation and operating weights, and installation, operation and service clearances.
 - 2. All electrical, piping, and ductwork requirements, including sizes, connection locations, and connection method recommendations.
 - 3. Each component of the unit shall be identified and mechanical specifications shall be provided for unit and accessories describing construction, components, and options.
 - 4. All performance data, including capacities and airside and waterside pressure drops, for components.
 - 5. Fan curves shall be provided for fans with the design operating points indicated. Data shall be corrected to actual operating conditions, temperatures, and altitudes.
 - 6. A filter schedule must be provided for each air handling unit supplied by the air handling unit manufacturer. Schedule shall detail unit tag, unit size, corresponding filter section location within the AHU, filter arrangement (e.g. angled/flat), filter depth, filter type (e.g. pleated media), MERV rating, and filter quantity and size.
 - 7. A schedule detailing necessary trap height shall be provided for each air handling unit. Schedule shall detail unit tag, unit size, appropriate trap schematic with recommended trap dimensions, and unit supplied base rail height. Contractor shall be responsible for additional trap height required for trapping and insulation beyond the unit supplied base rail height by adequate housekeeping pad.
 - 8. An electrical MCA – MOP schedule shall be provided for each electrical circuit to which field-power must be supplied. Schedule to detail unit tag, circuit description,

voltage/phase/hertz, Minimum Circuit Ampacity (MCA), and calculated Maximum Overcurrent Protection (MOP).

9. Sound data shall be provided using ARI 260 test methods. Unit discharge, inlet, and radiated sound power levels in dB shall be provided for 63, 125, 250, 500, 1000, 2000, 4000, and 8000 Hz.

- B. The AHU manufacturer shall list any exceptions to the specification.

1.3 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air-handling units to include in emergency, operation, and maintenance manuals.
- B. Include an electronic copy of the IOM.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Filters: One set(s) for each air-handling unit.
 2. Fan Belts: One set(s) for each air-handling unit fan.

1.5 QUALITY ASSURANCE

- A. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.
- B. Air Coils: Certify capacities, pressure drops and selection procedures in accordance with current ARI Standard 410.
- C. Certify air handling units in accordance with ARI Standard 430.
- D. Units shall be manufactured to conform to UL 1995 and shall be listed by either UL/CUL or ETL. Units shall be provided with listing agency label affixed to the unit. In the event the unit is not UL/CUL or ETL approved, the contractor shall, at his/her expense, provide for a field inspection by a UL/CUL or ETL representative to verify conformance. If necessary, contractor shall perform modifications to the unit to comply with UL/CUL or ETL as directed by the representative, at no additional expense to the owner.

1.6 COORDINATION

- A. Coordinate sizes and locations of roof curbs and roof openings with GC.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturer must clearly define any exceptions made to Plans and Specifications. Any deviations in layout or arrangement shall be submitted to consulting engineer prior to bid date. Acceptance of deviation(s) from specifications shall be in the form of written approval from the consulting engineer. Mechanical Contractor is responsible for expenses that occur due to exceptions made.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Trane.
 - 2. AAON, Inc.
 - 3. Daikin.

2.2 GENERAL

- A. Unit layout and configuration shall be as defined in project plans and schedules.
- B. Entire unit shall have an 8-inch full perimeter base rail.

2.3 UNIT CASING

- A. Unit manufacturer shall ship separate segments so unit can be broken down for ease of installation in tight spaces. The entire air handler shall be constructed of galvanized steel. Casing finished to meet ASTM B117 250-hour salt-spray test. The removal of access panels or access doors shall not affect the structural integrity of the unit. All removable panels shall be gasketed. All doors shall have gasketing around full perimeter to prevent air leakage. Contractor shall be responsible to provide connection flanges and all other framework that is needed to properly support the unit.
- B. Casing performance – Casing air leakage shall not exceed leak class 6 (CL = 6) per ASHRAE 111 at specified casing pressure, where maximum casing leakage (cfm/100 ft² of casing surface area) = CL X P^{0.65}.

- C. Air leakage shall be determined at a casing static pressure of 8 inches w.g. Specified air leakage shall be accomplished without the use of caulk. Total estimated air leakage shall be reported for each unit in CFM, as a percentage of supply air, and as an ASHRAE 111 Leakage Class.
- D. Under 55°F supply air temperature and design conditions on the exterior of the unit of 81°F dry bulb and 73°F wet bulb, condensation shall not form on the casing exterior. The AHU manufacturer shall provide tested casing thermal performance for the scheduled supply air temperature plotted on a psychrometric chart. The design condition on the exterior of the unit shall also be plotted on the chart. If tested casing thermal data is not available, AHU manufacturer shall provide, in writing to the Engineer and Owner, a guarantee against condensation forming on the unit exterior at the stated design conditions above. The guarantee shall note that the AHU manufacturer will cover all expenses associated with modifying units in the field should external condensate form on them. In lieu of AHU manufacturer providing a written guarantee, the installing contractor must provide additional external insulation on AHU to prevent condensation.
- E. Unit casing (wall/floor/roof panels and doors) shall be able to withstand up to 1.5 times design static pressure, or 8" w.g., whichever is less, and shall not exceed 0.0042" per inch of panel span (L/240).
- F. Floor panels shall be double-wall construction and designed to support a 250-lb load during maintenance activities and shall deflect no more than 0.0042" per inch of panel span.
- G. Unit casing panels shall be 2" double-wall construction, with solid galvanized exterior and solid galvanized interior, to facilitate cleaning of unit interior.
- H. Unit casing panels (roof, walls, floor) and doors shall be provided with a minimum thermal resistance (R-value) of 13 Hr*Ft²*°F/BTU.
- I. Unit casing panels (roof, walls, floor) and external structural frame members shall be completely insulated filling the entire panel cavity in all directions so that no voids exist. Panel insulation shall comply with NFPA 90A.
- J. Casing panel inner liners must not extend to the exterior of the unit or contact the exterior frame. A mid-span, no-through-metal, internal thermal break shall be provided for all unit casing panels.
- K. Access panels and/or access doors shall be provided in all sections to allow easy access to drain pan, coil(s), motor, drive components and bearings for cleaning, inspection, and maintenance.

- L. Access panels and doors shall be fully removable without the use of specialized tools to allow complete access of interior surfaces.

2.4 ACCESS DOORS

- A. Access doors shall be 2" double-wall construction. Interior and exterior shall be of the same construction as the interior and exterior wall panels.
- B. All doors downstream of cooling coils shall be provided with a thermal break construction of door panel and door frame.
- C. Gasketing shall be provided around the full perimeter of the doors to prevent air leakage.
- D. Door hardware shall be surface-mounted to prevent through-cabinet penetrations that could likely weaken the casing leakage and thermal performance.
- E. Handle hardware shall be designed to prevent unintended closure.
- F. Access doors shall be hinged and removable without the use of specialized tools to allow.
- G. Hinges shall be interchangeable with the door handle hardware to allow for alternating door swing in the field to minimize access interference due to unforeseen job site obstructions.
- H. Door handle hardware shall be adjustable and visually indicate locking position of door latch external to the section.
- I. All doors shall be a minimum 60" high when sufficient height is available, or the maximum height allowed by the unit height.
- J. Door handles shall be provided for each latching point of the door necessary to maintain the specified air leakage integrity of the unit.

2.5 FANS

- A. The fan type shall be provided as required for stable operation and optimum energy efficiency. The fan shall be statically and dynamically balanced at the factory as a complete fan assembly. The fan shaft shall not exceed 75 percent of its first critical speed at any cataloged speed. Fan wheels shall be keyed to the fan shaft to prevent slipping.
- B. Fans shall be equipped with self-aligning, antifriction bearings with an L-50 life of 200,000 hours as calculated per ANSI/AFBMA Standard 9. Fan performance shall be certified as complying with AHRI Standard 430.

- C. Direct-Drive Plenum Fans: The fans shall be a single-width, single-inlet, 9-blade or 12-blade plenum fan. The fan blades shall be aluminum backward-inclined airfoil. Plenum fan shall be direct-driven.
 - 1. Fan sections containing multiple fans shall be controlled using a common control signal to modulate the fan speed.
- D. Fan Motors: Premium efficient motors rated for variable frequency duty. Motors shall be designed and manufactured to meet the most current specifications defined by NEMA MG 1 Section IV, "Performance Standards Applying to All Machines," Part 31, "Definite Purpose Inverter-Fed Polyphase Motors."
 - 1. Class H insulation.
 - 2. AEGIS SGR bearing protection rings.

2.6 COILS

- A. Coils section side panels shall be removable to allow for removal and replacement of coils without impacting the structural integrity of the unit.
- B. Coils shall be manufactured with plate fins to maximize airside thermal efficiency. Fin tube holes shall have drawn and belled collars to maintain consistent fin spacing to ensure performance and air pressure drop across the coil as scheduled. Tubes shall be mechanically expanded and bonded to fin collars for maximum thermal conductivity. Use of soldering or tinning during the fin-to-tube bonding process is not acceptable due to the inherent thermal stress and possible loss of bonding at that joint.
- C. Construct coil casings of galvanized steel. End supports and tube sheets shall have belled tube holes to minimize wear of the tube wall during thermal expansion and contraction of the tube.
- D. All coils shall be completely cleaned prior to installation into the air handling unit. Complete fin bundle in direction of airflow shall be degreased and steam cleaned to remove any lubricants used in the manufacturing of the fins, or dirt that may have accumulated.
- E. Hydronic Coils
 - 1. Supply and return header connections shall be clearly labeled on unit exterior such that direction of coil water-flow is counter to direction of unit air-flow.
 - 2. Coils shall be proof-tested to 300 psig and leak-tested to 200 psig air pressure under water.
 - 3. Headers shall be constructed of round copper pipe.
 - 4. Tubes shall be 1/2 inch O.D., minimum 0.016 inch thick copper. Fins shall be aluminum.

5. Hydronic coils shall be supplied with factory installed drain and vent piping to the unit exterior.

2.7 DAMPERS SECTIONS

- A. Combination Filter/Mixing Box: Parallel-blade dampers in a reinforced, galvanized steel cabinet. Damper blades shall be galvanized steel mechanically fastened to steel operating rod. Connect operating rods for each set of dampers together with a common linkage and interconnect linkages so dampers operate simultaneously and in the opposite direction (one opens when the other closes). Cabinet shall have support members to hold 2-inch-thick, pleated, flat permanent or throwaway filters. Mixing boxes shall have hinged access panels or doors to allow removal of filters for both sides of unit.

2.8 FILTERS

- A. Provide factory-fabricated filter section of the same construction and finish as unit casings. Filter section shall have filter guides and access door(s) extending the full height of the casing to facilitate filter removal. Provide fixed filter blockoffs as required to prevent air bypass around filters. Blockoffs shall not need to be removed during filter replacement.
- B. Provide Merv 8 pre filters and Merv 13 filters for each unit. - Revised per RFI 52 response.
- C. Manufacturer shall provide three sets of filters.
 1. One set of filters for construction phase.
 2. One set of specified filters installed prior to testing and balancing.
 3. One set of spare filters.
- D. Filter Gage:
 1. 3-1/2-inch diameter, diaphragm-actuated dial in metal case.
 2. Vent valves.
 3. Black figures on white background.
 4. Front recalibration adjustment.
 5. 3 percent of full-scale accuracy.
 6. Range: 0- to 0.5-inch wg.
 7. Accessories: Static-pressure tips with integral compression fittings, 1/4-inch aluminum tubing.

2.9 DISCHARGE PLENUM SECTION

- A. Factory fabricated plenum with openings matching sizes and locations indicated on the drawings.

2.10 ACCESS SECTIONS

- A. Access sections shall be provided where indicated in the schedule and plans to allow additional access for inspection, cleaning, and maintenance of unit components. The unit shall be installed for proper access. Procedure for proper access, inspection and cleaning of the unit shall be provided in the AHU manufacturer's maintenance manual.

2.11 COMBINATION VFD AND DISCONNECTS

- A. A combination VFD/disconnect shall be provided for each fan motor. Each VFD/disconnect shall be properly sized, factory mounted in a full metal enclosure, wired to the fan motor, and commissioned to facilitate temporary heating, cooling, ventilation, and/or timely completion of the project. VFD/disconnects shall include a circuit breaker disconnect with a through-the-door interlocking handle designed to rest only in the full ON or OFF state and shall be lockable in these states. A concealed defeater mechanism shall allow entry into the enclosure when the handle is in the ON position. The VFD package shall also include:
 - 1. • Electronic manual speed control.
 - 2. • Hand-Off-Auto (H-O-A) selector switch.
 - 3. • Inlet fuses to provide maximum protection against inlet short circuit.
 - 4. • Current limited stall prevention.
 - 5. • Auto restart after momentary power loss.
 - 6. • Speed search for starting into rotating motor.
 - 7. • Anti-windmill with DC injection before start.
 - 8. • Phase-to-phase short circuit protection.
 - 9. • Ground fault protection.
- B. The VFD shall be UL508C listed and CSA certified and conform to applicable NEMA, ICS, NFPA, and IEC standards.
- C. VFD shall be mounted externally on the fan section in a NEMA Type 4 equivalent unit casing within a dedicated controls section or housed fan section. The internal enclosure shall be an integral part of the unit casing to allow for thermal venting to casing interior, but shall be accessible from unit exterior through access door. Internally mounted VFDs shall have doors with the same construction as other doors on unit. An external disconnect shall be mounted through the access door to the VFD to disconnect full power from VFD, lights, or control power.

PART 3 - EXECUTION

3.1 SHIPPING

- A. Paper copies of the IOM shall be shipped with each AHU.
- B. The AHU manufacturer shall identify all shipments with the order number. Enough information shall be provided with each shipment to enable the Mechanical Contractor to confirm the receipt of units when they are received. For parts too small to mark individually, the AHU manufacturer shall place them in containers.
- C. To protect equipment during shipment and delivery, all indoor units shall be completely stretch or shrink wrapped. Wrap shall be a minimum of 7 mil plastic. Pipe ends and pipe connection holes in the casing shall be capped or plugged prior to shipment.
- D. After loading the equipment for shipment, the AHU manufacturer shall contact the shipping contact on the order and provide the name of the carrier, description of equipment, order number, shipping point, and date of shipment.

3.2 ON-SITE STORAGE

- A. If equipment is to be stored for a period of time prior to installation, the Mechanical Contractor shall remove all stretch or shrink wrap from units upon receipt to prevent unit corrosion and shall either place the units in a controlled indoor environment or shall cover the units with canvas tarps and place them in a well-drained area. Covering units with plastic tarps shall not be acceptable.

3.3 FIELD EXAMINATION

- A. The Mechanical Contractor shall verify that the mechanical room and/or roof are ready to receive work and the opening dimensions are as indicated on the shop drawings and contract documents.
- B. The Mechanical Contractor shall verify that the proper power supply is available prior to starting of the fans.

3.4 INSTALLATION

- A. Arrange installation of units to provide access space around air-handling units for service and maintenance.

- B. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction, with new, clean filters.
- C. Coordinate installation requirements to ensure that a complete installation for each unit is being provided. Coordination efforts shall include such items as unloading and hoisting requirements, field wiring requirements, field piping requirements, field ductwork requirements, requirements for assembly of field-bolted or welded joints, and all other installation and assembly requirements.
- D. The AHU manufacturer shall provide all screws and gaskets for joining of sections in the field.
- E. The Mechanical Contractor shall verify that the following items have been completed prior to scheduling the AHU manufacturer's final inspection and start up:
 - 1. All spring-isolated components have had their shipping restraints removed and the components have been leveled.
 - 2. On all field-joined units, that all interconnections have been completed, i.e., electrical and control wiring, piping, casing joints, bolting, welding, etc.
 - 3. All water and steam piping connections have been completed and hydrostatically tested and all water flow rates have been set in accordance with the capacities scheduled on the Drawings.
 - 4. All ductwork connections have been completed and all ductwork has been pressure tested for its intended service.
 - 5. All power wiring, including motor starters and disconnects, serving the unit has been completed.
 - 6. All automatic temperature and safety controls have been completed.
 - 7. All dampers are fully operational.
 - 8. All shipping materials have been removed.
 - 9. All (clean) filter media has been installed in the units.
- F. Install filter-gage, static-pressure taps upstream and downstream of filters. Mount filter gages on outside of filter housing or filter plenum in accessible position. Provide filter gages on filter banks, installed with separate static-pressure taps upstream and downstream of filters.
- G. Connect hydronic coils to supply and return piping. Install shutoff valve in supply branch and shutoff valve, and control valve in return branch piping. Install manual air vents at high points and drain valves at low points and as required for maintenance. Provide pressure/temperature ports at coil supply and return connections.

3.5 LEVELING

- A. The Mechanical Contractor shall level all unit sections in accordance with the unit manufacturer's instructions. The Mechanical Contractor shall provide and install all necessary permanent shim material to ensure individual sections and entire assembled units are level.

3.6 CLEANING

- A. After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems and after completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.7 FINAL INSPECTION AND START UP SERVICE

- A. After the Mechanical Contractor has provided all water and steam piping connections, ductwork connections, and field control wiring, and Electrical Contractor has provided all the field power wiring, the Mechanical Contractor shall inspect the installation. The AHU Manufacture shall then perform startup of the equipment.
- B. Engage a factory-authorized service representative to perform startup service.

3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-handling units.

END OF SECTION 237343

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SECTION 237416.11 - PACKAGED, ROOFTOP AIR-CONDITIONING UNITS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes packaged, rooftop air-conditioning units (RTUs) and energy recovery units (ERUs) with the following components:
 - 1. Casings.
 - 2. Fans, drives, and motors.
 - 3. Coils.
 - 4. Refrigerant circuit components.
 - 5. Heat wheels.
 - 6. Air filtration.
 - 7. Dampers.
 - 8. Electrical power connections.
 - 9. Controls.
 - 10. Roof curbs.
 - 11. Accessories.

1.2 DEFINITIONS

- A. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, rooftop air-conditioning units and Energy Recovery Units (RTUs that incorporate energy recovery devices). This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.

1.3 ACTION SUBMITTALS

- A. Product Data: For each RTU.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
 - 2. Include rated capacities, dimensions, required clearances, characteristics, and furnished specialties and accessories.
 - 3. Include unit dimensions and weight.
 - 4. Include cabinet material, metal thickness, finishes, insulation, and accessories.
 - 5. Fans:

- a. Include certified fan-performance curves with system operating conditions indicated.
 - b. Include certified fan-sound power ratings.
 - c. Include fan construction and accessories.
 - d. Include motor ratings, electrical characteristics, and motor accessories.
6. Include certified coil-performance ratings with system operating conditions indicated.
7. Include filters with performance characteristics.
8. Include dampers, including housings, linkages, and operators.
- B. Shop Drawings: For each packaged, small-capacity, rooftop air-conditioning unit.
 1. Include plans, elevations, sections, and mounting details.
 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 3. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans and other details, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.
- B. Sample Warranty: For manufacturer's warranty.
- C. System startup reports.
- D. Field quality-control reports.
- E. UL certification for A2I Refrigerant Safeties.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For RTUs 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 of filters for each unit.

2. Gaskets: One set for each access door.
3. Fan Belts: One set for each belt-driven fan.

1.7 WARRANTY

- A. Warranty: Manufacturer agrees to repair or replace components of outdoor, semi-custom, air-handling unit that fail in materials or workmanship within specified warranty period.
 1. Warranty Period: 3 years from date of Substantial Completion.
 2. Warranty Period for Heat Exchangers: Manufacturer's standard, but not less than 10 years from date of Substantial Completion
 3. Warranty Period for Compressors: 5 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of RTUs and components.
- C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- D. ASHRAE 15 Compliance: For refrigeration system safety.
- E. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- F. UL Compliance: Comply with UL 1995.

2.2 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. AAON.
 2. Daikin Applied.
 3. Trane.

2.3 UNIT CASINGS

- 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. Double-Wall Construction:
 - 1. Outside Casing Wall: Galvanized steel, minimum 18 gauge thick with manufacturer's standard finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.
 - 2. Inside Casing Wall: G90-coated galvanized steel, 0.034 inch thick.
 - 3. Floor Plate: G90 galvanized steel, minimum 18 gauge thick.
 - 4. Casing Insulation:
 - a. Materials: Injected polyurethane foam insulation.
 - b. Casing Panel R-Value: Minimum 13
 - c. Insulation Thickness: 2 inch.
 - d. Thermal Break: Provide continuity of insulation with no through-casing metal in casing walls, floors, or roof of unit.
- C. Airstream Surfaces: Surfaces in contact with airstream shall comply with requirements in ASHRAE 62.1.
- D. Static-Pressure Classifications:
 - 1. For Unit Sections Upstream of Fans: Minus 3-inch wg.
 - 2. For Unit Sections Downstream and Including Fans: 4-inch wg.
- E. Panels and Doors:
 - 1. Panels:
 - a. Fabrication: Formed and reinforced with same materials and insulation thickness as casing.
 - b. Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels to be opened against air-pressure differential.
 - c. Gasket: Neoprene, applied around entire perimeters of panel frames.
 - d. Size: Large enough to allow inspection and maintenance of air-handling unit's internal components.
 - 2. 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. Size: Large enough to allow inspection and maintenance of air-handling unit's internal components.
 3. Locations and Applications:
 - a. Fan Section: Doors and inspection and access panels.
 - b. Access Section: Doors.
 - c. Coil Section: Inspection and access panels.
 - d. Damper Section: Doors.
 - e. Filter Section: Doors large enough to allow periodic removal and installation of filters.
 - f. Mixing Section: Doors.
- F. Condensate Drain Pans:
 1. Location: Each type of cooling coil rotary heat exchanger.
 2. Construction:
 - a. Single-wall, stainless steel sheet.
 3. Drain Connection:
 - a. Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on both ends of pan.
 - b. Minimum Connection Size: NPS 1.
 4. Slope: Minimum 0.125-in./ft. slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and from humidifiers and to direct water toward drain connection.
 5. Length: Extend drain pan downstream from leaving face for distance to comply with ASHRAE 62.1.
 6. Width: Entire width of water producing device.
 7. Depth: A minimum of 2 inches deep.
 8. Pan-Top Surface Coating for Galvanized-Steel Drain Pans: Asphaltic waterproofing compound.
 9. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

2.4 FANS, DRIVES, AND MOTORS

- A. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.
- B. Supply-Air Fans: Centrifugal, rated according to AMCA 210; galvanized or painted steel; mounted on solid-steel shaft.
 - 1. Shafts: With field-adjustable alignment.
 - a. Turned, ground, and polished hot-rolled steel with keyway.
 - 2. Shaft Bearings:
 - a. Heavy-duty, self-aligning, pillow-block type with an L-50 rated life of minimum 100,000 hours according to ABMA 9.
 - b. Shaft grounding ring factory installed.
 - 3. Housings: Formed- and reinforced-steel panels to form curved scroll housings with shaped cutoff and spun-metal inlet bell.
 - a. Bracing: Steel angle or channel supports for mounting and supporting fan scroll, wheel, motor, and accessories.
 - 4. Centrifugal Fan Wheels: Inlet flange, backplate, and shallow blades with inlet and tip curved forward in direction of airflow and mechanically fastened to flange and backplate; steel or aluminum hub swaged to backplate and fastened to shaft with setscrews.
 - 5. Mounting: For internal vibration isolation. Factory-mount fans with manufacturer's standard vibration isolation mounting devices having a minimum static deflection of 1 inch.
 - 6. Shaft Lubrication Lines: Extended to a location outside the casing.
 - 7. Flexible Connector: Factory fabricated with a fabric strip minimum 3-1/2 inches wide, attached to two strips of minimum 2-3/4-inch-wide by 0.028-inch- thick, galvanized-steel sheet.
 - a. Flexible Connector Fabric: Glass fabric, double coated with neoprene. Fabrics, coatings, and adhesives shall comply with UL 181, Class 1.
- C. Drives, Direct: Factory-mounted, direct drive.
- D. Condenser-Coil Fan: Variable-speed propeller, mounted on shaft of permanently lubricated multispeed ECM motors.

- E. Relief-Air Fan: Forward curved or Backward inclined, shaft mounted on variable speed ECM motors with shaft grounding ring factory installed.

2.5 COILS

A. General Requirements for Coils:

1. Comply with AHRI 410.
2. Fabricate coils section to allow for removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).
3. Coils shall not act as structural component of unit.

B. Supply-Air Refrigerant Coil:

1. Tubes: Copper.
2. Fins: Aluminum Plate
3. Fin and Tube Joints: Mechanical bond.
4. Headers: Seamless-copper headers with brazed connections.
5. Frames: Galvanized steel.
6. Coatings: None.
7. Ratings: Designed, tested, and rated according to ASHRAE 33 and AHRI 410.
 - a. Working Pressure: Minimum 300 psig.

C. Outdoor-Air Refrigerant Coil:

1. Tubes: Copper.
2. Fins: Aluminum Plate
3. Fin and Tube Joints: Mechanical bond.
4. Headers: Seamless-copper headers with brazed connections.
5. Frames: Galvanized steel.
6. Coatings: None.
7. Ratings: Designed, tested, and rated according to ASHRAE 33 and AHRI 410.
 - a. Working Pressure: Minimum 300 psig.

D. Hot-Gas Reheat Refrigerant Coil:

1. Tubes: Copper.
2. Fins: Aluminum Plate
3. Fin and Tube Joints: Mechanical bond.
4. Headers: Seamless-copper headers with brazed connections.
5. Frames: Galvanized steel.
6. Coatings: None.

7. Ratings: Designed, tested, and rated according to ASHRAE 33 and AHRI 410.
 - a. Working Pressure: Minimum 300 psig.
 8. Suction-discharge bypass valve.
- E. Hydronic heating coil:
1. Tubes: Copper.
 2. Fins: Aluminum Plate
 3. Fin and Tube Joints: Mechanical bond.
 4. Headers: Seamless-copper headers with brazed connections.
 5. Frames: Galvanized steel.
 6. Coatings: None.
 7. Ratings: Designed, tested, and rated according to ASHRAE 33 and AHRI 410.

2.6 REFRIGERANT CIRCUIT COMPONENTS

- A. Compressor: Hermetic, variable capacity scroll, mounted on vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief, and crankcase heater.
- B. Refrigeration Specialties:
1. Refrigerant: R-454B.
 2. Expansion valve with replaceable thermostatic element.
 3. Refrigerant filter/dryer.
 4. Manual-reset high-pressure safety switch.
 5. Automatic-reset low-pressure safety switch.
 6. Minimum off-time relay.
 7. Automatic-reset compressor motor thermal overload.
 8. Liquid line sight glass.
 9. Hot-gas reheat solenoid valve modulating with a replaceable magnetic coil.
 10. Hot-gas bypass solenoid valve with a replaceable magnetic coil.
 11. Four-way reversing valve with a replaceable magnetic coil, thermostatic expansion valves with bypass check valves, and a suction line accumulator.
- C. Refrigeration only controller.
1. DDC controller capable of running all components associated with the refrigerant circuit.

2.7 AIR FILTRATION

A. Panel Filters:

1. Description: Flat, non-pleated factory-fabricated, self-supported, disposable air filters with holding frames.
2. Filter Unit Class: UL 900.
3. Media: Interlaced glass, synthetic or cotton fibers coated with nonflammable adhesive and antimicrobial coating.
4. Filter-Media Frame: Beverage board with perforated metal retainer, or metal grid, on outlet side.
5. Pre-filter Rating: 2 Inch Merv 8
6. Post-filter Rating: 4 Inch Merv 13

2.8 DAMPERS

- A. Outdoor- -Air Dampers: Low-leakage, double-skin, airfoil-blade, galvanized-steel dampers with compressible jamb seals and extruded-vinyl blade edge seals with zinc-plated steel operating rods rotating in sintered bronze or nylon bearings mounted in a single galvanized-steel frame, and with operating rods connected with a common linkage. Leakage rate shall not exceed 4 cfm/sq. ft. at 1-inch wg and 8 cfm/sq. ft. at 4-inch wg.
- B. Barometric relief dampers.

2.9 ELECTRICAL POWER CONNECTIONS

- A. RTU shall have a single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection.

2.10 HEAT WHEELS

A. Casing:

1. Galvanized steel, stainless steel, or aluminum with standard factory finish.
2. Casing seals on periphery of rotor and on duct divider.
3. Support vertical rotors on grease-lubricated ball bearings having extended grease fittings or permanently lubricated bearings with an L-10 400,000 hours. Support horizontal rotors on tapered roller bearing.

- B. Rotor: Aluminum or polymer segmented wheel strengthened with radial spokes, with nontoxic, noncorrosive, silica-gel desiccant coating.
- C. Drive: Fractional horsepower motor and gear reducer, and self-adjusting multilink belt around outside of rotor.
 - 1. 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."
- D. 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.

2.11 ROOF CURBS

- A. 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 C1071, Type I or II.
 - b. Thickness: 2 inches.
 - 2. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.
 - a. Curb insulation is to be acoustic treatment.
 - b. Liner Adhesive: Comply with ASTM C916, Type I.
 - c. 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.
 - d. Liner materials applied in this location shall have airstream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.
 - e. Liner Adhesive: Comply with ASTM C916, Type I.
- B. Curb Dimensions: Height of 24 inches unless noted otherwise.

2.12 ACCESSORIES

- A. Safeties:
 - 1. Condensate overflow switch.

2. Phase-loss reversal protection.
3. High and low pressure control.
4. Outdoor-air intake weather hood.

2.13 MATERIALS

A. Steel:

1. ASTM A36/A36M for carbon structural steel.
2. ASTM A568/A568M for steel sheet.

B. Stainless Steel:

1. Manufacturer's standard grade for casing.
2. Manufacturer's standard type, ASTM A240/A240M for bare steel exposed to airstream or moisture.

C. Galvanized Steel: ASTM A653/A653M.

D. Aluminum: ASTM B209.

E. Corrosion-Resistant Coating: Coat with a corrosion-resistant coating capable of withstanding a 3000-hour salt-spray test according to ASTM B117.

1. Standards:
 - a. ASTM B117 for salt spray.
 - b. ASTM D2794 for minimum impact resistance of 100 in-lb.
 - c. ASTM B3359 for cross-hatch adhesion of 5B.
2. Application: Spray.
3. Thickness: 1 mil.
4. Gloss: Minimum gloss of 60 on a 60-degree meter.

2.14 SOURCE QUALITY CONTROL

A. AHRI Compliance:

1. Comply with AHRI 210/240 for testing and rating energy efficiencies for RTUs.
2. Comply with AHRI 340/360 for testing and rating energy efficiencies for RTUs.
3. Comply with AHRI 270 for testing and rating sound performance for RTUs.
4. Comply with AHRI 1060 for testing and rating performance for air-to-air exchanger.

B. AMCA Compliance:

1. Comply with AMCA 11 and bear the AMCA-Certified Ratings Seal for air and sound performance according to AMCA 211 and AMCA 311.
2. Damper leakage tested according to AMCA 500-D.
3. Operating Limits: Classify according to AMCA 99.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of 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.

3.2 INSTALLATION

- A. Unit Support: Install unit level on structural curbs. Coordinate wall penetrations and flashing with wall construction. Secure RTUs to structural support with anchor bolts.

3.3 PIPING CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to RTU, allow space for service and maintenance.
- C. Connect piping to unit mounted on vibration isolators with flexible connectors.
- D. Connect condensate drain pans using NPS 1-1/4, ASTM B88, Type M copper tubing. Extend to nearest equipment or roof drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.

3.4 DUCT CONNECTIONS

- A. Comply with duct installation requirements specified in other HVAC Sections. Drawings indicate 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 test and inspect components, assemblies, and equipment installations, including connections.
- B. 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.
- C. RTU will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.6 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Inspect for visible damage to unit casing.
 - 3. Inspect for visible damage to furnace combustion chamber.
 - 4. Inspect for visible damage to compressor, coils, and fans.
 - 5. Inspect internal insulation.

6. Verify that labels are clearly visible.
7. Verify that clearances have been provided for servicing.
8. Verify that controls are connected and operable.
9. Verify that filters are installed.
10. Clean condenser coil and inspect for construction debris.
11. Clean furnace flue and inspect for construction debris.
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. Calibrate thermostats.
21. Adjust and inspect high-temperature limits.
22. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
23. Start refrigeration system and measure and record the following when ambient is a minimum of 15 deg F above return-air temperature:
 - a. Coil leaving-air, dry- and wet-bulb temperatures.
 - b. Coil entering-air, dry- and wet-bulb temperatures.
 - c. Outdoor-air, dry-bulb temperature.
 - d. Outdoor-air-coil, discharge-air, dry-bulb temperature.
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 failure modes. Inspect the following:
 - a. Low-temperature safety operation.
 - b. Filter high-pressure differential alarm.
 - c. Economizer to minimum outdoor-air changeover.
 - d. Relief-air fan operation.
 - e. 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. After completing system installation and testing, adjusting, and balancing RTUs and air-distribution systems, clean RTUs internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.8 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. 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.
- C. RTU will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.9 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain RTUs.

END OF SECTION 237416.11

SECTION 238109 – BLOWER COIL UNITS

PART 1 - GENERAL

1.1 Scope of work:

- A. This Section includes indoor constant volume blower coil units including casing, coils, fan, filters, and accessories.

1.2 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Product Data for each type of product specified.

1.3 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Engage a firm experienced in manufacturing fan-coil units similar to those indicated for this Project and that have a record of successful in-service performance.
- B. Comply with ARI 440 for testing and rating units.
- C. Comply with ASHRAE 33 for testing air coils.
- D. Comply with NFPA 70 for components and installation.
- E. Listing and Labeling: Provide products specified in this Section that are listed and labeled.
 - 1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

1.4 EXTRA MATERIALS

- A. Furnish one additional complete set of air filters for each air handling unit.
- B. Furnish one additional complete set of belts for each belt driven air handling unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the Work include, but are not limited to, the following:
 - 1. Magic Aire
 - 2. Carrier Air Conditioning.
 - 3. The Trane Co.
 - 4. York International Corp

2.2 GENERAL

- A. Chassis: Galvanized steel with flanged edges.
- B. Insulation: Faced, heavy-density, ¾" foil face, 1.5# glass-fiber insulation over entire unit.
- C. Drain Pans: Galvanized steel, with connection for drain. Drain pan insulated with polystyrene or polyurethane insulation.
- D. Cabinet: Galvanized steel with removable panels.
- E. Filters: 2" pleated 30% filters. Filter rack shall be sized for less than 500 FPM at nominal airflow, provide with access doors on both sides of cabinet.

2.3 WATER COILS

- A. Fin tube coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch , leak test to 450 psig underwater. Maximum operating conditions are 200psig, 200 Deg. F.

2.4 MIXING BOX

- A. Constructed of heavy gauge galvanized steel with two low-leak parallel blade dampers that are factory linked together. A ½" extendible drive rod for actuator connection, either internally or externally. Damper blades are extruded aluminum having interlocked PVC extruded edge seals. Damper frame seals shall be PVC extruded forms interlocked to the damper frame and provided with a continuous edge seal to the blades. Damper seals rated stable for temperature range of -50°F to 230°F. Two side access panels as standard to provide access to the unit's internal components

2.5 FAN

- A. Centrifugal fan, with forward-curved, with heavy-duty adjustable speed v-belt drive. Fan shaft shall be supported by heavy-duty permanently sealed ball bearings. Fan shall be statically and dynamically balanced.

2.6 MOTORS

- A. Torque Characteristics: Sufficient to accelerate the driven loads satisfactorily.
- B. Motor Sizes: Minimum size as indicated. If not indicated, large enough so that the driven load will not require the motor to operate in the service factor range.
- C. Temperature Rating: 50°C maximum temperature rise at 40°C ambient for continuous duty at full load (Class A Insulation).
- D. Service Factor: 1.15 for polyphase motors and 1.35 for single-phase motors.
- E. Motor Construction: 50/60 Hertz, variable speed, multiple voltage brushless, electronically commutated motor with a plus or minus 10 percent voltage utilization range. Open type with permanently sealed ball bearings, internal overload protection, and size 48 frame belly band design. The motor is factory installed, programmed, and wired to the air handler control panel.
- F. Motor controller: On board ECM engine controller to automatically control motor speed based on analog input. Seven segment data display.

2.7 On board microprocessor based controller

- A. BACnet® MS/TP control designed to provide control of the blower coil designed to be used part of another BACnet MS/TP Building Automation System and capable to function as a completely standalone controller in situations where a building automation system (BAS) is not present.

2.8 Condensate Overflow Detection

- A. A float switch factory-installed in the drain pan shall detect a high condensate water level. When the float switch rises, the normally-closed input opens a corresponding set of binary input terminals. This also causes the fan to disable, and the control valve and fresh air damper options to close. Manually reset controller.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances, support posts, and other conditions affecting performance of blower coil units.
- B. Examine rough-in for piping and electrical to verify actual locations of connections prior to installation.
- C. Do not proceed until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install blower coil units level and plumb, in accordance manufacturer's written instructions.
- B. Provide neoprene and spring vibration isolation hangers for suspended units.
- C. Arrange installation of units to provide access space around blower coil units for service and maintenance. Refer to manufacturers installation instructions.

3.3 CONNECTIONS

- A. The following are specific connection requirements:
 - 1. Arrange piping installations adjacent to units to allow unit servicing and maintenance.
 - 2. Connection piping to blower coil units with flexible connectors.
 - 3. Connect heating hot water piping including ball valve shutoffs at each branch, 2-way control valve and calibrated balance valve on return piping, manual air vents at all high points and drain valves with caps at low points.

END OF SECTION 238109

SECTION 238132 – DUCTLESS SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes ductless split-system air-conditioning units consisting of separate evaporator-fan and compressor-condenser components.

1.2 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.

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Warranty: Sample of special warranty.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. The units shall be tested by a Nationally Recognized Testing Laboratory (NRTL) and shall bear the ETL label.
- B. All wiring shall be in accordance with the National Electrical Code (NEC).
- C. The units shall be rated in accordance with Air-conditioning Refrigeration Institute's (AHRI) Standard 210 and bear the ARI Certification label.
- D. A dry air holding charge shall be provided in the indoor section.
- E. The outdoor unit shall be pre-charged with R-410a refrigerant for 70 feet of refrigerant tubing.
- F. System efficiency shall meet or exceed 20 SEER2.

1.6 COORDINATION

- A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.7 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: Seven years from date of Substantial Completion.
 - b. For Parts: Five years from date of Substantial Completion.
 - c. For Labor: One 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. Hitachi.
 - 2. Mitsubishi.
 - 3. Daikin
 - 4. Samsung
 - 5. Carrier.

2.2 INDOOR UNIT

- A. Unit Cabinet:
 - 1. The indoor unit shall be mounted to a separate back plate, which shall be included with the unit.
 - 2. The front panel shall be removable for access to wiring and internal components.
 - 3. The unit shall support multi-directional refrigerant piping.
 - 4. The unit shall support multi-directional drain piping.
 - 5. The cabinet shall include an integrated infrared sensor to receive commands from the wireless remote controller.

6. The Wall mounted unit shall include the following factory-installed safety and control features:
 - a. Control Circuit Fuse Capacitor
 - b. Freeze Protection Thermostat
 - c. Thermostat Differential Control
- B. Fan: Direct drive, centrifugal.
- C. .Filter: Washable type.
- D. Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.
- E. 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. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
 - d. Mount unit-mounted disconnect switches on interior of the unit.

2.3 OUTDOOR UNITS:

- 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.
- B. Cabinet: galvanized steel and finished with a baked enamel coating. The cabinet shall include removable service panels to provide access to all major components for maintenance and servicing.
- C. Coil:
 1. A condensate base pan with built in heater and a drain connection shall be located beneath the coil to manage water runoff during defrost cycles.

2. The outdoor coil shall be constructed using a multi-pass cross-finned tube configuration, with aluminum fins and copper tubing.
3. The coil shall be protected by a pre-coated metal guard to prevent physical damage and extend service life.

D. Refrigerant: R32

E. Compressor:

1. Each outdoor unit shall include a digitally controlled, inverter-driven rotary, and best in class R32 compressor.
2. The compressor shall modulate its speed to match the exact room load conditions, improving energy efficiency and reducing operating costs while improving service life of the compressor.
3. Compressors shall be factory-mounted with rubber grommets to minimize vibration transmission and ensure long-term reliability.
4. The compressor shall feature low torque fluctuation, low vibration, and a wide rotational speed range.
5. Compressor capacity shall be automatically modulated by varying refrigerant flow to meet real-time heating or cooling demands.
6. Unit shall be equipped with electric belt heaters around the compressor and wrapped internally with insulation for cold climate operation.

F. Fan:

1. The condensing unit shall be equipped with Direct Drive Propeller Fan(s) for energy-efficiency and quiet operation. Single for will be equipped for small cabinet, Dual Fan for Large Cabinet.
2. A steel wire air outlet fan guard grill shall be provided to ensure personnel safety and prevent contact with moving parts while still allowing for maximum airflow.
3. The fan shall be configured for horizontal discharge airflow, drawing air from the rear of the unit and discharging it through the front, with the fan located in front of the condensing coil. Motor: Permanently lubricated, with integral thermal-overload protection.

G. Accessories: Front wind baffle, side wind baffle, and rear wind baffle.

H. The unit shall support low ambient cooling operation down to -40°F (-18°C).

- I. The unit shall support low ambient heating operations down to -13°F (-25°C).
- J. The unit shall support no ambient temperature cut-off.
- K. The system shall include a base pan heater installed on the outdoor unit chassis to prevent ice buildup and enhance heating capacity in low ambient conditions.
- L. Stop valve built with 4-directional outlet piping for easier pipe installation. The refrigerant pipes shall connect the stop valves from the front and right, rear and bottom of the unit.

2.4 CONTROL:

- A. The Wall mounted unit shall be supplied with a wireless handheld controller.
- B. The indoor circuit board shall process and receive sensor data, including coil temperature, return air temperature, and setpoint commands from the remote control to effectively communicate demand to the outdoor unit for proper load control.
- C. Units shall have optional wired remote control allowing for provide on/off control, temperature setpoint adjustment, louver controls, fan speed selections, mode settings, function settings, and service settings.

2.5 ACCESSORIES

- A. Mini Condensate Pump: Power connection from unit.
- B. 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.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install units level and plumb.
- B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
- C. Install ground-mounted, compressor-condenser components on polyethylene mounting base.
- D. Install roof-mounted, compressor-condenser components on equipment supports. Anchor units to supports with removable, cadmium-plated fasteners.

- E. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
 - 1. 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.

3.3 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.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 238132

SECTION 238132 - DUCTLESS SPLIT HHEAT PUMP

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes ductless split-system air-conditioning units consisting of separate evaporator-fan and compressor-condenser components.

1.2 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.

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Warranty: Sample of special warranty.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. The units shall be tested by a Nationally Recognized Testing Laboratory (NRTL) and shall bear the ETL label.
- B. All wiring shall be in accordance with the National Electrical Code (NEC).
- C. The units shall be rated in accordance with Air-conditioning Refrigeration Institute's (AHRI) Standard 210 and bear the ARI Certification label.
- D. A dry air holding charge shall be provided in the indoor section.
- E. System efficiency shall meet or exceed 13.0 EER2 and COP 3.8.

1.6 COORDINATION

- A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.7 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: Seven year(s) from date of Substantial Completion.
- b. For Parts: Five year(s) from date of Substantial Completion.
- c. For Labor: One 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. Hitachi
- 2. Carrier Corporation; Home Comfort and HVAC Building & Industrial Systems.
- 3. Mitsubishi Electric & Electronics USA, Inc.; HVAC Advanced Products Division.
- 4. SANYO North America Corporation; SANYO Fisher Company.

2.2 INDOOR UNIT

- A. Unit Cabinet:

- 1. The indoor unit cabinet shall be wall mounted by means of a factory supplied mounting plate, The cabinet shall be formed from high strength molded plastic with front panel access for filter. Cabinet color shall be white.

2. The indoor unit shall be factory assembled, wired and tested. Contained within the unit shall be all factory wiring and internal piping, control circuit board and fan motor.
 3. The unit in conjunction with the wired, wall mounted controller shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, and a test run switch. Indoor unit and refrigerant pipes shall be purged with dry nitrogen before shipment from the factory.
- B. Fan: The evaporator fan shall be high performance, double inlet, forward curve, direct drive two speed fan. Fans shall be statically and dynamically balanced and run on a motor with permanently lubricated bearings.
- C. Vane: There shall be a motorized horizontal vane to automatically direct air flow in a horizontal and downward direction for uniform air distribution. The horizontal vane shall significantly decrease downward air resistance for lower noise levels, and shall close the outlet port when operation is stopped. There shall also be a set of vertical vanes to provide horizontal swing airflow movement selected by remote control.
- D. Filter: Washable type.
- E. Coil: Aluminum fins on copper tubing. Coils shall be pressure tested at the factory. A condensate pan and drain shall be provided under the coil.
- F. Electrical: Voltage as scheduled. Power supplied from outdoor unit. The power to the indoor unit shall be supplied from the outdoor unit, using a three (3) conductor AWG-14 wire with ground to provide power feed and bi-directional control transmission between the outdoor and indoor units.
- G. Controls:
1. The control system shall consist of two (2) microprocessors, one on each indoor and outdoor unit. Field wiring shall run directly from the indoor unit interconnected by a single non-polar two-wire AWG-16 stranded cable to the wall mounted controller with no splices. The control system between the outdoor unit and indoor unit shall be supplied from the outdoor unit
 2. The system shall be capable of automatic restart when power is restored after power interruption. The system shall have self-diagnostics ability, including total hours of compressor run time. Diagnostics codes for indoor and outdoor units shall be displayed on the wired controller panel.

3. The microprocessor located in the indoor unit shall have the capability of monitoring return air temperature and indoor coil temperature, receiving and processing commands from the wired controller, providing emergency operation and controlling the outdoor unit.
4. The indoor unit shall be connected to a wall mounted wired controller to perform input functions necessary to operate the system. The wired controller shall have a large multi-language DOT liquid crystal display (LCD) presenting contents in eight (8) different languages, including English, French, Chinese, German, Japanese, Spanish, Russian, and Italian. There shall be a built-in weekly timer with up to eight pattern settings per day. The controller shall consist of an On/Off button, Increase/Decrease Set Temperature buttons, a Cool/Dry/Fan mode selector, a Timer Menu button, a Timer On/Off button, Set Time buttons, a Fan Speed selector, a Vane Position selector, a Louver Swing button, a Ventilation button, a Test Run button, and a Check Mode button. The controller shall have a built-in temperature sensor. Temperature shall be displayed in either Fahrenheit (°F) or Celsius (°C). Temperature changes shall be by increments of 1°F (1°C) with a range of 67°F to 87°F (19°C to 30°C).
5. The wired controller shall display operating conditions such as set temperature, room temperature, pipe temperatures (i.e. liquid, discharge, indoor and outdoor), compressor operating conditions (including running current, frequency, input voltage, On/Off status and operating time), LEV opening pulses, sub cooling and discharge super heat.

2.3 OUTDOOR UNITS:

- A. The outdoor unit shall be capable of operating at -13°F ambient temperature without additional low ambient controls (optional wind baffle may be required).
- B. The outdoor unit shall be able to operate with a maximum height difference of 100 feet (30 meters) indoor unit to outdoor unit,
- C. Cabinet
 1. The casing shall be constructed from galvanized steel plate, coated with a finished with an electrostatically applied, thermally fused acrylic or polyester powder coating for corrosion protection and have a munsell 3Y 7.8/1.1 finish. The fan grille shall be of ABS plastic.

D. Coil

1. The L shaped condenser coil shall be of copper tubing with flat aluminum fins to reduce debris build up. The coil shall be protected with an integral metal guard. Refrigerant flow from the condenser shall be controlled by means of linear expansion valve (LEV) metering orifice. The LEV shall be control by a microprocessor controlled step motor.

E. Compressor

1. The compressor for models PUY-A12NHA, PUY-A18NHA, PUY-A24NHA, PUY-A30NHA and PUY-A36NHA shall be a DC rotary compressor with Variable Compressor Speed Inverter Technology. The compressor shall be driven by inverter circuit to control compressor speed. The compressor speed shall dynamically vary to match the room load for significantly increasing the efficiency of the system which results in vast energy savings. To prevent liquid from accumulating in the compressor during the off cycle, a minimal amount of current shall be intermittently applied to the compressor motor to maintain enough heat. The outdoor unit shall have an accumulator and high pressure safety switch. The compressor shall be mounted to avoid the transmission of vibration.

F. Electrical

1. The electrical power of the unit shall be 208volts or 230 volts, 1 phase, 60 hertz. The unit shall be capable of satisfactory operation within voltage limits of 198 volts to 253 volts. The outdoor unit shall be controlled by the microprocessor located in the indoor unit.
2. The control signal between the indoor unit and the outdoor unit shall be pulse signal 24 volts DC. The unit shall have Pulse Amplitude Modulation circuit to utilize 98% of input power supply.

2.4 ACCESSORIES

- A. Mini Condensate Pump: Power connection from unit.
- B. 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.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install units level and plumb.
- B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
- C. Install ground-mounted, compressor-condenser components on polyethylene mounting base.
- D. Install roof-mounted, compressor-condenser components on equipment supports specified in Section 077200 "Roof Accessories." Anchor units to supports with removable, cadmium-plated fasteners.
- E. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
 - 1. 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.

3.3 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.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 238132

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SECTION 238214 – CHILLED BEAMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Active chilled beam units specified herein per the lengths and quantities indicated on the Drawings and Schedules.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Plans, elevations, sections, mounting and attachment details.
2. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
3. Room Equipment Layout Schedule: Indicate Drawing designation, room designation, full equipment layout detail within room including: quantity, model number, size, and accessories furnished.
4. Finishes – as needed.

C. Product Schedule: For active chilled beam units.

1.3 REFERENCE STANDARDS

- A. AHRI Standard 410 – Standard for Forced-Circulation Air-Cooling and Air-Heating Coils
- B. AHRI 1240-2017- Performance Rating of Active Chilled Beams.
- C. ASHRAE Standard 55 – Thermal Environmental Conditions for Human Occupancy
- D. ASHRAE Standard 62.1 – Ventilation for Acceptable Indoor Air Quality
- E. ASHRAE Standard 70 – Method of Testing the Performance of Air Outlets and Air Inlets
- F. ASHRAE Standard 90.1 – Energy Standard for Buildings Except Low-Rise Residential Buildings
- G. ASHRAE Standard 90.2 – Energy-Efficient Design of Low-Rise Residential Buildings
- H. ASHRAE 200-2018 - Methods of Testing Chilled Beams
- I. ASTM Standard 653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process

- J. ASTM Standard D610 – Standard Practice for Evaluating Degree of Rusting on Painted Steel Surfaces
- K. ASTM Standard D714 – Standard Test Method for Evaluating Degree of Blistering of Paints
- L. ASTM Standard D1308 – Standard Test Method for Effect of Household Chemicals on Clear and Pigmented Organic Finishes
- M. ASTM Standard D1654 – Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
- N. ASTM Standard D4752 – Standard Practice for Measuring MEK Resistance of Ethyl Silicate (Inorganic) Zinc-Rich Primers by Solvent Rub
- O. NFPA 70- National Electric Code
- P. ASTM C 534 / ASTM C 1427 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
- Q. ASTM C 1534 - Standard Specification for Flexible Polymeric Foam Sheet Insulation Used as a Thermal and Sound Absorbing Liner for Duct Systems
- R. ASTM D 1056, 2C1 - Standard Specification for cellular materials, both Sponge (Open Cell) and Expanded (Closed Cell)
- S. ASTM E 84, UL723 - Standard Test Method for Surface Burning Characteristics of Building Materials
- T. ASTM G21/C1338 - Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings
- U. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems
- V. NFPA 90B - NFPA 90A, 90B - Standard for the Installation of Air-Conditioning and Ventilating Systems
- W. UL 181 - Standard for Safety Factory-Made Air Ducts and Air Connectors
- X. UL 94 5VA - Classification and Flame-Retardant Thermoplastics
- Y. Division 23 – Heating, Ventilation and Air Conditioning (HVAC)

1.4 INFORMATIONAL SUBMITTALS

- A. Mechanical Data:
 - 1. Coil piping selection
 - 2. Induction selection
 - 3. Coil finish selection
 - 4. Hanging selection
 - 5. Inlet size selection
 - 6. Face grille selection
 - 7. Paint color selection
 - 8. Insulation requirements

- 9. Plenum finish and hanging bracket selection
- B. Data Sheet Performance Information:
 - 1. Cooling and heating performance
 - 2. Primary air, induced air and supply air CFMs
 - 3. Airside pressure drops
 - 4. Water flow rates – Cooling and Heating
 - 5. Waterside pressure drops
 - 6. Supply air temperatures
 - 7. Sound levels
- C. IOM Data
 - 1. Unit weights and dimensions
 - 2. Ceiling assembly and mounting bracket details
 - 3. Border detail for ceiling suspension integration
 - 4. Manufacturers recommendations for installation
- 1.5 QUALITY ASSURANCE / CONTROL
 - A. Product Options: Drawings indicating size, profiles, and dimensional requirements of active beam units and are based on the specific system indicated.
 - 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. Active chilled beams and accessories shall be rated and tested for pressure as shown on the Drawings.
 - D. Identification: Label each Induction Unit with the appropriate tagging identifier.
- 1.6 WARRANTY
 - A. Manufacturer shall provide a parts-only warranty for a period of twelve (12) months from the initial startup-up, or eighteen (18) months from date of shipment, whichever occurs first.
 - B. Labor warranty shall be the responsibility of the Installing Contractor(s)
 - C. Products will be free from defects in material and manufacture. Installing contractor shall document products were installed in accordance with: 1) Manufacturer's installation guidelines, 2) Recommended Start-Up procedures, and 3) Recommended maintenance procedures.
 - D. Provide documented records indicating that Manufacturer's normal conditions for service have been maintained during stated warranty period.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Capacities and Characteristics:
 - 1. See Schedule and Notes on Plans

2.2 MANUFACTURERS

- A. Basis of Design: Carson Solutions Model CB-H24.
- B. Alternate Manufacturers: In order to attain prior approval as an alternate manufacturer, the manufacturer shall provide ALL following documents for consideration:
 - 1. Prior approval documentation from [Owner] [School District] and shall provide documentation of successful execution and operation for three (3) years for no less than five (5) separate projects.
 - 2. A detailed CAD drawing, Factory Performance Data must be submitted to the Engineer to be considered for Prior Approval. The manufacturer must also include a detailed Table of Conformance detailing acceptance or rejection of all specification sections.
- C. If Basis of Design Manufacturer is not provided, Contractor shall be responsible and bear all financial risks for all costs associated with the substitution of an alternative product including, but not limited to additional field labor, structural changes, and attenuation to meet project acoustical requirements. All consequential damages, project delays, and additional Engineering costs shall be borne by the Mechanical Contractor.

2.3 CONSTRUCTION

- A. Furnish and install CARSON SOLUTIONS CB-H24 series dual slot active chilled beams of sizes and capacities as indicated on the drawings and within the mechanical equipment schedules. The quantity and length of the beams shall be as shown in the drawings. The beams shall be constructed and delivered to the job site as single units.
- B. Casing to be manufactured from 20 GA G-60 galvanized sheet steel and 20 GA CRS sheet steel conforming to ASTM-653 standards. Casing shall house an integral hydronic coil and a primary air plenum delivering air to a series of induction nozzles. A single round primary air connection shall be mounted on either side or top of the unit as indicated in the Drawings. All sheet metal joints in the primary air plenum and air connection spigot shall be sealed airtight.
 - 1. Units with exposed border shall have the plenum painted to match the front face color selection.

- C. The face of the beam shall consist of a room air induction section of 51% free area perforated steel flanked by two linear supply slots. The entire visible face section shall be finished in WHITE powder coated paint or as specified by the architect. Maximum overall height shall not exceed nine (8.5) inches for inlet sizes 4", 5", and 6".
 - 1. If a non-standard 8" supply inlet is selected whereas the plenum height will be a maximum of 11 inches.
- D. Face panel shall be fully hinged to allow access to hydronic coil. The hinge face panel to be also reversible to allow the swing direction to be changed if necessary, by the installing contractor.
- E. Beams shall be provided with side and end details which will allow its integration into the applicable (nominal 24 inch wide) acoustical ceiling grid as specified by the architect.
 - 1. Tegral Border Style Casing
 - a. The manufacturer will provide an edge detail to allow the beam to sit flush with the face of the T-bar ceiling.
 - b. Tegral profiles of 9/16" and 15/16" shall be accommodated.
 - c. Exposed Mounted Border Style Casing shall include factory mounted Coanda plates to ensure horizontal discharge of the supply air with a nominal width of 36 inches.
- F. K-Factor Label and Air Pressure Commissioning Port: Beams shall be fitted with an uncapped air pressure tap for measuring the static pressure differential between the primary air plenum and the room. Air pressure port shall be accessible from the hinged face panel. Each active chilled beam shall be provided with an airflow calibration label affixed showing primary airflow rate for given nozzle configuration at varying plenum pressures.
- G. Hydronic Coil: Active Chilled Beams shall be provided with an integral hydronic coil providing cooling and heating performance as indicated on plans and schedules. The coils shall be mounted horizontally and shall be manufactured per the following details:
 - 1. Coils shall have a continuous aluminum plate fin surface, with seamless copper tubes mechanically expanded into aluminum fin collars for secure, crack-free bonding.
 - 2. Copper tube connections shall be 1/2" O.D. x 0.028" thick.
 - 3. Aluminum fins shall have a minimum fin thickness of 0.0055". [0.0075"/0.0095"] optional.
 - 4. Aluminum fin spacing shall not exceed 8 fins per inch.
 - 5. Coils shall be tested to a minimum of 360 psi and a max of 500 psi. air pressure under water.
 - 6. Coil normal operating pressure is rated at 250 psig max up to 300°F. The maximum working pressure should not exceed 360 psi.
 - 7. Manual air vents shall be located at each coil circuit high point.

8. Water drains shall be located at each coil circuit low point.
 9. Coils shall be circuited for [2 or 4 pipe] operation.
 10. Coil connections shall be ½" plain copper pipe or ½" NPT male threaded fittings.
 11. Coils shall be delivered cleaned and flushed.
 12. Coils to be AHRI 410 certified by coil manufacturer.
- H. The chilled water coil shall be provided with ½" NPT male threaded fittings where specified. These fittings must be suitable for field connection to a similar (½" NPT) female flexible hose spigot and shall be at least 1½" long to facilitate field connection (by others). Other fitting sizes and connections are available from factory.
- I. Stainless Steel Braided Hoses Kit Assemblies
- a. One end connection shall swivel to allow for equipment movement during operation.
 - b. ½" – 1" shall be made of CPE (Chlorinated Polyethylene).
 - c. 1¼" – 2" shall be made of EPDM (Ethylene Propylene Diene Monomer).
 - d. Maximum working pressures:
 - e. 500# WPSI Static (½" – 1")
 - f. 200# WPSI Static (1¼" – 2")
 - g. Maximum temperature rating: 212°F
- J. Provide 1/8" or ½" thick thermal insulation applied to the exterior of the primary air plenum to prevent condensation forming on the outside of the unit casing and the interior surfaces of the primary air chamber. Technical data sheet to be provided by request.
- K. Source Quality Control: Comply with ASHRAE 200, AHRI-410, and AHRI 1240
1. Coil capacity rated in accordance with AHRI 410-2000, Forced Circulation Air-Cooling & Air-Heating Coils
 2. Capacity performance and sound levels of induction coils (chilled beams) rated in accordance with ASHRAE 200-2018, Methods of Testing Chilled Beams
 3. Capacity and performance of active chilled beams coils shall be rated in accordance with AHRI 1240-2017, Performance Rating of Active Chilled Beams.
- 2.4 GENERAL PROTECTION REQUIREMENTS
- A. Protect finishes on exposed surfaces from damage by applying a removable, temporary protective covering at the factory before shipping.
- B. Protect coil and piping openings with removable end caps before shipping.
- C. Protect duct connection openings with removable end caps before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive displacement inductions units for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for duct, piping and wiring to verify actual locations of connections before installation.
- C. Proceed with installation only after unsatisfactory conditions have been field corrected.
- D. Ensure all units received have appropriate and individual tagging identifiers.
 - 1. Chilled Beam manufacturer must label each shipping package AND equipment, including accessories, with room by room tags, along with model numbers for ease of site coordination.

3.2 INSTALLATION

- A. Coordinate the size, tagging and capacity of the beams to their proper location.
- B. Install active chilled beam level and plumb in accordance with manufacturer's IOM documentation.
- C. Chilled beams up to five feet in length shall be independently suspended from the structure above by four (4) threaded rods of $\frac{3}{8}$ " diameter. For beams beyond six feet in length, six (6) threaded rods of $\frac{3}{8}$ " diameter shall be used. Wire rope is allowable as a substitute. Provide auxiliary support steel necessary to avoid obstructions above units.
- D. Install piping adjacent to beams to allow service and maintenance.
- E. Installing overhead beams according to Division 23 – Heating, Ventilation and Air Conditioning (HVAC) Section 23 05 29 "Hangers and Supports for HVAC Piping and Equipment".

3.3 PIPING CONNECTIONS

- A. Comply with requirements for piping specified in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.

- B. Comply with requirements for general duty valves specified in Section 230523.11 "Globe Valves for HVAC Piping," Section 230523.12 "Ball Valves for HVAC Piping," and Section 230523.15 "Gate Valves for HVAC Piping."
- C. Make piping connections to chilled beam units at locations indicated on Drawings.
- D. Verify any and all identification tags are visible.
- E. Verify control connections are complete to control valves as needed.
- F. Verify controls respond to inputs specified.

3.4 DUCT CONNECTIONS

- A. Comply with requirements for ductwork specified in Section 233113 "Metal Ducts." and Section 233346 "Flexible Ducts." Drawings indicate general arrangement of ductwork.
- B. Make ductwork connections to chilled beam units at locations indicated on Drawings.
- C. Where installing ductwork adjacent to chilled beams, allow space for service and maintenance.

3.5 ELECTRICAL CONNECTIONS

- A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

3.6 CONTROLS

- A. Comply with requirements for controls specified in Section 230923 "Direct Digital Control (DDC) System for HVAC and Section 230993.11 "Sequence of Operations for HVAC DDC."

3.7 IDENTIFICATION

- A. Identify hydronic piping and valves. Comply with requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

3.8 CLEANING AND PROTECTION

- A. Protect exposed surfaces of displacement induction units from damage with factory-installed protective covering. Maintain covering in place until start of unit testing and balancing.
- B. Protect chilled beam units' water connections with factory-installed protective covers and keep them covered until making final field piping connections.
- C. Clean chilled beam units inside and out to a factory-new condition.
- D. Reject damaged chilled beam units and replace them with new units.
- E. Only if acceptable to the Owner, minor damage to finishes may be repaired as required to restore the beams to factory-new appearance. Any variation in visual appearance between factory and repaired finish shall be rejected.

3.9 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections with the assistance of a factory authorized service representative.
- C. Tests and Inspections:
 - 1. Leak Test: After installation, fill the system with water under design pressure and test for leaks. Repair leaks and retest until no leaks exist.
- D. Chilled beam units will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, and route to Owner, Architect, Engineer, and Contractor.

3.10 ADJUSTING

- A. Occupancy Adjustments: When requested, within [12] months from date of Substantial Completion provide on-site assistance in adjusting system to suit actual occupied conditions.

3.11 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain displacement induction ventilation units.

END OF SECTION 238214

SECTION 23 82 15 – CABINET STYLE DISPLACEMENT VENTILATION UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Floor mounted, cabinet style, displacement induction ventilation unit and associated cabinet accessories as detailed on plan and schedule drawings.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Plans, elevations, sections, mounting and attachment details.
2. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
3. Room Equipment Layout Schedule: Indicate Drawing designation, room designation, full equipment layout detail within room including: quantity, model number, size, and accessories furnished.
4. Cabinet Finishes – as needed.

C. Product Schedule: For displacement induction ventilation units.

1.3 REFERENCE STANDARDS

- A. AHRI Standard 410 – Standard for Forced-Circulation Air-Cooling and Air-Heating Coils
- B. AHRI 1240-2017- Performance Rating of Active Chilled Beams.
- C. ASHRAE Standard 55 – Thermal Environmental Conditions for Human Occupancy
- D. ASHRAE Standard 62.1 – Ventilation for Acceptable Indoor Air Quality
- E. ASHRAE Standard 70 – Method of Testing the Performance of Air Outlets and Air Inlets
- F. ASHRAE Standard 90.1 – Energy Standard for Buildings Except Low-Rise Residential Buildings
- G. ASHRAE Standard 90.2 – Energy-Efficient Design of Low-Rise Residential Buildings
- H. ASHRAE 200-2018 - Methods of Testing Chilled Beams

- I. ASTM Standard 653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
- J. ASTM Standard D610 – Standard Practice for Evaluating Degree of Rusting on Painted Steel Surfaces
- K. ASTM Standard D714 – Standard Test Method for Evaluating Degree of Blistering of Paints
- L. ASTM Standard D1308 – Standard Test Method for Effect of Household Chemicals on Clear and Pigmented Organic Finishes
- M. ASTM Standard D1654 – Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
- N. ASTM Standard D4752 – Standard Practice for Measuring MEK Resistance of Ethyl Silicate (Inorganic) Zinc-Rich Primers by Solvent Rub
- O. NFPA 70- National Electric Code
- P. ASTM C 534 / ASTM C 1427 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form
- Q. ASTM C 1534 - Standard Specification for Flexible Polymeric Foam Sheet Insulation Used as a Thermal and Sound Absorbing Liner for Duct Systems
- R. ASTM D 1056, 2C1 - Standard Specification for cellular materials, both Sponge (Open Cell) and Expanded (Closed Cell)
- S. ASTM E 84, UL723 - Standard Test Method for Surface Burning Characteristics of Building Materials
- T. ASTM G21/C1338 - Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings
- U. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems
- V. NFPA 90B - NFPA 90A, 90B - Standard for the Installation of Air-Conditioning and Ventilating Systems
- W. UL 181 - Standard for Safety Factory-Made Air Ducts and Air Connectors
- X. UL 94 5VA - Classification and Flame-Retardant Thermoplastics
- Y. Division 23 – Heating, Ventilation and Air Conditioning (HVAC)

1.4 INFORMATIONAL SUBMITTALS

- A. Product Data: For each product indicated, include the following:
 - 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static pressure drop, and noise ratings.

2. Room Equipment Layout Schedule: Indicate Drawing designation, room designation, full equipment layout detail within room to include quantity, model number, size, and accessories furnished.

- B. Coordination Drawings: Floor plans, reflected ceiling plans, sections, and other details, or BIM model, drawn to scale, showing the items described in this Section and coordinated with all building trades.

1.5 QUALITY ASSURANCE / CONTROL

- J. 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.
- K. Identification: Label each induction displacement induction unit with the appropriate tagging identifier.

1.6 WARRANTY

- A. Manufacturer shall provide a parts-only warranty for a period of twelve (12) months from the initial startup-up, or eighteen (18) months from date of shipment, whichever occurs first.
- B. Labor warranty shall be the responsibility of the Installing Contractor(s)
- C. Products will be free from defects in material and manufacture. Installing contractor shall document products were installed in accordance with: 1) Manufacturer's installation guidelines, 2) Recommended Start-Up procedures, and 3) Recommended maintenance procedures.
- D. Provide documented records indicating that Manufacturer's normal conditions for service have been maintained during stated warranty period.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Capacities and Characteristics:
 1. See Schedule and Notes on Plans

2.2 MANUFACTURERS

- A. Basis of Design: Carson Solutions Model QLCI.

- B. Alternate Manufacturers: In order to attain prior approval as an alternate manufacturer, the manufacturer shall provide ALL following documents for consideration:
1. Prior approval documentation from [Owner] [School District] and shall provide documentation of successful execution and operation for three (3) years for no less than five (5) separate projects.
 2. A detailed CAD drawing, Factory Performance Data must be submitted to the Engineer to be considered for Prior Approval. The manufacturer must also include a detailed Table of Conformance detailing acceptance or rejection of all specification sections.
 3. Submit documentation of independent, third-party testing of equipment performance. Minimum requirements of the testing and documentation shall show validation of:
 - a. Documentation shall be provided to the Engineer prior to approval.
 - b. Lab verified values AND CFD modeling of Ventilation Effectiveness proving stratified conditions in ALL modes of cooling AND heating.
 - c. Lab verified values AND CFD modeling proving Thermal Comfort adherence to ASHRAE 55 limit of 5.4°F "from toes to nose."
 - d. Use of SF6 tracer gas in lab for clear measurement of contaminants shall be documented.
- C. If Basis of Design Manufacturer is not provided, Contractor shall be responsible and bear all financial risks for all costs associated with the substitution of an alternative product including, but not limited to additional field labor, structural changes, and attenuation to meet project acoustical requirements. All consequential damages, project delays, and additional Engineering costs shall be borne by the Mechanical Contractor.

2.3 CONSTRUCTION

- A. Basic Unit Description:
1. Assembly shall consist of a QLCI air conditioning terminal housed in an architecturally approved enclosure. All internal sheet metal components shall be galvanized to inhibit corrosion.
 2. Terminal shall consist of 6"Ø or 8"Ø duct connection(s), a series of injection nozzles, an integral heat transfer coil of 2 pipe circuiting and a perforated equalizing grid behind discharge louver to reduce velocity and noise.
 3. An integral sloped drain pan with fully welded seams shall be piped to remove any condensate that might collect on the coil during cooling operation.
 4. Primary air and water piping connections shall be configured to allow connection of up to three units in series.
 5. No integral fans, compressors or other components requiring a power supply shall be allowed within the terminal room equipment.

6. Displacement terminals must be able to handle 100% outside air temperatures of 50°F-55°F and provide supply air to the space so that the temperature gradient through the occupied space falls within the guidelines of ASHRAE Standard 55 Thermal Environmental Conditions for Human Occupancy.
 7. Displacement terminal units shall have a 3" high toe kick-plate to elevate the painted cabinet above the floor level. Maximum cabinet height to the top of the unit above the floor level shall not exceed 30".
 8. The heat transfer coil shall be easily removable from unit and fully accessible from the front panel for ease of cleaning.
 - a. Coils shall have a continuous aluminum plate fin surface, with seamless copper tubes mechanically expanded into aluminum fin collars for secure, crack-free bonding.
 - b. Copper tube connections shall be 1/2" O.D. x 0.028" thick.
 - c. Aluminum fins shall have a minimum fin thickness of 0.0055".
 - d. Aluminum fin spacing shall not exceed 8 fins per inch.
 - e. Coils shall be tested to a minimum of 360 psi and a max of 500 psi. air pressure under water.
 - f. Coil normal operating pressure is rated at 250 psig max up to 300°F. The maximum working pressure should not exceed 360 psi.
 - g. Manual air vents shall be located at each circuit high point.
 - h. Coils shall be circuited for 2 pipe operation.
 - i. Coils shall have integral drain fittings on each circuit low point.
 - j. Coil connections shall be 1/2" NPT male threaded fittings.
 - k. Coils shall be delivered cleaned and flushed.
 9. Drain pans shall be powder coated galvanized or stainless steel. Drain pans must be easily accessible for cleaning via removable front panel.
 - a. A 1/2" plastic drain fitting (1/2" OD) is terminated at roughly 2" below the drain pan.
- B. Cabinet Construction Details:
1. Cabinets shall be constructed of minimum 16-gauge A1008 CS Type B sheet steel and finished with powder coat paint in a standard color as selected by Architect.
 2. Finish shall be DuroCoat Sand Textured Powder Coating to hide small scratches and fingerprints.
 - a. Smooth (without textured finish), gloss-based paint finishes are NOT acceptable due to high-traffic fingerprint pickup.
 3. Construction shall be sufficient to allow maintenance personnel to stand on the cabinet without any deflection.
 4. Cabinet structure MUST have front panel center mullion, providing each cabinet unit with a minimum of FOUR SEPARATE front panels for rigidity and removal ease.
 - a. Diffusers with single face access panels will NOT be acceptable due to removal and reduced rigidity concerns.

5. Face panels shall be louvered pencil proof and at least 45 percent free area. Cabinet structure must have front panel center mullion for rigidity.
 6. Front louvers must be easy to remove and less than 42" for rigidity and mobility.
 - a. Front induction panels should be lockable with multiple cam locks to allow for easy access to the hydronic coil. Sheet metal screws are NOT an acceptable means for securing induction panel assembly or removal for routine maintenance.
 - b. The top surface of cabinet shall be flat and allow the entire surface to be used as a bookshelf or other useable storage.
 - c. The Cabinet shall have structural frame around louver opening to ensure structural strength when louver is removed.
 - d. Cabinet shall be rated to support a 250lb load without deflection.
 7. Supply Air Diffuser Plate: An angled perforated plate shall be mounted on the supply air discharge to promote even air distribution into room.
- C. Duct and Pipe Chase and Additional Enclosures
1. Architecturally approved cover with a finish that matches the cabinet for all required units to conceal all vertical ductwork and piping to the units. See plan for locations and field measure height requirements before release of order. Provide utility cabinet at the unit where the duct drops from the ceiling and connects to the units.
 2. Provide Basic filler sections between units and/or between walls, book shelves will not be permitted.
- D. Displacement Induction Operation Description:
1. Outside air at the primary airflow rate listed on the plans and schedules shall be conditioned and delivered displacement units at the scheduled supply air conditions.
 - a. This conditioned primary air shall be ducted to the lead connection(s) of a series of QLCI terminals.
 - b. Injection of this primary air through nozzles shall induce room air through an integral heat transfer coil and recondition return air prior to its mixing with the primary air.
 - c. The mixture (2/3 induced room air, 1/3 primary air) passes through an equalization plate and is discharged to the classroom at the scheduled outlet velocity to assure displacement ventilation during system operation.
 - d. Using primary (Outside) outside air to drive air out the top is not acceptable for this outside air cannot be counted as being introduced into the breathing zone per ASHRAE 62.1-2016. 20% more outside air must be provided for units that use primary air to drive vertical airflow outside breathing zone.
 - e. Performance Requirements to be maintained and delivered in submittals.

- 1) Diffuser Air Velocities at Discharge and 5' away from diffuser: Documented and less than or equal to velocities shown on the schedule.
 - 2) Primary Air Plenum Pressures: Documented and less than or equal to pressures shown on the schedule.
 - 3) Estimated Room Sound Levels: Documented and less than or equal to pressures shown on the schedule.
 - 4) Sensible Cooling Loads: Document and greater than or equal to capacities shown on the schedule.
 - 5) Sensible Heating Loads: Document and greater than or equal to capacities shown on the schedule.
 - 6) Latent Capacities: Document and greater than or equal to capacities shown on the schedule.
 - 7) Air performance showing: Primary Air, Induction Rates or Supply Air CFMs
- E. K-Factor Label and Air Pressure Commissioning Port: All displacement induction diffusers shall be fitted with an uncapped air pressure tap for measuring the static pressure differential between the primary air plenum and the room. Air pressure port shall be accessible behind the upper-left return/induction front face panel. Each displacement unit shall be provided with an airflow calibration label affixed showing primary airflow rate for given nozzle configuration at varying plenum pressures.
- F. Description for Acoustic Performance (Conformance to ANSI S12.60)
1. Terminals shall be sized and selected such that their collective noise generation shall not contribute to a classroom noise level exceeding NC 35 per ANSI Standard S12.60. NC levels of the individual terminals shall not exceed those scheduled.
- G. Accessories and Options
3. Stainless Steel Braided Hoses Kit Assemblies
 - a. One end connection shall swivel to allow for equipment movement during operation.
 - b. 1/2" – 1" shall be made of CPE (Chlorinated Polyethylene).
 - c. 1 1/4" – 2" shall be made of EPDM (Ethylene Propylene Diene Monomer).
 - d. Maximum working pressures:
 - e. 500# WPSI Static (1/2" – 1")
 - f. 200# WPSI Static (1 1/4" – 2")
 - g. Maximum temperature rating: 212°F
 - h. Hoses shall incorporate stainless steel ferrules.
- H. Source Quality Control: Comply with ASHRAE 200, AHRI-410, and AHRI 1240

1. Coil capacity rated in accordance with AHRI 410-2000, Forced Circulation Air-Cooling & Air-Heating Coils
2. Capacity performance and sound levels of induction coils (chilled beams) rated in accordance with ASHRAE 200-2018, Methods of Testing Chilled Beams
3. Capacity and performance of active chilled beams coils shall be rated in accordance with AHRI 1240-2017, Performance Rating of Active Chilled Beams.

2.4 GENERAL PROTECTION REQUIREMENTS

- A. Protect finishes on exposed surfaces from damage by applying a removable, temporary protective covering at the factory before shipping.
- B. Protect coil and piping openings with removable end caps before shipping.
- C. Protect duct connection openings with removable end caps before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive displacement inductions units for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for duct, piping and wiring to verify actual locations of connections before installation.
- C. Proceed with installation only after unsatisfactory conditions have been field corrected.
- D. Ensure all units received have appropriate and individual tagging identifiers.
 1. DIV manufacturer must label each shipping package AND equipment, including accessories, with room by room tags, along with model numbers for ease of site coordination.

3.2 INSTALLATION

- A. Displacement induction units and accessories shall arrive on site as a factory assembled, housed cabinet structure. Cabinets sections shall only require secure attachment to the wall and associated air and water connections. ABSOLUTELY NO field erection of cabinet framing support members or diffuser cabinet housing panels

shall be allowed due to excessive field labor requirements and uniform fit and finish variability.

- B. Install displacement unit's level and plumb in accordance with manufacturer's IOM documentation.
- C. Arranged installation of units to provide access space around displacement units for proper service and maintenance.

3.3 PIPING CONNECTIONS

- J. Make piping connections to displacement induction units in a reverse return configuration.
- K. Where installing piping adjacent to displacement induction units, allow space for service and maintenance.

3.4 DUCT CONNECTIONS

- J. Make ductwork connections to displacement induction units closest to the drop, then from there connect them together (in series).
- K. Where installing ductwork adjacent to displacement induction units, allow space for service and maintenance.

3.5 ELECTRICAL CONNECTIONS

3.6 IDENTIFICATION

- A. Identify hydronic piping and valves. Comply with requirements specified in Section 230553 "Identification for HVAC Piping and Equipment."

3.7 CLEANING AND PROTECTION

- A. Protect exposed surfaces of displacement induction units from damage with factory-installed protective covering. Maintain covering in place until start of unit testing and balancing.
- B. Protect displacement induction units' air connections with factory installed protective covers and keep them covered until making final field duct connections.

- C. Clean displacement induction units inside and out to a factory-new condition.
- D. Reject damaged displacement induction units and replace them with new units.
- E. Only if acceptable to the Owner, minor damage to finishes may be repaired as required to restore displacement induction units to factory-new appearance. Any variation in visual appearance between factory and repaired finish shall be rejected.

3.8 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections with the assistance of a factory authorized service representative.
- C. Tests and Inspections:
 - 1. Leak Test: After installation, fill the system with water under design pressure and test for leaks. Repair leaks and retest until no leaks exist.
- D. Displacement induction units will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, and route to Owner, Architect, Engineer, and Contractor.

3.9 ADJUSTING

- A. Occupancy Adjustments: When requested, within [12] months from date of Substantial Completion provide on-site assistance in adjusting system to suit actual occupied conditions.

3.10 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain displacement induction ventilation units.

END OF SECTION 238215

SECTION 238216.11 - HYDRONIC AIR COILS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Hydronic air coils.
2. Integral face-and-bypass hot-water coils.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each air coil.
2. Include rated capacities, operating characteristics, and pressure drops for each air coil.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, sections, and other details, or BIM model, drawn to scale, showing the items described in this Section and coordinated with all building trades.

B. Product Data:

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include rated capacities, dimensions, required clearances, characteristics, and furnished specialties and accessories.
3. Include unit dimensions and weight.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air coils to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. ASHRAE 62.1 Compliance: Comply with applicable requirements in ASHRAE 62.1, Section 5, "Systems and Equipment," and Section 7, "Construction and Startup."
- B. Performance Ratings: Tested and rated in accordance with AHRI 410 and ASHRAE 33.
- C. Minimum Working-Pressure/Temperature Ratings: 200 psig/300 deg F.
- D. Select dual temperature coils for no moisture carryover at design conditions. Provide moisture eliminators on discharge face of cooling coil if necessary to eliminate moisture carryover.

2.2 HYDRONIC AIR COILS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Aerofin.
 - 2. Capital Coil.
 - 3. Modine Commercial and Industrial Solutions.
 - 4. Trane.
 - 5. USA Coil & Air.
- B. Source Limitations: Obtain hydronic coils from single source from single manufacturer.
- C. Description: Coils constructed of staggered tubes mechanically expanded into continuous collars that are die-formed into the coil fins; self-venting; counterflow design of air to fluid.
- D. Tubes:
 - 1. Material: Copper.
 - 2. Nominal Diameter: Minimum 1/2 inch or 5/8 inch (16 mm) before expanding, selected to provide performance indicated.
 - 3. Nominal Wall Thickness: As required by performance, minimum 0.035 inch thick.
 - 4. Return Bends: 180-degree bends; material and nominal diameter to match tubes.
 - 5. Fluid Velocity at Design Flow Rate:
 - a. Maximum: 6 fps.
 - b. Minimum: 3 fps.

6. Features: Cleanable.
- E. Fins:
1. Type: Plate.
 2. Materials:
 - a. Aluminum: 0.0060 inch (0.15 mm) thick.
 - b. Copper: 0.0060 inch (0.15 mm) thick.
 3. Spacing: Maximum 12 fins per inch.
 4. Collars: Full collars for accurate fin spacing and maximum tube contact while leaving no surface of tube exposed.
 5. Configuration: Fin type as required by performance requirements.
- F. Headers:
1. Material: Carbon steel Copper, removable for cleaning and inspection of tubes.
 2. Tube-to-Header Connections: Tube-to-header holes to intrude inward, so landed surface area is 3 times the core tube thickness, to provide enhanced-header-to-tube joint integrity. Evenly extend tubes within the ID of the header no more than 0.12 inch (3 mm).
 3. Header Top and Bottom Caps: End caps to be die-formed and installed on the ID of header, such that the landed surface area is 3 times the header wall thickness.
 4. Drains: Include low point of header with a NPS 1/2 (DN 13) drain connection.
 5. Vents: Include high point of header with a NPS 1/2 (DN 13) vent connection.
 6. Supply and Return Connections: Copper Carbon steel pipe; threaded or flanged, same end of coil.
 7. Protect opening of supply, return, vent, and drain connections with a threaded cap to prevent entry of dirt into coil.
 8. Fluid Velocity at Design Flow Rate: Maximum of 6 fps (1.8 m/s).
- G. Holes: Include number, size, and location of holes in casing and end tube sheets required for coil installation.
- H. Hardware: Use hex-head bolts, nuts, and washers constructed of Type 304 or Type 316 stainless steel.
- I. Nameplate: Aluminum or stainless steel nameplate with brass or stainless steel chain for each coil, with the following data engraved or embossed:
1. Manufacturer name, address, telephone number, and website address.
 2. Manufacturer model number.
 3. Serial number.

4. Manufacturing date.
5. Coil identification (indicated on Drawings).
6. Coil fin length.
7. Coil fin height.
8. Coil weight with fluid/without fluid.
9. Coil casing material and thickness.
10. Coil fin material and thickness.
11. Coil tube material and thickness.
12. Coil header material and thickness.

J. Casing: Galvanized Steel

2.3 MATERIALS

- A. Aluminum: ASTM B209.
- B. Copper Tube: ASTM B75/ASTM 75M annealed temper or ASTM B280 drawn temper.
- C. Copper Sheet: ASTM B152.
- D. 90/10 Cupronickel Alloy: ASTM B122/ASTM B122M.
- E. Steel:
 1. Pipe Connections: ASTM A53/A53M.
- F. Corrosion-Resistant Coating: Where indicated on Drawings, coat coils with a corrosion-resistant coating capable of withstanding a 3000-hour salt-spray test in accordance with ASTM B117.
 1. Standards:
 - a. ASTM B117 for salt spray.
 - b. ASTM D2794 for minimum impact resistance of 100 in. lb.
 - c. ASTM D3359 for cross-hatch adhesion of 5B.
 2. Application: Spray.
 3. Thickness: 1 mil.
 4. Gloss: Minimum gloss of 60 on a 60-degree meter.

2.4 SOURCE QUALITY CONTROL

- A. Hydronic Coils: Factory tested with air while coil is completely submerged underwater to design pressure indicated, but not less than 300-psig internal pressure.
- B. Coils to display a tag with inspector's identification as proof of testing.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine ducts, plenums, and casings to receive air coils for compliance with requirements for installation tolerances and other conditions affecting coil performance.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before coil installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install coils level and plumb.
- B. Install coils in metal ducts and casings constructed in accordance with SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."
- C. Install stainless steel drain pan under each dual temperature coil.
 - 1. Construct drain pans with connection for drain; insulated and complying with ASHRAE 62.1.
 - 2. Construct drain pans to extend beyond coil length and width and to connect to condensate trap and drainage.
 - 3. Extend drain pan upstream and downstream from coil face.
 - 4. Extend drain pan under coil headers and exposed supply piping.
- D. Install moisture eliminators for dual temperature coils. Extend drain pan under moisture eliminator.
- E. Straighten bent fins on air coils.
- F. Clean coils using materials and methods recommended in writing by manufacturers, and clean inside of casings and enclosures to remove dust and debris.

3.3 PIPING CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to coils to allow service and maintenance.
- C. Connect water piping with unions and shutoff valves to allow coils to be disconnected without draining piping.

END OF SECTION 238216.11

SECTION 238219– FAN COIL UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes cabinet unit heaters with centrifugal fans and hot-water coils.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, and details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include location and size of each field connection.
 - 4. Include details of anchorages and attachments to structure and to supported equipment.
 - 5. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.
 - 6. Indicate location and arrangement of piping valves and specialties.
 - 7. Indicate location and arrangement of integral controls.
 - 8. Wiring Diagrams: Power, signal, and control wiring.
- C. Samples: For each exposed product and for each color and texture specified.
- D. Samples for Initial Selection: Finish colors for units with factory-applied color finishes.
- E. Samples for Verification: Finish colors for each type of cabinet unit heater indicated with factory-applied color finishes.

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, using input from installers of the items involved:
 - 1. Suspended ceiling components.
 - 2. Structural members to which cabinet unit heaters 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.
 - 6. Perimeter moldings for exposed or partially exposed cabinets.
- B. Field quality-control reports.

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. Cabinet Unit-Heater Filters: Furnish one spare filter(s) for each filter installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Airtherm; a Mestek company.
2. QMark; Marley Engineered Products.
3. Trane.
4. Sterling

2.2 DESCRIPTION

- A. Factory-assembled and -tested unit complying with AHRI 440.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with UL 2021.

2.3 PERFORMANCE REQUIREMENTS

- A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- B. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

2.4 CABINETS

- A. Material: Steel with baked-enamel finish with manufacturer's standard paint, in color selected by Architect.
 1. Vertical Unit, Exposed Front Panels: Minimum 0.0677-inch- thick galvanized sheet steel, removable panels with channel-formed edges secured with tamperproof cam fasteners.
 2. Horizontal Unit, Exposed Bottom Panels: Minimum 0.0677-inch- thick galvanized sheet steel, removable panels secured with tamperproof cam fasteners and safety chain.
 3. Recessed Flanges: Steel, finished to match cabinet.
 4. Control Access Door: Key operated.
 5. Base: Minimum 0.0528-inch- thick steel, finished to match cabinet, 4 inches high with leveling bolts.
 6. Extended Piping Compartment: 8-inch- wide piping end pocket.
 7. False Back: Minimum 0.0428-inch- thick steel, finished to match cabinet.
 8. Provide condensate Drain Pan

2.5 FILTERS

- A. Minimum Efficiency Reporting Value and Average Arrestance: According to ASHRAE 52.2.
- B. Minimum Efficiency Reporting Value: According to ASHRAE 52.2.
- C. Material: Pleated cotton-polyester media, MERV 8.

2.6 COILS

- A. Dual Temp Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain.

2.7 CONTROLS

- A. Fan and Motor Board: Removable.
 - 1. Fan: Forward curved, double width, centrifugal, directly connected to motor; thermoplastic or painted-steel wheels and aluminum, painted-steel, or galvanized-steel fan scrolls.
 - 2. Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - 3. Wiring Terminations: Connect motor to chassis wiring with plug connection.
- B. Electrical Connection: Factory-wired motors and controls for a single field connection.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive cabinet unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for piping and electrical connections to verify actual locations before unit-heater installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install 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. Suspend cabinet unit heaters from structure with elastomeric hangers.
- D. Install wall-mounted thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.
- E. Install new filters in each fan-coil unit within two weeks of Substantial Completion.

3.3 CONNECTIONS

- A. Install piping adjacent to machine to allow service and maintenance.
- B. Connect piping to cabinet unit heater's factory, hot-water piping package. Install the piping package if shipped loose.
- C. Connect supply and return ducts to cabinet unit heaters with flexible duct connectors.
- D. Comply with safety requirements in UL 1995.

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 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.
- B. Units will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.5 ADJUSTING

- A. Adjust initial temperature set points.
- B. 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 factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain cabinet unit heaters.

END OF SECTION 238219

SECTION 238240 – DUCTLESS CASSETTE FANCOILS

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 cassette style fancoils with hydronic coils and centrifugal blowers.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, and details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include details of anchorages and attachments to structure and to supported equipment.
 - 4. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.
 - 5. Wiring Diagrams: Power, signal, and control wiring.
- C. Samples: For each exposed product and for each color and texture specified.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For wall and ceiling unit heaters to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Carrier
 - 2. JCI, York
 - 3. Multiaqua.
 - 4. Modine

2.2 DESCRIPTION

- A. Electrical Components, Devices, and Accessories: ETL Certified in accordance with U.L. Standard 95, latest version (U.S.A.). Electrical line voltage connections shall be made at the factory supplied terminal block. Factory wiring shall be rated according to UL listing at the time of manufacturing.
- B. Unit shall be a factory assembled and tested water fan coil. 2
- C. Contained within the unit shall be all factory wiring, piping, and associated controls.

2.3 UNIT CABINET AND COVER:

- A. Cabinet is constructed of galvanized sheet metal.
- B. Cover composed of high impact polymers.
- C. Internally and externally insulated to ensure quiet operation.

2.4 FAN AND MOTOR

- A. Fan motor shall be three speed, direct drive, and PSC type.
- B. Fan motor shall be totally enclosed.
- C. Fan motor shall be internal overload protected.
- D. Radial blower wheel shall be dynamically balanced

2.5 AIR DISTRIBUTION:

- A. Unit shall contain four manually adjustable discharge air louvers. Electrical Connection: Factory wire motors and controls for a single field connection with disconnect switch.

2.6 WATER COIL:

- A. Manufactured with water coils containing copper tubing mechanically bonded to aluminum fins.
- B. Coils are factory tested to 300 psig.
- C. Coils are designed to accept an entering water temperature not to exceed 160°F
- D. Pressure independent flow control required on both coils to not exceed max flow for each coil.

2.7 DRAIN PAN:

- A. Constructed of injected molded polystyrene.
- B. CVMini Condensate Pump

2.8 FILTERS:

- A. Unit shall contain a woven panel washable filter.

2.9 CONTROLS AND SAFETIES:

- A. Fan coils shall be factory wired and tested.
- B. Unit shall include a terminal block that is capable of incorporating a 24 vac, field supplied, hard wired thermostat.

2.10 SAFETIES:

- A. Fan coil shall contain a renewable fuse on the low voltage side of the transformer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive cassette fancoils for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

- B. Examine roughing-in for electrical connections to verify actual locations before cassette installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install cassette fancoils to comply with NFPA 90A.
- B. Install cassette fancoils level and plumb.
- 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."

END OF SECTION 238240

SECTION 250923 - BUILDING AUTOMATION SYSTEM (BMS) FOR HVAC

PART 1 - GENERAL

1.1 CONTROL SYSTEM DESCRIPTION

- A. Controls System shall be Web-based and accessible either directly connected and/or through the owners IP LAN network.
- B. The BAS shall meet BACnet communication standards to ensure the system maintains "interoperability" to avoid proprietary arrangements that will make it difficult for the Owner to consider other BAS manufacturers in future projects.
- C. BAS controllers shall be listed by BACnet Testing Laboratories (BTL) with appropriate classification.
- D. Direct Digital Control (DDC) technology shall be used to facilitate the functions necessary for control of mechanical systems and equipment on this project.

1.2 APPROVED CONTROL SYSTEM MANUFACTURER

- A. Subject to compliance with requirements, products by:
 - 1. Siemens

1.3 CODES AND STANDARDS

- A. Codes and Standards: Meet requirements of all applicable standards and codes, except when more detailed or stringent requirements are indicated by the Contract Documents, including requirements of this Section.
 - 1. Underwriters Laboratories: Products shall be UL-916-PAZX listed.
 - 2. National Electrical Code - NFPA 70.
 - 3. Federal Communications Commission - Part J.
 - 4. ASHRAE/ANSI 135-2012 (BACnet) - (System Level Devices) - Building Controllers shall conform to the listed version of the BACnet specification to improve interoperability with various building system manufacturers' control systems and devices.
 - 5. ASHRAE/ANSI 135-2012 (BACnet) - (Unit Level Devices) - Unit Controllers shall conform to the listed version of the BACnet specification to improve interoperability with various building system manufacturers' control systems and devices.

1.4 SYSTEM PERFORMANCE

A. Performance Standards. The BAS system shall conform to the following:

1. Graphic Display. The system shall display a graphic with a minimum of 20 dynamic points. All current data shall be displayed within 10 seconds of the operator's request.
2. Graphic Refresh. The system shall update all dynamic points with current data within 10 seconds.
3. Object Command. The maximum time between the command of a binary object by the operator and the reaction by the device shall be 5 seconds. Analog objects shall start to adjust within 5 seconds.
4. Object Scan. All changes of state and change of analog values shall be transmitted over the high-speed network such that any data used or displayed at a controller or workstation will be current within the prior 10 seconds.
5. Alarm Response Time. The maximum time from when an object goes into alarm to when it is annunciated at the workstation shall not exceed 10 seconds.
6. Program Execution Frequency. Custom and standard applications shall be capable of running as often as once every 5 seconds. The Contractor shall be responsible for selecting execution times consistent with the mechanical process under control.
7. Programmable Controllers shall be able to execute DDC PID control loops at a selectable frequency from at least once every 5 seconds. The controller shall scan and update the process value and output generated by this calculation at this same frequency.
8. Reporting Accuracy. Table 1 lists minimum acceptable reporting accuracies for all values reported by the specified system.
 - a. Table 1: Reporting Accuracy

Measured Variable	Reported Accuracy
Space Temperature	±0.5°C [±1°F]
Ducted Air	±1.0°C [±2°F]
Outside Air	±1.0°C [±2°F]
Water Temperature	±0.5°C [±1°F]
Delta –T	±0.15°C[±0.25°F]
Relative Humidity	±5% RH
Water Flow	±5% of full scale
Air Flow (terminal)	±10% of reading *Note 1
Air Flow (measuring stations)	±5% of reading
Air Pressure (ducts)	±25 Pa [±0.1 "W.G.]
Air Pressure (space)	±3 Pa [±0.01 "W.G.]
Water Pressure	±2% of full scale *Note 2
Electrical Power	5% of reading *Note 3
Carbon Monoxide (CO)	± 50 PPM
Carbon Dioxide (CO2)	± 50 PPM

Note 1: (10%-100% of scale) (cannot read accurately below 10%)

Note 2: for both absolute and differential pressure

Note 3: * not including utility supplied meters

1.5 SUBMITTAL REQUIREMENTS

- A. A complete bill of materials of equipment to be used indicating quantities, manufacturers and model numbers.
- B. A schedule of all control valves including the valve size, pressure drop, model number (including pattern and connections), flow, CV, body pressure rating, and location.
- C. A schedule of all control dampers including damper size, pressure drop, manufacturer, and model number.
- D. All manufacturers' technical cut sheets for major system components.
- E. Proposed Building Automation System architectural diagram depicting various controller types, workstations, device locations, addresses, and communication cable requirements
- F. Detailed termination drawings showing all required field and factory terminations, as well as terminal tie-ins to DDC controls by mechanical equipment manufacturers. Terminal numbers shall be clearly labeled.

- G. Points list showing all system objects and the proposed English language object names.
- H. Sequence of operation for each controlled mechanical system and terminal end devices.
- I. BACnet Protocol Implementation Conformance Statement (PICS) for each BACnet system level device (i.e. Building Controller & Operator Workstations) type. This defines the points list for proper coordination of interoperability with other building systems if applicable for this project.
- J. BAS Workstation and HMI interface screen graphics for all systems, showing system schematics, control and instrumentation points, monitoring data, setpoints with adjustments, and alarms. A
- K. Additional information or data which is deemed necessary to determine compliance with the specifications or which is deemed valuable in documenting and understanding the system to be installed.
- L. As-built drawings showing any and all modifications to the shop drawings that took place during the construction process.

1.6 WARRANTY REQUIREMENTS

- A. Warrant all work as follows:
 - 1. BAS system labor and materials shall be warranted free from defects for a period of twelve (12) months after final completion acceptance by the Owner. BAS failures during the warranty period shall be adjusted, repaired, or replaced at no charge to the Owner. The BAS manufacturer shall respond to the Owner's request for warranty service within 24 hours of the initiated call and will occur during normal business hours (8AM-5PM).
 - 2. At the end of the final start-up/testing, if equipment and systems are operating satisfactorily to the Owner and Engineer, the Owner shall sign certificates certifying that the BAS is operational and has been tested and accepted in accordance with the terms of this specification. The date of Owner's acceptance shall be the start of the warranty period.

1.7 SYSTEM MAINTENANCE

- A. Perform Building Automation System preventative maintenance and support for a period of 1 year (beginning the date of substantial completion).
 - 1. Make a minimum of 2 complete Building Automation System inspections, in addition to normal warranty requirements. Inspections to include:
 - a. System Review – Review the BAS to correct programming errors, failed points, points in alarm, and points that have been overridden manually.

- b. Seasonal Control Loop Tuning – Control loops are reviewed to reflect changing seasonal conditions and / or facility heating and cooling loads.
 - c. Sequence of operation verification – Systems all verified to be operating as designed and in automatic operation. Scheduling and setpoints are reviewed and modified.
 - d. Database back-up
 - e. Operator coaching
- 2. Technician shall review critical alarm log and advise of additional services that may be required.
 - 3. Technician shall submit a written report after each inspection.

1.8 OWNERSHIP OF BAS MATERIAL

- A. Project specific software and documentation shall become the owner's property upon project completion. This includes the following:
 - 1. Operator Graphic files
 - 2. As-built hardware design drawings
 - 3. Operating & Maintenance Manuals
 - 4. BAS System software database
 - 5. Controller application programming databases
 - 6. Application Specific Controller configuration files
 - 7. Required Licensed software

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Use new products that the manufacturer is currently manufacturing and that have been installed in a minimum of 25 installations. Do not use this installation as a product test site unless explicitly approved in writing by the owner or the owner's representative. Spare parts shall be available for at least five years after completion of this contract.

2.2 COMMUNICATION

- A. A. Network communication protocol(s) used throughout entire DDC system shall be open to Owner and available to other companies for use in making future modifications to DDC system.

- B. This project shall be comprised of a high speed Ethernet network utilizing BACnet/IP communications between System Controllers and Workstations. Each System Controller shall function as a BACnet Router to each unit controller providing a unique BACnet Device ID for all controllers within the system.
- C. Communications between System Controllers and sub-networks of Custom Application Controllers and/or Application Specific Controllers shall meet the ASHRAE 135 Standard either via BACnet MS/TP or BACnet over Zigbee.
 - 1. Wireless Equipment Level Controller Communication and Auxiliary Control Devices shall conform to:
 - a. Each System Controller shall perform communications to a network of Custom Application and Application Specific Controllers on a certified, open standard wireless solution to enable integration with other suppliers using the same open standard.
 - b. Each communication interface shall be ZigBee certified as a BACnet tunneling device as allowed by the BACnet Standard and defined by the Zigbee Alliance.
 - c. Each System Controller shall function as a BACnet Router to each unit controller providing a unique BACnet Device ID for all controllers within the system.
 - d. The controls wireless network shall be capable of similar performance to a wired, equally quantified network by responding to controls requests within 10% timing comparison to facilitate a similar user experience for facility managers and occupants.
 - e. The controls wireless network shall be secured using Advanced Encryption Standard AES-128 (FIPS Pub 197) and HMAC (FIPS Pub 198). A Trust Center will create a randomly generated 128-bit network security key for each ZigBee network.
 - f. IEEE 802.15.4 radios to minimize risk of interference and maximize battery life, reliability, and range.
 - g. Indoor design range shall be a minimum of 200 feet (60 m); open range shall be 2,500 ft. (762 m) with less than 2% packet error rate to minimize the need for repeaters and optimize network reliability.
 - h. To maintain robust communication, self-healing, redundant mesh networking and two-way communications shall be used to optimize the wireless network reliability.
 - i. Wireless communication shall be capable of many-to-one sensors per controller to support averaging, monitoring, and multiple zone applications.
 - j. Space/wall sensors shall be available with batteries with a typical life of 15 or more years to minimize maintenance costs or with power harvesting capabilities to minimize the need for batteries.

- k. Space/wall sensors shall be available with temperature, relative humidity, occupancy, and CO₂ to support common HVAC controls applications.
 - l. Occupancy sensors shall have adequate range, sensing patterns, and number of sensors required for 100% coverage.
 - m. CO₂ sensors shall have a design life of 15 or more years, and include barometric pressure sensing and be self-calibrating to minimize maintenance expenses over the life of the sensor.
 - n. Certifications shall include FCC CFR47 - RADIO FREQUENCY DEVICES - Section 15.247 & Subpart E
- D. ASHRAE 135 Protocol:
- 1. ASHRAE 135 communication protocol shall be sole and native protocol used throughout entire DDC system.
 - 2. DDC system shall not require use of gateways except to integrate HVAC equipment and other building systems and equipment, not required to use ASHRAE 135 communication protocol.
 - 3. If used, gateways shall connect to DDC system using ASHRAE 135 communication protocol and Project object properties and read/write services indicated by interoperability schedule.
 - 4. Operator workstations, controllers and other network devices shall be tested and listed by BACnet Testing Laboratories.

2.3 OPERATOR INTERFACE

- A. Operator Web Interface shall conform to following:
- 1. System Security
 - a. Each operator shall be required to login to the system with a user name and password in order to view, edit, add, or delete data.
 - b. User Profiles shall restrict the user to only the objects, applications, and system functions as assigned by the system administrator.
 - c. Each operator shall be allowed to change their user password.
 - d. The System Administrator shall be able to manage the security for all other users.
 - e. The system shall include pre-defined "roles" that allow a system administrator to quickly assign permissions to a user.
 - f. User logon/logoff attempts shall be recorded.
 - g. The system shall track and record all user log-in activity and all changes done at the enterprise level including who made the change, when, what was changed, pervious value and new value.
 - 2. Customizable Navigation Tree

- a. The operator web interface shall include a fully customizable navigation tree that shall allow an operator to do the following:
 - 1) Move and edit any of the nodes of the tree.
 - 2) Move entire groups to any area of the tree
 - 3) Change the name of any node in the tree
 - 4) Create custom nodes for any page in the web interface including: graphics, data log views, schedules, and dashboards
 - 5) Support navigation from multi-building to single building view
 - 6) Ability to create folders and assign and change hierarchy of nodes of the tree
3. Standard Equipment Pages
 - a. The operator web interface shall include standard pages for all major equipment.
 - b. These pages shall allow an operator to obtain information relevant to the operation of the equipment, including:
 - 1) Animated Equipment Graphics for each major piece of equipment and floor plan in the System.
 - 2) Alarms relevant to the equipment or application without requiring a user to navigate to an alarm page and perform a filter.
 - 3) Data Logs for the equipment without requiring a user to navigate to a Data Log page and perform a filter.
4. System Graphics Package
 - a. The operator web interface shall be graphically based and shall include at least one 3-D color graphic per piece of equipment, graphics for each hydronic system, and graphics that summarize conditions on each floor of each building included in this contract.
 - b. Graphics Package shall include at a minimum:
 - 1) 3-D Color Site Map (for multiple building campus projects) or 3-D Building Rendering (for single building projects)
 - 2) 3-D Color Custom Floor Plans
 - a) Floor Plan Graphics to show accurate ductwork of system
 - b) Toggle Switch to turn ductwork on/off per each floor plan
 - c) Indicate thermal comfort on floor plan graphics using colors to represent zone temperature relative to zone set point
 - 3) 3-D Color Hydronic System Graphics with Animations
 - a) Example Animation: Pump Flashing when On
 - 4) 3-D Color Major Equipment Graphics with Animations
 - a) Example Animation: Fan Spinning when On
5. Manual Control and Override
 - a. Point Control – There shall be a method for a user to view, override, and edit if applicable, the status of any object and property in the system. The point status shall be available by menu, on graphics or through custom programs.

- b. Temporary Overrides - The user shall be able to perform a temporary override wherever an override is allowed, automatically removing the override after a specified period of time.
- 6. Engineering Units
 - a. Allow for selection of the desired engineering units (i.e. Inch pound or SI) in the system.
- 7. Scheduling
 - a. A user shall be able to perform the following tasks utilizing the operator web interface:
 - b. Create a new schedule, defining the default values, events and membership.
 - c. Create exceptions to a schedule for any given day.
 - d. Apply an exception that spans a single day or multiple days.
 - e. View a schedule by day, week and month.
 - f. Exception schedules and holidays shall be shown clearly on the calendar.
 - g. Modify the schedule events, members and exceptions.
 - h. Create schedules and exceptions for multiple buildings
 - i. Apply emergency schedule to multiple buildings
 - j. Drag and drop scheduling editing
 - k. Global schedule and exceptions across multiple buildings
- 8. Data Logs
 - a. Data Logs Definition.
 - 1) The operator web interface shall allow a user with the appropriate security permissions to define a Data Log for any data in the system.
 - b. Data Log Viewer.
 - 1) The operator web interface shall allow Data Log data to be viewed and printed.
 - 2) The operator web interface shall allow a user to view Data Log data in a text-based format (time –stamp/value).
 - 3) The operator shall be able to view the data collected by a Data Log in a graphical chart in the operator web interface.
 - 4) Data Log viewing capabilities shall include the ability to show a minimum of five points on a chart.
 - 5) Each data point data line shall be displayed as a unique color.
 - 6) Data points can be hidden on the display view by clicking on the point
 - 7) The operator shall be able to specify the duration of historical data to view by scrolling, zooming, or selecting from a pull down list.
 - 8) The system shall have a graphical trace display of the associated time stamp and value for any selected point along the x-axis.

- c. Export Data Logs.
 - 1) The Enterprise operator web interface shall allow a user to export Data Log data in CSV, xlsx or text format for use by other industry standard word processing and spreadsheet packages.
- 9. Alarm/Event Notification
 - a. An operator shall be notified of new alarms/events as they occur while navigating through any part of the system via an alarm icon.
 - b. The operator will have the option of selecting an audible alarm notification for all alarm classes they subscribe to.
 - c. The system operator will have the option of setting specific times and days that that they will receive alarm notifications.
 - d. Alarm/Event Log. The operator shall be able to view all logged system alarms/events from any operator web interface.
 - 1) The operator shall be able to sort and filter alarms from events. Alarms shall be sorted in categories based on severity.
 - 2) The alarm/event log shall include a comment field for each alarm/event that allows a user to add specific comments associated with any alarm.
- 10. User Change Log
 - a. The operator shall be able to view all logged user changes in the system from any operator web interface.
 - 1) An operator shall be able to group user changes by: date, affected, date & affected, user, date & user, transaction type, date & transaction type, or sort only.
 - 2) The operator will have the option of additional filtering capability of: date, transaction, type, user, affected, and details that can be used individually or in conjunction with other filters.
- 11. Reports
 - a. The operator web interface shall have a reporting package that allows the operator to select reports to run.
 - b. The operator web interface shall have the ability to schedule reports to run at specified intervals of time.
 - c. The Enterprise operator web interface shall have the ability to email schedule reports at specified intervals of time.
 - d. The following standard reports shall be available without requiring a user to manually design the report:
 - 1) All Points in Alarm Report: On demand report showing all current alarms.
 - 2) All Points in Override Report: On demand report showing all overrides in effect.
 - 3) Schedules Report: List of all weekly events for all schedules in selected buildings

- 4) Space Comfort Analysis Report: List of spaces that meet selected criteria for potential comfort issues (temp variance, high, low, unoccupied)
12. Operator Web Interface must meet the following Agency Compliance:
 - a. BACnet Testing Laboratory (BTL) Listed

2.4 MOBILE APP INTERFACE

- A. Mobile App Operator Interface shall support the following Operating systems
 1. Apple iOS 6
 2. Apple iOS 7
 3. Apple iOS 8
 4. Android V2.3
 5. Android V4.3
 6. Android V4.4
- B. The operator interface shall support system access on a mobile device via a mobile app to:
 1. Alarm log
 2. System Status
 3. Equipment status
 4. Space Status
 5. Standard Equipment graphics
- C. The operator interface shall support actions on a mobile device via a mobile app to:
 1. Override set points
 2. Override occupancy
 3. Acknowledge Alarms
 4. Comment on Alarms

2.5 PROGRAMMING TOOLS

- A. Custom Application Programming Tools to create, modify, and debug custom application programming, under license for a period of at least (1) year. The operator shall be able to create, edit, and download custom programs at the same time that all other system applications are operating. The system shall be fully operable while custom routines are edited, compiled, and downloaded. Upon expiration of software license the building owner may choose to renew the license at their discretion.

- B. Custom Graphic Editor. The tools necessary to create, modify, and debug custom graphics. The operator shall be able to create, edit, and download custom graphics at the same time that all other system applications are operating. The system shall be fully operable while custom graphics are edited, compiled, and downloaded.

2.6 BUILDING CONTROLLERS

- A. There shall be one or more independent, standalone microprocessor based System Controllers to manage the global strategies described in Application and Control Software section.
- B. The System Controller shall have sufficient memory to support its operating system, database, and programming requirements.
- C. The operating system of the Controller shall manage the input and output communications signals to allow distributed controllers to share real and virtual point information and allow central monitoring and alarms.
- D. All System Controllers shall have a real-time clock.
- E. Data shall be shared between networked System Controllers.
- F. The System Controller shall continually check the status of its processor and memory circuits. If an abnormal operation is detected, the controller shall:
 - 1. Assume a predetermined failure mode.
 - 2. Generate an alarm notification.
 - 3. Create a retrievable file of the state of all applicable memory locations at the time of the failure.
 - 4. Automatically reset the System Controller to return to a normal operating mode.
- G. Environment. Controller hardware shall be suitable for the anticipated ambient conditions. Controller used in conditioned ambient shall be mounted in an enclosure, and shall be rated for operation at -40° C to 50° C [-40° F to 122° F].
- H. Clock Synchronization.
 - 1. All System Controllers shall be able to synchronize with a NTP server for automatic time synchronization.
 - 2. All System Controllers shall be able to accept a BACnet time synchronization command for automatic time synchronization.
 - 3. All System Controllers shall automatically adjust for daylight savings time if applicable.
- I. Serviceability

1. Diagnostic LEDs for power, communications, and processor

- J. Memory. The System Controller shall maintain all BIOS and programming information indefinitely without power to the System controller.
- K. BACnet Test Labs (BTL) Listing. Each System Controller shall be listed as a Building Controller (B-BC) by the BACnet Test Labs with a minimum BACnet Protocol Revision of 14.

2.7 ADVANCED APPLICATION CONTROLLERS

- A. Advance Application Controllers shall be used to control all equipment or applications of medium and high complexity, including but not limited to Air Handlers, Boiler Plants and Chiller Plants.
- B. To meet the sequence of operation for each application, the Controller shall use programs by the controller manufacturer that are either factory loaded or downloaded with service tool to the Controller.
- C. Stand-Alone Operation: In case of communications failure stand-alone operation shall use default values or last values for remote sensors read over the network such as outdoor air temperature.
- D. Environment. Controller hardware shall be suitable for the anticipated ambient conditions.
- E. Input/Output: The Controller shall have on board or through expansion module all I/O capable of performing all functionality needed for the application. Controls by the equipment manufacturer must supply the required I/O for the equipment.
- F. Input/Output Expandability – For the application flexibility, the Controller shall be capable of expanding to a total of at least 100 hardware I/O terminations.
- G. Serviceability – The Controller shall have the following in order to improve serviceability of the Controller.
1. Diagnostic LEDs for power/normal operation/status, BACnet communications, sensor bus communications, and binary outputs. All wiring connections shall be clearly labeled and made to be field removable.
 2. To aid in service replacement, the Controller shall allow for setting its BACnet address via controller mounted rotary switches that correspond to the numerical value of the address. (DIP switch methodologies are not allowed). Setting of the address shall be accomplished without the need of a service tool or power applied to the controller.
 3. Controller data shall be maintained through a power failure.

- H. Transformer for the Controller must be rated at minimum of 115% of ASC power consumption, and shall be fused or current limiting type. 24 VAC, +/- 15% nominal, 50-60 Hz, 24 VA plus binary output loads for a maximum of 12 VA for each binary output.
- I. Controller must meet the following Agency Compliance:
 - 1. UL916 PAZX, Open Energy Management Equipment
 - 2. UL94-5V, Flammability
 - 3. FCC Part 15, Subpart B, Class B Limit
 - 4. BACnet Testing Laboratory (BTL) Listed

2.8 APPLICATION-SPECIFIC CONTROLLERS

- A. Application Specific Controllers (ASC) shall be microprocessor-based DDC controller, The controller shall use programs by the controller manufacturer that are either factory loaded or downloaded with service tool to the Controller.
- B. Zone Controllers are controllers that operate equipment that control the space temperature of single zone. Examples are controllers for VAV, Fan coil, Blower Coils, Unit Ventilators, Heat Pumps, and Water Source Heat Pumps.
- C. Stand-Alone Operation: In case of communications failure stand-alone operation shall use default values or last values for remote sensors read over the network such as outdoor air temperature.
- D. Environment: Controller hardware shall be suitable for the anticipated ambient conditions.
- E. Input/Output: The Controller shall have on board or through expansion module all I/O capable of performing all functionality needed for the application. Controls by the equipment manufacture must supply the required I/O for the equipment.
- F. Input/Output Expandability – For the application flexibility, the Controller shall be capable of expanding to a total of at least 100 hardware I/O terminations.
- G. Serviceability – The Controller shall have the following in order to improve serviceability of the Controller.
 - 1. Diagnostic LEDs for power/normal operation/status, BACnet communications, sensor bus communications, and binary outputs. All wiring connections shall be clearly labeled and made to be field removable.
 - 2. To aid in service replacement, the Controller shall allow for setting its BACnet address via controller mounted rotary switches that correspond to the numerical value of the address. (DIP switch methodologies are not allowed). Setting of the address shall be accomplished without the need of a service tool or power applied to the controller.

3. Controller data shall be maintained through a power failure.
- H. Transformer for the Controller must be rated at minimum of 115% of ASC power consumption, and shall be fused or current limiting type. 24 VAC, +/- 15% nominal, 50-60 Hz, 24 VA plus binary output loads for a maximum of 12 VA for each binary output.
- I. Controller must meet the following Agency Compliance:
 1. UL916 PAZX, Open Energy Management Equipment
 2. UL94-5V, Flammability
 3. FCC Part 15, Subpart B, Class B Limit
 4. BACnet Testing Laboratory (BTL) Listed

2.9 FIELD HARDWARE/INSTRUMENTATION

A. Temperature Sensing Devices

1. Type & Accuracy. Temperature sensors shall be of the type and accuracy indicated for the application. Sensors shall have an accuracy rating within 1% of the intended use temperature range.
2. Outside Air Temperature Sensors. Outside air temperature sensors' accuracy shall be within +1degF in the range of -52degF to 152degF.
3. Room Temperature Sensors. Room temperature sensors shall have an accuracy of +0.36degF in the range of 32degF to 96degF.
4. Chilled Water and Condenser Water Sensors. Chilled water and condenser water sensors shall have an accuracy of +0.25degF in their range of application.
5. Hot Water Temperature Sensors. Hot water temperature sensors shall have an accuracy of +0.75degF over the range of their application.

B. Pressure Instruments

1. Differential Pressure and Pressure Sensors: Sensors shall have a 4-20 MA output proportional signal with provisions for field checking. Sensors shall withstand up to 150% of rated pressure, without damaging the device. Accuracy shall be within +2% of full scale. Sensors shall be manufactured by Leeds & Northrup, Setra, Robertshaw, Dwyer Instruments, Rosemont, or be approved equal.
2. Pressure Switches: Pressure switches shall have a repetitive accuracy of +2% of range and withstand up to 150% of rated pressure. Sensors shall be diaphragm or bourdon tube design. Switch operation shall be adjustable over the operating pressure range. The switch shall have an application rated Form C, snap-acting, self-wiping contact of platinum alloy, silver alloy, or gold plating.

C. Flow Switches:

1. Flow switches shall have a repetitive accuracy of +1% of their operating range. Switch actuation shall be adjustable over the operating flow range. Switches shall have snap-acting Form C contacts rated for the specific electrical application.
- D. Humidity Sensors:
1. Sensors shall have an accuracy of +2.5% over a range of 20% to 95% RH.
- E. Current Sensing Relays
1. Relays shall monitor status of motor loads. Switch shall have self-wiping, snap-acting Form C contacts rated for the application. The setpoint of the contact operation shall be field adjustable.
- F. Output Relays
1. Control relay contacts shall be rated for 150% of the loading application, with self-wiping, snap-acting Form C contacts, enclosed in dustproof enclosure. Relays shall have silver cadmium contacts with a minimum life span rating of one million operations. Relays shall be equipped with coil transient suppression devices.
- G. Solid State Relays
1. Input/output isolation shall be greater than 10 billion ohms with a breakdown voltage of 15 V root mean square, or greater, at 60 Hz. The contact operating life shall be 10 million operations or greater. The ambient temperature range of SSRs shall be 20F-140F. Input impedance shall be greater than 500 ohms. Relays shall be rated for the application. Operating and release time shall be 10 milliseconds or less. Transient suppression as an integral part of the relays.
- H. Valve and Damper Actuators
1. Electronic Direct-Coupled: Electronic direct-coupled actuation.
 2. Actuator Mounting: The actuator shall be direct-coupled over the shaft, enabling it to be mounted directly to the damper shaft without the need for connecting linkage. The fastening clamp assemble shall be of a 'V' bolt design with associated 'V' shaped toothed cradle attaching to the shaft for maximum strength and eliminating slippage. Spring return actuators shall have a 'V' clamp assembly of sufficient size to be directly mounted to an integral jackshaft of up to 1.05 inches when the damper is constructed in this manner. Single bolt or screw type fasteners are not acceptable
 3. Electronic Overload Sensing: The actuator shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the entire rotation of the actuator. Mechanical end switches or magnetic clutch to deactivate the actuator at the end of rotation are not acceptable.
 4. Power Failure/Safety Applications: For power failure/safety applications, an internal mechanical spring return mechanism shall be built into the actuator housing. Non-mechanical forms of fail-safe operation are not acceptable.

5. Spring Return Actuators: All spring return actuators shall be capable of both clockwise or counterclockwise spring return operation by simply changing the mounting orientation.
6. Proportional Actuators: Proportional actuators shall accept a 0 to 10VDC or 0 to 20mA control input and provide a 2 to 10VDC or 4 to 20mA operating range. An actuator capable of accepting a pulse width modulating control signal and providing full proportional operation of the damper is acceptable. All actuators shall provide a 2 to 10VDC position feedback signal.
7. 24 Volts (AC/DC) actuators: All 24VAC/DC actuators shall operate on Class 2 wiring and shall not require more than 10VA for AC or more than 8 watts for DC applications. Actuators operating on 120VAC power shall not require more than 10VA. Actuators operating on 230VAC shall not require more than 11VA.
8. Non-Spring Return Actuators: All non-spring return actuators shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered. Spring return actuators with more than 60 in-lb torque shall have a manual crank for this purpose.
9. Modulating Actuators: All modulating actuators shall have an external, built-in switch to allow reversing direction of rotation.
10. Conduit Fitting & Pre-Wiring: Actuators shall be have a conduit fitting and a minimum 3ft electrical cable, and shall be pre-wired to eliminate the necessity of opening the actuator housing to make electrical connections.
11. U.L. Listing: Actuators shall be Underwriters Laboratories Standard 873 listed and Canadian Standards Association Class 4813 02 certified as meeting correct safety requirements and recognized industry standards.
12. Warranty: Actuators shall be designed for a minimum of 60,000 full stroke cycles at the actuator's rated torque and shall have a 2-year manufacturer's warranty, starting from the date of installation. Manufacturer shall be ISO9001 certified.
13. Controls valve actuator application fail-safe positions shall be as follows
 - a. AHU coils: normally open
 - b. Boilers: normally open
 - c. Chiller evaporator: normally open
 - d. Cooling tower isolation: normally open
 - e. Chiller condenser: normally open
 - f. Terminal equipment heating: normally open
 - g. Terminal equipment cooling: normally closed
 - h. Two-pipe changeover valves: fail to heating
- I. Control Valves: Factory fabricated U.S. forged and assembled electric control valves of type, body material, and pressure class indicated. Where type or body material is not

indicated, make selection as determined by manufacturer for installation requirements and pressure class, based on maximum pressure and temperature in piping system. The valve size shall be in accordance with scheduled or specified maximum pressure drop across control valve. Except as otherwise indicated, valves shall mate and match material of connecting piping. Equip control valves with control valve motor actuators, with proper shutoff rating for each individual application.

1. Water Service Valves: Equal percentage characteristics with rangeability of 50 to 1, Class 150 at 250°F and maximum full flow pressure drop 5 psig. Globe type with replaceable plugs and seats of stainless steel or brass. Select operators to close valves against pump shutoff head.
2. Double Seated Valves: Balanced plug type, with caged type trim providing seating and guiding surfaces on "top and bottom" guided plugs.
3. Valve Trim and Stems: Polished stainless steel.
4. Packing: Spring-loaded teflon, self-adjusting.
5. Terminal Unit Control Valves: Unless indicated otherwise, modulating, electrically actuated (by 24VAC max) control ball valves shall control terminal units including, but not necessarily limited to, convectors, finned tube radiation, and fan coil units that are of integral motor type.

J. Pressure-Independent Control Valves:

1. Valves shall have stainless-steel stems and stuffing boxes with extended necks to clear the piping insulation. Valve bodies shall meet ASME B16.34 or ASME B16.15 pressure and temperature class ratings based on the design operating temperature and 150 percent of the system design operating pressure. Valve leakage shall meet FCI 70-2 Class IV leakage rating (0.01 percent of valve Kv). Valves shall be two-way pressure independent globe-style bodies.
 - a. Bodies for valves 2 inches and smaller shall be brass or bronze, with union ends
 - b. Bodies for valves 2 to 3 inches shall be of brass, bronze or iron.
 - c. Bodies for valves 2.5 inches and larger shall have flanged-end connections.
 - d. Valve and actuator combination shall be normally open or normally closed as shown.
2. Two-Way Pressure Independent Globe Valve: The valve shall be two-way globe style with integrated differential pressure control regulator. Where indicated modulating proportional valve application shall utilize controller or actuator to match required control signal to complement controlled coil heat transfer characteristic for linear control. The valve shall have:
 - a. Integrated pressure regulator; regulator to control pressure across control valve orifice.

- b. Regulator incorporating EPDM diaphragm, stainless steel spring and pressure control disc. Pressure control seat shall be brass construction with vulcanized EPDM.
- c. Counterbalance of supply pipe pressure to return pipe pressure across diaphragm to prevent diaphragm damage when control valve is closed
- d. User adjustable maximum flow within valve control range; Adjustment method shall indicate percentage of valve flow range and utilize spring locked method of adjustment.
- e. The ability to regulate internal control valve differential pressure to have 100% control valve authority.
- f. shall have linear flow characteristic.
- g. Back seated globe design to allow service of packing under pressure without leakage.
- h. Entering to leaving (P1-P3) pressure control across low flow ½" valve in size from 2.3PSI - 60PSI.
- i. Entering to leaving (P1-P3) pressure control across valves ½" - ¾" in size from 5PSI - 60PSI.
- j. Entering to leaving (P1-P3) pressure control across valves 1" - 1¼" in size from 5PSI - 60PSI.
- k. Entering to leaving (P1-P3) pressure control across valves 1½" - 10" in size from 4PSI - 60PSI.
- l. Union connections for ½" - 2" valve size: ANSI flanged connections for 2.5" - 10" valve sizes
- m. Stainless steel internal trim with brass globe and seat.
- n. A Threaded actuator connection
- o. Flow requirements sized for nominal body selection no more than one size smaller to corresponding nominal pipe connection.
 - 1) ½" bodies shall be utilized for ½" and may be utilized for ¾" pipe connection and flow less than 5 GPM.
 - 2) ¾" bodies may be utilized for ¾" pipe and may be applied to 1" pipe connection with flow less than 7.5 GPM.
 - 3) 1" bodies may be utilized for 1" pipe and may be applied to 1¼" pipe connection with flow less than 12 GPM.
 - 4) 1¼" bodies may be utilized for 1¼" and may be applied to 1½" pipe connection with flow less than 17.5 GPM.
 - 5) 1½" bodies may be utilized for 1½" pipe and may be applied to 2" pipe connection with flows less than 33 GPM.
 - 6) Flows less than 55 GPM may use 2" bodies.
 - 7) Flows less than 85 GPM may use 2½" bodies.
 - 8) Flows less than 120 GPM may use 3" bodies.

- 9) Flows less than 165 GPM may use 4" bodies.
 - 10) Flows less than 395 GPM may use 5" bodies.
 - 11) Flows less than 640 GPM may use 6" bodies.
 - 12) Flows less than 830 GPM may use 8" bodies.
 - 13) Flows less than 1230 GPM may use 10" bodies.
- K. Dampers: Automatic control low leakage, opposed blade dampers, with damper frames not less than formed 13-gauged galvanized steel and mounting holes for enclosed duct mounting. Damper blades not less than formed 16-gauged galvanized steel, with maximum blade width of 8-inch. Equip dampers with motors of proper rating of each application.
1. Secure blades to ½ inch diameter zinc-plated axles using zinc-plated hardware. Seal off against spring stainless steel blade bearings. Blade bearings to be Nylon with thrust bearings at each end of every blade. Construct blade linkage hardware of zinc-plated steel and brass. Submit leakage and flow characteristics plus size schedule for controlled dampers.
 2. Operating Temperature Range: From -20° to 200°F (-29° to 93°C).
 3. For low leakage application or opposed blade design (as selected by manufacturers sizing techniques) with inflatable steel blade edging or replaceable rubber seals, rated for leakage less than 4 cfm per square foot of damper area, AR differential pressure of 4-inch w.g. when damper is being held by torque 50 inch-pounds.
 4. Outdoor air and exhaust air dampers shall be low leakage and thermally insulated.
- L. Electromagnetic Flow Meters
1. complete with all installation hardware necessary to enable insertion and removal of the meter without system shutdown. The flow meter shall be hand-insertable up to 400 psi. For installations in non-metallic pipe, install grounding rings or probes. Materials of construction for wetted metal components shall be 316 SS. The flow meter shall average velocity readings from two sets of diametrically opposed electrodes. Each flow meter shall be individually wet calibrated against a primary volumetric standard that is accurate to within 0.1% and traceable to NIST*. A certificate of calibration shall be provided with each flow meter. Accuracy shall be within ± 1% of rate from 2-20 ft/s. Overall turndown shall exceed 100:1. Output signals shall be completely isolated and shall consist of the following: (1) analog output; 4-20mA, 0-10V, or 0-5V jumper selectable, (1) scalable dry contact output for totalization, and (1) high resolution frequency output for use with peripheral devices such as an ONICON display module or Btu meter. Each flow meter shall be covered by the manufacturer's two-year warranty.
 2. Optional Flow Display: D-100 Series Display Module for network interface and local/remote indication of flow rate and total.
- M. Refrigerant Monitor: DST GS4B / DST GS32 or equal.

- N. Dual-Gas Monitoring Toxic and Combustible Gas Sensor, GS-1: Wall-mounted gas detector for monitoring carbon monoxide (CO) and methane (CH₄), installed as a standalone device with dual-gas monitoring. Accuracy: $\pm 3\%$ of full scale @ 25°C. Audible Alarm: >85 dBA at 3 m (10 ft). Visual Indicators: Green LED: Power, Amber LED 1: Alarm/Fault, Amber LED 2: Alarm/Fault. Display: 8 character, 2 line backlit LCD. Communications: 4-20mA. Relay Output: 2 DPDT relays, 5A @ 250Vac; 5A @ 30Vdc.
- O. Ultrasonic Flow Meters: Provide a clamp-on transit time ultrasonic flowmeter complete with matched transducers, self-aligning installation hardware and triaxial transducer cables and calibration certificate
1. Flowmeter shall consist of a processor / transmitter, matched pair of transducers and mounting hardware including pipe clamps and mounting bracket for the line size and material specified
 - a. Sensing Technology: Ultrasonic transit time velocity-measurement utilizing non-wetted transducers matched for the specific applications in terms of pipe size and pipe material
 - b. Enclosure: Wall mount, NEMA4X polycarbonate with clear shatterproof enclosure
 - c. Maximum Temperature Rating: 250 deg F
 - d. Meter shall have CE approval
 - e. Each flowmeter shall be covered by the manufacturer's two-year warranty
 2. Operation and Configuration
 - a. Flow Range: Flow-measuring element and transmitter shall cover operating range of equipment or system served.
 - b. Accuracy: Flowmeter shall have calibrated outputs directly from the transmitter, throughout the operating range with plus or minus 1.0% of flow rate from 1 to 20 ft/sec velocity
 - c. Calibration: Each flow meter shall be individually calibrated against a N.I.S.T. traceable standard and receive a certificate of calibration. Each flow meter shall be factory programmed based on the application data specified at time of order.
 - d. Transmitter and Display: Operator interface consisting of five pushbuttons. Display shall visually indicate instantaneous flow rate and total fluid volume. Output signals shall be RS485 serial network protocol, BACnet MS/TP or MODBUS RTU, native to the transmitter, two (2) programmable pulse outputs configured for totalizing pulse, flow direction or flow alarm indication and one (1) analog output signal.

- e. Flow meter shall be capable of operating from 24V ac/dc or 120V ac mains power.

PART 3 - EXECUTION

3.1 COORDINATION

- A. Power is to be sourced from existing electrical distribution system as necessary for the controls system. Must comply with the National Electrical Code.
- B. Test and Balance
 - 1. The contractor shall furnish a single set of all tools necessary to interface to the control system for test and balance purposes.
 - 2. The tools used during the test and balance process shall be returned to the contractor at the completion of the testing and balancing.

3.2 INSTALLATION

- A. Connect and configure equipment and software to achieve sequences of operations specified
- B. Verify location of exposed control sensors with architect prior to installation. Install devices 48 inches above the floor, or lower if necessary.
- C. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.

3.3 ELECTRICAL WIRING AND CONNECTION INSTALLATION

- A. Where Class 2 wires are in concealed and accessible locations; including ceiling return air plenums, approved cables outside of electrical raceway can be used if the following conditions are met:
 - 1. Circuits meet NEC Class 2 (current-limited) requirements. (Low-voltage power circuits shall be sub-fused when required to meet Class 2 current-limit.)
 - 2. All cables shall be UL listed for application (i.e., cables used in ceiling plenums shall be UL listed specifically for that purpose).
- B. Do not install Class 2 wiring in conduits containing Class 1 wiring. Boxes and panels containing high voltage may not be used for low voltage wiring except for the purpose of interfacing the two via control relays and transformers.
- C. Where Class 2 wiring is run exposed, wiring shall be run parallel along a surface or perpendicular to it, and bundled, using approved wire ties at no greater than 3 m (10 ft.)

intervals. Such bundled cable shall be fastened to the structure, using industry approved fasteners, at 1.5 m (5 ft.) intervals or more often to achieve a neat and workmanlike result.

- D. Maximum allowable voltage for control wiring shall be 120Vac. If only higher voltages are available for use, use step-down transformers to achieve the desired control voltages.
- E. All control wiring shall be installed as continuous lengths, where possible. Any required splices shall be made only within an approved junction box or other approved protective device.
- F. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment
- G. Install plenum wiring in sleeves where it passes through walls and floors. Maintain fire rating at all penetrations in accordance with Contract Documents and National and/or Local Codes.
- H. Control and status relays are to be located in pre-fabricated enclosures that meet the application. These relays may also be located within packaged equipment control panel enclosures as coordinated. These relays shall not be located within Class 1 starter enclosures.
- I. Follow manufacturer's installation recommendations for all communication and network bus cabling. Network or communication cabling shall be run separately from all control power wiring.
- J. BAS manufacturer shall terminate all control and/or interlock wiring and shall maintain updated (as-built) wiring diagrams with terminations identified at the job site.
- K. Flexible metal conduits and liquid-tight flexible metal conduits shall not exceed 3' in length and shall be supported at each end. Flexible metal conduit less than 1/2" electrical trade size shall not be used. In areas exposed to moisture, including chiller and boiler rooms, liquid-tight, flexible metal conduits shall be used.

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. 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 each point through its full operating range to verify that safety and operating control setpoints are as required.
4. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
5. Test each system for compliance with sequence of operation.
6. 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 flow instruments. Inspect tag number and line and bore size and verify that inlet side is identified and that meters are installed correctly.
5. Check control valves. Verify that they are in correct direction.
6. Check DDC system as follows:
 - a. a. Verify that wires at control panels are tagged with their service designation and approved tagging system.
 - b. b. Verify that DDC controllers are protected from power supply surges.

- D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.5 CONTROL SYSTEM DEMONSTRATION AND ACCEPTANCE

- A. Demonstration: A complete demonstration of the capabilities of the BAS system shall be performed by the BAS manufacturer's field personnel. The BAS manufacturer shall dedicate a minimum of (16) hours on-site with the Owner representatives, and Engineer to demonstrate a complete functional test of all the BAS system requirements. This BAS demonstration shall constitute an acceptance inspection, and will represent the process of approving the BAS as designed and specified. Functional testing shall include, but is not limited to, the following system level components where installed:
- B. Acceptance: The BAS will not be accepted as meeting the requirements of Completion until all tests described in this specification have been performed to the satisfaction of both the Engineer and Owner. Any tests that cannot be performed due to circumstances beyond the control of the Contractor may be exempt from the Completion requirements if stated as such in writing by the Owner's representative.

3.6 TRAINING

- A. Two training sessions of four (4) hours minimum per session, with sessions on separate days for the facility maintenance staff. The training shall review accessing the web based building automation system (BAS) by password, show how to navigate through each of the system's graphic screens to identify each of the parameters which are just monitored and what parameters can be adjusted (setpoints and schedules), review each of the alarms which can be sent to the BAS and how the maintenance staff should address each, and proper logging out of the system.
 - 1. Review with the maintenance staff current setpoints and instruct them how to adjust the setpoints. Instruct the staff in how to adjust equipment schedules and assist them in setting up each applicable schedule.
 - 2. Instruct the staff in system troubleshooting. Instruct them in setup of trending / data logging and how to review the resulting data.
 - 3. Instruct the staff how to do seasonal system startups and shutdowns.
 - 4. Perform a walk-through of the building and review the location of room sensors and unit controllers.

END OF SECTION 250923

SECTION 250993 - SEQUENCE OF OPERATIONS

1.1 GENERAL SUMMARY

- A. Section includes control sequences for direct digital controls for HVAC systems, subsystems, and equipment.

1.2 ACTION SUBMITTALS

- A. Product Data:
 - 1. An instrumentation points list for each controlled system. Label each element of the controlled system in table format. Show, in the table:
 - a. Point Number
 - b. Point Tag
 - c. Description
 - d. Manufacturer and Model Number
 - e. System
 - f. Equipment
 - g. Instrument Tag
 - h. Loop Number
 - i. Control Function Matrix identifying: Binary In (BI), Analog In (AI), Binary Out (BO), Analog Out (AO)
 - j. Ethernet Communication
 - k. Hardware Installation Matrix identifying: Original Equipment Manufacturer (OEM) provided, Field Installed, Existing Device
 - l. PLC or direct digital control panel ID
 - 2. A complete description of the operation of the control system, including sequences of operation. Include and reference a schematic diagram of the controlled system.
- B. Shop Drawings:
 - 1. Riser diagrams showing control network layout, communication protocol, and wire types.
 - 2. Schematic diagram of each controlled system. Include all control points labeled with point names shown or listed. Show the location of control elements in the system.
 - 3. Wiring diagram for each controlled system. Show all control elements labels. Where a control element is the same as that shown on the control system schematic, label with the same name. Label all terminals.

1.3 GENERAL

- A. Setpoints and schedules described in the operation of building systems are operator adjustable unless otherwise indicated.
- B. Provide digital input from fire alarm system to indicate activation of system. Coordinate interface with the electrical contractor.
- C. Data Logging: The building automation system trends all monitored values within a period of 1 year. The frequency of recording is adjustable from every 1 minute to 1 hour. The trends can be printed in the Microsoft Excel format with clearly defined headings.
- D. Global Point Summary:
 - a. Outdoor air temperature - AI
 - b. Outdoor air dewpoint Temperature - AI
 - c. Fire Alarm Status - BI
- E. Hardwired Safeties (always enabled)
 - 1. When provided, the duct smoke detectors shall shut down the supply and exhaust fans on a smoke condition through the fire alarm system. The unit shutdown wiring from the fire alarm system output module to the variable frequency drive shutdown circuit shall be provided and installed by the fire alarm contractor. The fire alarm system shall notify the building automation system to restore normal controls upon deactivation of fire alarm condition.
 - 2. The building automation system shall shut down the supply and exhaust fans upon abnormal current detected by the variable frequency drives and raise critical alarm.
- F. Freeze Protection:
 - 1. When any freezestat detects the temperature drops below 40°F (adjustable), the control valve is 100% open, the mixed air dampers are in the full return air position and the fan is off off.
- G. Space temperature setpoints:
 - 1. Occupied Cooling: 75°F (adjustable)
 - 2. Occupied Heating: 70°F (adjustable)
 - 3. Unoccupied Cooling: 80°F (adjustable)
 - 4. Unoccupied Heating: 60°F (adjustable)
 - 5. Maintain 5° dead band between heating and cooling setpoints for all systems.
- H. Occupied space cooling humidity set point: 50% RH
- I. Points for all equipment:
 - 1. Air Filter Timer: For all filters without differential pressure sensors, fan run compare fan run time to a filter maintenance timer setpoint which will notify the BAS at a user definable duration.

2. Alarms:
 - a. Variable frequency drive fault.
 - b. Fan failure: Commanded ON, but the status is OFF.
 - c. Fan running in hand: commanded OFF, but the status is ON.
 - d. Activation of the freezestat.

J. Typical Morning Start Up:

1. For all equipment, when space temperature reaches occupied space heating/cooling temperature setpoint, the system switches to occupied mode operation. Provide optimal start algorithm for morning warm-up mode to minimize warm-up period while achieving comfort conditions by the start of the scheduled occupied period.

K. Economizer Modes:

Units without energy recovery: When the space temperature rises above space cooling temperature setpoint and outdoor air temperature is less than space temperature, the mixed air damper modulates to increase outdoor air as required to maintain space cooling temperature setpoint. Provide low-limit override to prevent discharge air temperature from dropping below low limit setpoint of 55°F (adjustable) by modulating the mixed air damper to decrease the outdoor air without dropping below the minimum scheduled value.

PART 2 -

2.1 **HEATING/COOLING PLANT**

- A. Main system components
1. Boiler Primary Loop
 2. Dual temperature distribution pumps
 3. Chiller Primary Loop
 4. Heat Exchanger

2.2 **BOILER PRIMARY LOOP**

- A. Main System Components:
1. (3) Condensing boilers.
 2. (3) Boiler pumps, modulating with variable speed drives for speed control
- B. System Description
1. Heating hot water is provided to the primary loop by the condensing boilers and associated pumps which are in lead/lag/standby configuration.

- C. System Off
 - 1. Condensing boilers are off
 - 2. Boiler pumps are off.
- D. Boiler Heating Mode
 - 1. Boilers and boiler pumps stage/modulate to maintain heating hot water supply temperature (of the secondary loop) according to the boiler factory controls.
 - a. Heating hot water supply temperature shall be reset linearly in 5 °F (adjustable) increments based on OA temperature within the following range:
 - 1) 140°F (adjustable) when OAT is less than 20°F (adjustable)
 - 2) 120°F (adjustable) when OAT is greater than 40°F (adjustable)
- E. Hardwired Safeties (always enabled)
 - 1. Boilers shall shutdown upon detection of any of the following:
 - a. Low Water Level
 - b. High Heating Water Supply Temperature.
 - c. Emergency Boiler Shut-Down Activation
- F. Boiler Emergency Shut-down
 - 1. Provide manually reset momentary contact latching switch at each boiler room door. The switch shall be marked as "Emergency Boiler Shutdown".
 - 2. Wire boiler primary control circuits through switch to de-energize the boilers and close the gas control valve when the switch is depressed.
 - 3. An affected boiler shall be shut down upon the following alarm conditions:
 - a. Low water level alarm.
 - b. Flame failure.
 - c. High hot water supply temperature.
 - d. Flow below minimum flow.
- G. Alarms:
 - 1. Common boiler alarms via packaged boiler controls.
 - 2. Carbon monoxide/Natural gas detected. Interface with fire alarm system to initiate trouble at fire alarm panel.
 - 3. Pump Alarms
 - a. Pump failure: commanded ON, but the status is OFF.
 - b. Pump running in hand: commanded OFF, but the status is ON.
 - c. Pump runtime exceeded: status runtime exceeds a user definable limit.

2.3 **DUAL TEMPERATURE DISTRIBUTION PUMPS**

A. Main System Components:

1. (4) Distribution pumps, modulating with variable speed drives for speed control.

B. System Description

1. Dual temperature water is provided to the building (terminal units) by the distribution pumps.

C. System Off

1. Distribution pumps are off.

D. System On:

1. The distribution pumps modulate to maintain the loop differential pressure setpoint as measured by the TAB agency.
2. Pump modulation/staging:
 - a. The lead pump modulates to maintain differential pressure set point.
 - b. If the pump speed is at its minimum per the manufacturers recommendations, and the differential pressure of the system is above set point, the minimum flow bypass will modulate to maintain set point.
 - c. If the pump reaches 90% (adjustable) of it's maximum speed and the differential pressure remains below the setpoint, the lag pump starts and the pump speeds modulate to match while maintain differential pressure set point.
 - d. If both pumps reach 40% (Adj.) of their maximum speed and the system differential pressure remains above the setpoint, the lag pump will turn off.

E. Pump Alarms

1. Pump failure: commanded ON, but the status is OFF.
2. Pump running in hand: commanded OFF, but the status is ON.
3. Pump runtime exceeded: status runtime exceeds a user definable limit.

2.4 **CHILLER PRIMARY LOOP**

A. Main System Components:

1. Inverter driven heat-pump chillers and associated isolation valves, 2 -position.
2. Chiller pumps, constant speed with ECM for speed control.

B. System Description

1. In cooling mode, chilled water is provided to a primary loop by the chiller and associated pumps.

- C. System Off:
 - 1. Chillers are off.
 - 2. Chiller pumps are off.
- D. Cooling Mode:
 - 1. Chiller modules stage/modulate to maintain chilled water supply temperature of 44°F (adjustable) according to their factory controls when the outdoor air temperature is above 75°F (adjustable)
- E. Hardwired Safeties (always enabled)
 - 1. Chillers shall shutdown upon detection of any of the following:
 - a. Low Water Level
 - b. Low water Supply Temperature.
 - c. Flow below minimum flow.
 - d. Refrigerant leak.
- F. Alarms:
 - 1. Common chiller alarms via packaged chiller controls.
 - 2. Refrigerant leak detected. Interface with fire alarm system to initiate trouble at fire alarm panel.
 - 3. Pump Alarms
 - a. Pump failure: commanded ON, but the status is OFF.
 - b. Pump running in hand: commanded OFF, but the status is ON.
 - c. Pump runtime exceeded: status runtime exceeds a user definable limit.

2.5 **DUAL TEMPERATURE CHANGEOVER AND LOOP TEMPERATURE CONTROL**

- A. Main System Components:
 - 1. Dual temperature pressure independent control valve, modulating.
 - 2. Dual temperature 3-way bypass valve, 2 position.
 - 3. Dual temperature 2-way control valve, 2 position.
 - 4. Dual temperature 3-way bypass valve, 2 position.
- B. System Description
 - 1. A 3-way valve opens the dual temp loop to either chilled water or hot water. Separate two-way chilled water and hot water control valves modulate open and closed as the required capacity for heating or cooling in the dual temp loop varies.
- C. System Off
 - 1. Dual temperature pressure independent control valve is closed.

2. 3-way changeover valve is fully open to the HW position.
3. Dual temperature pumps off.

D. Boiler Heating Mode

1. Hot water pressure independent control valve modulates to maintain dual temperature supply temperature.
2. Dual temperature 3-way changeover valve is in the heating position.
3. Chilled water 2-way control valve is closed.

E. Cooling Mode

1. Chilled water pressure independent control valve modulates to maintain dual temperature supply temperature.
2. Dual temperature 3-way changeover valve is in the cooling position.
3. Hot water 2-way control valve is closed.

2.6 ENERGY RECOVERY UNIT

A. System Components

1. Energy recovery unit.
 - a. Supply fan, constant volume with variable frequency drive for automatic balancing and outdoor air damper, 2-position.
 - b. Exhaust fan, constant volume with variable frequency drive for automatic balancing and exhaust damper 2-position.
 - c. Energy recovery wheel with VFD modulating.

B. System Description

1. An energy recover unit on the roof provides tempered ventilation, and exhaust.

C. System Off

1. Energy recovery unit:
 - a. Supply fan is off and outdoor air damper is closed.
 - b. Exhaust fan is off and exhaust damper is closed.
 - c. Energy recovery wheel is off.

D. Start-Up:

1. Energy recovery unit:
 - a. Supply fan is on, and outdoor air damper is open.
 - b. Exhaust fan is on, and exhaust damper is open.
 - c. Energy recovery wheel is off.

E. Occupied Mode

1. Energy recovery unit:

- a. Supply fan is on, and outdoor air damper is open.
 - b. Exhaust fan is on, and exhaust damper is open.
 - c. Energy recovery wheel is on unless space temperature rises above space cooling temperature setpoint and outdoor air temperature is less than space temperature (economizer mode), then it slows to its minimum. Provide low-limit override to prevent discharge air temperature from dropping below low limit setpoint (default = 55°F) by modulating the speed of the wheel.
 - 1) Jog the wheel to prevent freezing.
 - d. Duct mounted exhaust air damper is open unless fume hood is commanded on, then it is closed.
- F. Unoccupied Mode:
- 1. Energy recovery unit:
 - a. Supply fan is off and outdoor air damper is closed.
 - b. Exhaust fan is off and exhaust damper is closed.
 - c. Energy recovery wheel is off.
 - d. When the motorized damper, MD-108B is open (interlocked to open whenever the kiln is energized), ERU-D shall be in occupied mode.

2.7 **CAFETERIA & KITCHEN**

- A. Main System Components
- 1. Air Handling Unit
 - a. Outdoor air damper, 2-position.
 - b. Supply fan, constant volume with VFD for automatic balancing.
 - c. Recirculation air damper, modulating.
 - d. Existing Kitchen Hood Exhaust fan and exhaust air damper, 2-position.
 - e. Dual temp coil pump, on/off.
 - 2. Kitchen hood exhaust fan, constant speed with variable frequency drive for balancing.
 - 3. Kitchen general exhaust fan, constant speed, and exhaust air damper, 2 position.
- B. System Description:
- 1. A roof mounted energy recovery unit provides cooling, heating, ventilation, and exhaust to the cafeteria. Transfer air is provided to the kitchen and exhausted through either the general exhaust fan or kitchen hood and a cabinet heater provides heating.
- C. System Off:
- 1. Air Handling Unit:
 - a. Outdoor air damper is closed.

- b. Supply fan is off.
 - c. Recirculation air damper is 100% open.
 - d. Exhaust fan is off and exhaust air damper is closed.
 - e. Dual temp coil pump is off.
 - 2. Kitchen hood exhaust fan is off.
 - 3. Kitchen general exhaust fan is off, and damper is closed.
- D. Start-Up
 - 1. Air Handling Unit:
 - a. Outdoor air damper is closed.
 - b. Supply fan is on.
 - c. Recirculation air damper is open.
 - d. Dual temp coil pump is on whenever mixed air temperature is below 40F.
 - 2. Kitchen hood exhaust fan is off.
 - 3. Kitchen general exhaust fan is off, and damper is closed.
- E. Occupied Mode
 - 1. Air Handling Unit:
 - a. Outdoor air damper is open.
 - b. Supply fan is on.
 - c. Recirculation air damper is open to provide minimum volumetric flow rate of outdoor air as scheduled unless space temperature rises above space cooling temperature setpoint and outdoor air temperature is less than space temperature (economizer mode), then the return air damper modulates to increase outdoor air as required to maintain space cooling temperature setpoint. Provide low-limit override to prevent discharge air temperature from dropping below low limit setpoint (default = 55°F) by modulating the mixed air damper to decrease the outdoor air without dropping below the minimum scheduled value.
 - d. Energy recovery wheel is on unless in economizer mode, then the wheel slows to its minimum speed.
 - 1) Jog the wheel to prevent freezing.
 - e. Exhaust fan modulates to match the outdoor air minus the sum of the kitchen fans that are in operation, and exhaust air damper is open.
 - f. Dual temp coil pump modulates to maintain space temperature setpoint.
 - 2. Kitchen hood exhaust fan is off unless it is commanded on.
 - 3. General exhaust fan is on unless kitchen hood is commanded on then it is off.
- F. Unoccupied Mode
 - 1. Kitchen hood exhaust fan is off unless it is commanded on.
 - 2. General exhaust fan is off.

2.8 **GYMNASIUM**

A. Main System Components

1. Air handling unit
 - a. Supply fan, constant volume.
 - b. Dual temp coil control valve, modulating.
 - c. Dual temp coil pump, on/off.
 - d. Mixed (outdoor and return) air damper, modulating.
2. Exhaust fan with ECM varying speed to track outside air damper position.

B. System Description:

1. The indoor air handling unit provides heating, cooling and ventilation. The outdoor air is supplied through a louver and gravity ventilators in the penthouse connected to the AHUs. During normal mode, each air handling unit brings in outdoor air as scheduled for normal operation.
2. Logging data: Provide CO2 sensor(s) in space. Space CO2 concentrations shall be recorded at not greater than 15-minute intervals.
3. The exhaust fan tracks the outdoor air damper position.

C. System Off

1. Air handling units:
 - a. Supply fan is off.
 - b. Dual temp coil control valve is closed.
 - c. Dual temp coil pump is off
 - d. Mixed air damper is in 100% return air position.
2. Exhaust fan is off and exhaust dampers are closed.
3. Relief dampers are closed.

D. Start-Up

1. Air handling units:
 - a. Supply fan is on.
 - b. Heating hot water coil control valve is 100% open.
 - c. Mixed air damper is in 100% return air position.
2. Exhaust fans are off and exhaust dampers are closed.
3. Relief dampers closed.

E. Occupied Mode

1. Air handling units:

- a. Supply fan is on.
 - b. Dual temp coil control valve modulates to maintain occupied space temperature setpoint.
 - c. Dual temp coil pump runs whenever mixed air temperature is below 40F, adj.
 - d. Mixed air damper modulates to provide outdoor air as scheduled for normal operation as measured by the air flow measuring station, unless the space temperature rises above space cooling temperature setpoint and outdoor air temperature is less than space temperature, then the mixed air damper modulates to increase outdoor air as required to maintain space cooling temperature setpoint. Provide low-limit override to prevent discharge air temperature from dropping below low limit setpoint of 55°F (adjustable) by modulating the mixed air damper to decrease the outdoor air without dropping below the minimum scheduled value.
2. The exhaust fan and the associated damper is open.
3. Relief damper is closed unless in event mode or economizer mode, then it is open.
- F. Event Mode – Scheduled through building automation by system operator.
 1. Air handling units:
 - a. Supply fan is on.
 - b. Dual temp coil control valve modulates to maintain occupied space temperature setpoint.
 2. When there is a scheduled event, the air handler brings in outdoor air as scheduled for normal operation. Occupancy shall be scheduled through building control system. In addition, occupancy shall be overridden on by manual control.
 3. Logging data: Provide CO2 sensor(s) in space. Space CO2 concentrations shall be recorded at not greater than 15-minute intervals. Relief dampers are open.
- G. Unoccupied Mode
 1. Air handling units:
 - a. Supply fan cycles.
 - b. Dual temp coil control valve is 100% open.
 - c. Mixed air damper is in 100% return air position.
 2. Exhaust fan is off and exhaust damper is closed.
 3. Relief dampers are closed.

2.9 **BATHROOM EXHAUST FAN – NEW AND EXISTING**

- A. System Components:

1. Exhaust fans, constant speed with ECM or VFD for balancing and associated damper.

B. System Description:

1. Exhaust fans provide exhaust during occupied mode.

C. Occupied Mode:

1. Exhaust fans are on, and dampers are open.

D. Unoccupied Mode:

1. Exhaust fans are off, and dampers are closed.

2.10 **BOILER ROOM VENTILATION FAN, F-M**

A. System Components:

1. Exhaust fans, constant speed with ECM for balancing and associated damper.

B. System Description:

1. Exhaust fans provide exhaust whenever the space temperature rises to 85F, adj.

2.11 **MACHINERY (CHILLER) ROOM VENTILATION FAN, F-D-B002**

A. System Components:

1. Exhaust fans, constant speed with ECM for balancing and associated damper.

B. System Description:

1. Exhaust fans provide exhaust whenever:
 - a. The machine room is occupied (interface with lighting occupancy sensor) or
 - b. The refrigerant monitor senses the presence of refrigerant or
 - c. The space temperature rises above 80F, adj.

2.12 **DISPLACEMENT VENTILATION UNITS & CHILLED BEAMS**

A. System Components:

1. Displacement ventilation units and chilled beams:
 - a. Dual temp (water) coil control valve, modulating.

B. System Description:

1. Displacement ventilation units or chilled beams provide supplemental heating and cooling, of the ventilation air provided by the energy recovery units..

C. System Off

1. Displacement ventilation units and chilled beams:
 - a. Dual temp (water) coil control valve is closed.

- D. System on:
 - 1. Displacement ventilation units and chilled beams:
 - a. Dual temp (water) coil control valve modulates to maintain space temperature setpoint.

2.13 **FAN COILS, BLOWER COIL, UNIT HEATERS, AIR CURTAIN**

- A. System Components:
 - 1. Fan coil, blower coil, air curtain and unit heater:
 - a. Supply fan, constant speed.
 - b. Dual temp (water) coil control valve, modulating.
- B. System Description:
 - 1. Fan coils and blower coil providing heating and cooling
 - 2. Fan coils, air curtain and unit heaters providing heat only
- C. System Off
 - 1. Fan coil:
 - a. Supply fan is off.
 - b. Dual temp (water) coil control valve is closed.
- D. System on:
 - 1. Fan coil:
 - a. Supply fan cycles.
 - b. Dual temp (water) coil control valve modulates to maintain space temperature setpoint.
 - c. When the dual temp system is in cooling mode, unit heaters, air curtain and fancoil units that are heating only units (no condensate drain), the coil control valve shall be fully closed.

2.14 **TYPICAL ROOF TOP UNIT – COOLING ONLY WITH DUCT MOUNTED HEATING COIL**

- A. System Components:
 - 1. Roof Top Unit.
 - a. Supply fan, modulating.
 - b. Mixed (outdoor and return) air damper, modulating.
 - c. DX, modulating. The refrigeration system is controlled by the unit's factory controller.
 - d. Exhaust fan, modulating.
 - e. (Where applicable) Indirect gas furnace, modulating.

2. (Where applicable) Ducted heating coil, hot water control valve, modulating.
- B. System Description:
 1. A roof top unit provides cooling, ventilation and exhaust and an indirect gas furnace provides heating.
- C. System Off:
 1. Roof Top Unit.
 - a. Supply fan is off.
 - b. Mixed air damper is in 100% return air position.
 - c. DX is off.
 - d. Exhaust fan is off and exhaust damper is closed.
 - e. (Where applicable) Indirect gas furnace is off.
 2. (Where applicable) Ducted heating coil, hot water control valve is closed.
- D. Start-Up:
 1. Roof Top Unit.
 - a. Supply fan is on.
 - b. Mixed air damper is in 100% return air position.
 - c. DX is on for cooling mode, otherwise it is off.
 - d. Exhaust fan is off and exhaust damper is closed.
 - e. (Where applicable) Indirect gas furnace is 100% on for heating mode, otherwise it is off.
 2. (Where applicable) Ducted heating coil, hot water control valve is open.
- E. Occupied Mode:
 1. Roof top unit:
 - a. Supply fan modulates as low as possible while maintaining occupied space temperature setpoint and minimum scheduled outdoor air quantity.
 - b. Mixed air damper opens to provide minimum volumetric flow rate of outdoor air as scheduled, unless economizer mode is activated.
 - c. DX modulates to maintain occupied space temperature setpoint in cooling mode, otherwise it is off.
 - d. Exhaust fan is on, and exhaust damper is open.
 - e. Ducted hot water coil control valve shall modulate to maintain occupied space temperature set point in heating mode, otherwise it is fully closed.
- F. Unoccupied Mode:

1. Roof top unit:
 - a. Supply fan cycles to maintain unoccupied temperature set point.
 - b. Mixed air damper is in 100% return air position.
 - c. DX is on for cooling mode otherwise it is off.
 - d. Exhaust fan is off, and exhaust damper is closed.
 - e. Ducted heating hot water coil control valve is open.

2.15 **DUCTLESS SPLIT UNITS**

- A. Unit controls shall be provided by equipment manufacturer as specified in Section 238240.
- B. Provide BACnet communications interface. Controls are built into the units and shall communicate with the building automation system. Display all available points on system graphic user interface.
- C. The system shall be always on to maintain space temperature not exceeding set point 80°F (adj.) 24 hours a day and 7 days a week.
- D. The DX split system shall be wired for normal and emergency power service.
- E. Alarms
 1. Provide remote alarm at the BAS work station for the following
 - a. Room temperature exceeding 90°F (adj.)
 - b. Temperature sensor failure
 - c. Indoor or outdoor unit failure
 - d. Any other alarms provided by the manufacturer

2.16 **TYPICAL CONVECTOR**

- A. System Description:
 1. Convector
 - a. Control valve modulates to maintain perimeter heat set point.
 - b. Whenever the dual temp system is in cooling mode, the control valve shall be fully closed.

END OF SECTION 230993

SECTION 260502 – ELECTRICAL DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

- A. Description of Work: Provide electrical removal work as indicated and as required for removal and/or abandonment of systems, equipment and devices, etc. made obsolete by this Project, and as required for removal and remodeling by the other trades.

1.2 EXISTING CONDITIONS

- A. General: In general, existing electrical systems, equipment and devices are not shown on the Drawings unless pertinent to the demolition and/or remodeling work. Existing electrical conditions, where indicated, are based on casual field observations, and must be verified. Report any discrepancies to the Engineer before disturbing the existing installation.
- B. Examination: Prior to bidding, examine the site to determine all actual observable conditions. No additional compensation will be granted on account of extra work made necessary by the Contractor's failure to investigate such existing conditions.

1.3 COORDINATION

- A. Adjoining Areas: It is expected that the Contractor understands that adjoining areas of the building (or project site) must remain in operation and electrical systems and services must remain in operation at all times, unless specifically approved otherwise.
- B. Scheduling: Electrical removal work shall be scheduled in conjunction with the other trades. Contractor cooperation will be expected under all conditions.
- C. Area Limits: Construction traffic and removal of debris will be limited to specific areas and routes. Confirm with the Owner.

1.4 ADJACENT MATERIALS

- A. Protection: During execution of removal work, primary consideration shall be given to protecting from damage, building structure, furnishings, finishes and the like, which are not specifically indicated to be removed.

- B. Repairs: Existing items or surfaces to remain, which are damaged as a result of this work shall be refinished, repaired or replaced to the satisfaction of the Owner, at no cost to the Contract.

1.5 TRANSIENT SERVICES

- A. Locate and identify any and all electrical services passing through the project area which serve areas outside the work limits.
- B. Maintain all electrical services to areas outside the work limits unless specifically authorized otherwise in writing by the Engineer or Owner's Representative. When transient services must be interrupted, provide temporary services for affected areas outside the work limits.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Patching: Materials used for patching shall be in conformance with the applicable sections of the Project Manual. Where materials are not specifically described, but required for proper completion of the Work, they shall be as selected by the Contractor, subject to approval of the Engineer.

PART 3 - EXECUTION

3.1 INSPECTION/VERIFICATION

- A. Inspection: Before commencing work of this Section, carefully inspect the project site and become familiar with existing systems and conditions.
- B. Items to be Salvaged: Verify with the Engineer and Owner's Representative, all systems, materials and equipment which are to be salvaged, and those which must be removed. The Owner reserves the right to salvage any or all existing electrical materials and equipment at the project site. Items to be salvaged include, but not limited to, the following: Fire Alarm System Components, Lighting Fixtures, Clocks and Copper Feeders Size #4 AWG and Larger. Return these items to Owner, as directed.

3.2 COORDINATION

- A. Coordinate all removal work with all other trades and utility companies, where applicable.

3.3 DEMOLITION

- A. General: Remove electrical equipment, devices, raceways, wiring and related materials within the project work limits, as indicated.
- B. Observe and follow established Lockout/Tagout procedures as applied to the specified scope of work for this project. Standardized procedures are based on the United States Department of Labor – Occupational Safety and Health Administration Standard No. 1910.147 – The Control of Hazardous Energy. Fully coordinate Lockout/Tagout procedures established for use within all School District buildings.
- C. Disconnections: Disconnect all electrical devices and equipment located in wall, ceilings or floors scheduled for removal and other equipment, as indicated. Disconnect electrical connections to mechanical and other equipment being removed by other trades.
- D. Wiring Removals: Where existing electrical devices or equipment are indicated or required to be removed, remove all associated wiring. Remove all abandoned or dead wiring back to source or last active device as applicable.
- E. Raceway Removals: Remove all abandoned raceway, boxes, supports, etc. where exposed (including those located above existing or new suspended ceilings and those located in cellars), and where they interfere with new work of any trade. Cut conduits flush with walls and floors and cap.
- F. Protection: Perform all removal work in such a manner so that damage to adjacent items and surfaces is minimized.
- G. Patching: When electrical materials are removed, patch and finish wall, surfaces, etc. to match surrounding surfaces. Provide blank cover plates as required etc.

3.4 EXISTING ELECTRICAL WORK TO REMAIN

- A. General: Protect and maintain access to existing electrical work which must remain. Reinstall existing electrical work disturbed.
- B. Reconnections: Where electrical work in adjoining areas or electrical work indicated to remain, becomes disconnected or affected by demolition work, reconnect circuits, etc., as

required, to restore original operation. Restoration work to comply with requirements for new work.

3.5 EXISTING ELECTRICAL WORK TO BE RELOCATED

- A. General: Disconnect, remove, reinstall and reconnect existing devices and equipment indicated to be relocated and where require to accommodate remodeling or new construction. Extend existing installations as required. Materials and methods used for relocations and extensions to conform to requirements for new work.

3.6 SHUTDOWNS

- A. General: All shutdowns to existing electrical services to be scheduled and approved, in writing, by the Owner.

3.7 DISPOSITION OF EXISTING MATERIALS AND EQUIPMENT

- A. Items to Salvage: Material and equipment which is indicated (or directed by Owner) to be salvaged, shall be carefully removed and stored where directed on the site.
- B. Items to Reuse/Relocate: Carefully remove and store on site, all material and equipment indicated to be reused or relocated. Thoroughly clean, and make any necessary minor repairs to such equipment, prior to installation.
- C. Items to Remove: Remove and legally dispose of all other materials and debris resulting from demolition work on a daily basis.

3.8 CLEANING

Remove from the Project Site all dirt, dust and debris resulting from removal operations on a daily basis. Refuse shall not be allowed to block or otherwise impair circulation in corridors, stairs, sidewalks, roadways or other traffic areas.

END OF SECTION 260502

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Copper building wire rated 600 V or less.
2. Metal-clad cable, Type MC, rated 600 V or less.
3. Connectors, splices, and terminations rated 600 V and less.

1.2 SUBMITTALS

- A. Product Data: For each type of product.
- B. Product Schedule: Indicate type, use, location, and termination locations.
- C. Field quality-control reports.

1.3 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of NETA.
1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

PART 2 - PRODUCTS

2.1 COPPER BUILDING WIRE

- A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.
- B. Standards:
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
 2. RoHS compliant.
 3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

- C. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.
- D. Conductor Insulation:
 - 1. Type THHN and Type THWN-2: Comply with UL 83.
 - 2. Type XHHW-2: Comply with UL 44.

2.2 METAL-CLAD CABLE, TYPE MC

- A. Description: A factory assembly of one or more current-carrying insulated conductors in an overall metallic sheath.
- B. Standards:
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
 - 2. Comply with UL 1569.
 - 3. RoHS compliant.
 - 4. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
- C. Circuits:
 - 1. Single circuit and multi-circuit with color-coded conductors.
- D. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.
- E. Ground Conductor: Insulated.
- F. Conductor Insulation:
 - 1. Type TFN/THHN/THWN-2: Comply with UL 83.
 - 2. Type XHHW-2: Comply with UL 44.
- G. Armor: Steel, interlocked.
- H. Jacket: PVC applied over armor (when specified).

2.3 CONNECTORS AND SPLICES

- A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as

defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

2.4 INSULATING TAPE

- A. Provide vinyl plastic tape that meets the requirements of UL 510 and has the following characteristics:
1. 8.5 Mil minim thickness.
 2. ASTM D-3005 Standard specification for low-temperature resistant vinyl Chloride plastic pressure-sensitive electrical insulating type – type1.
 3. Rated 600 volts and 150°C, suitable for indoor and outdoor applications.
 4. Retains flexibility, adhesion, and applicable at temperature ranges from 0 through 100°F without loss of physical or electrical properties.
 5. Resistant to abrasion, moisture, alkalis, acid, corrosion, and sunlight
 6. Tape manufacturer: 3M "Scotch Super 88" or approved equal.

2.5 MANUFACTURERS

- A. Wire Manufacturers: subject to compliance with requirements, provide products by one of the following (no exceptions):
1. Southwire Company
 2. General Cable
 3. The Okonite Company
- B. Connectors Manufacturers: subject to compliance with requirements, provide products by one of the following (no exceptions):
1. Hubbell
 2. Thomas & Betts
 3. 3M Company

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders/Branch circuits: Copper; solid for No. 10 AWG and No. 12 AWG; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Exposed Branch Circuits, Including in Crawlspace: Type THHN/THWN-2, single conductors in raceway.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- B. Contract drawings do not indicate size of branch circuit wiring; use No.12 AWG as a minimum wire size for branch circuit wiring. For 20 Ampere branch circuits whose length from the panel to the furthest outlet exceeds 100 feet for 120-volt circuits or 150 feet for 277-volt circuits; use No. 10 AWG or larger for the entire branch circuit installation.
- C. Complete raceway installation between conductor and cable termination points prior to pulling conductors and cables.
- D. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- E. Do not install wire in incomplete conduit runs nor until after concrete work and plastering is completed and moisture is swabbed from the conduits. Eliminate splices where possible. Where necessary, splice in readily accessible pull, junction or outlet box.
- F. Take precautions to avoid entrance of dirt and water into the conduit and cuts. Clean conduits and ducts to remove and pulling compound prior to pulling cables. Do not damage conductor insulation, braid jacket or sheath during installation. Any damaged conductors shall be replaced immediately.
- G. Use pulling means, including fish tape, cable, rope, cable reels on jacks, and basket-weave wire/cable grips, that will not damage cables or raceway. Do not exceed maximum recommended pulling tension of wire and cable
- H. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.
- I. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- B. Except where lugs are furnished with equipment, Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
- C. Circumferential compression type connector (provide for splices and connections No. 6 AWG and larger)
 - 1. Use for incoming and outgoing cable connections at enclosures and for ground connections.
 - 2. Use manufacturer's approved tool and correct size hex head with embossed die number on the connector or lug.
 - 3. Make crimped indentions parallel with insulation putty.
 - 4. Fill voids and irregularities with insulation putty.
 - 5. Cover nearly with four (4) layers of vinyl plastic tape except where insulated covers are permitted; half-lap tape in two (2) directions.
- D. Wiring at Outlets: Install conductor at each outlet, with at least 12 inches of slack.

3.5 IDENTIFICATION

- A. Identify each spare conductor at each end with identity number and location of other end of conductor and identify as spare conductor.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies.

3.7 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to the project specifications.

3.8 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections.
 - 1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
 - 2. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors and conductors feeding the following critical equipment and services for compliance with requirements:
 - 3. Perform each of the following visual and electrical tests:
 - a. Inspect exposed sections of conductor and cable for physical damage and correct connection.
 - b. Test bolted connections for high resistance using one of the following:
 - 1) A low-resistance ohmmeter.
 - 2) Calibrated torque wrench.
 - c. Inspect compression-applied connectors for correct cable match and indentation.
 - d. Inspect for correct identification.
 - e. Inspect cable jacket and condition.
 - f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable for a one-minute duration.
 - g. Continuity test on each conductor and cable.
 - h. Uniform resistance of parallel conductors.
 - i. Insulation resistance to comply with ICEA values.
- E. Cables will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports to record the following:
 - 1. Procedures used.
 - 2. Results that comply with requirements.
 - 3. Results that do not comply with requirements, and corrective action taken to achieve compliance with requirements.

END OF SECTION 260519

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SECTION 260523 - CONTROL-VOLTAGE ELECTRICAL POWER CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Category 6 balanced twisted pair cable.
 - 2. Balanced twisted pair cabling hardware.
 - 3. RS-485 cabling.
 - 4. Low-voltage control cabling.
 - 5. Control-circuit conductors.
 - 6. Identification products.

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.
- C. Plenum: A space forming part of the air distribution system to which one or more air ducts are connected. An air duct is a passageway, other than a plenum, for transporting air to or from heating, ventilating, or air-conditioning equipment.

1.4 ACTION SUBMITTALS

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

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Accredited by NETA.
 - 1. Testing Agency's Field Supervisor: Currently certified by BICSI to supervise on-site testing.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262, by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.
 - 1. Flame Travel Distance: 60 inches (1520 mm) or less.
 - 2. Peak Optical Smoke Density: 0.5 or less.
 - 3. Average Optical Smoke Density: 0.15 or less.
- C. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.
- D. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.
- E. RoHS compliant.

2.2 CATEGORY 6 BALANCED TWISTED PAIR CABLE

- A. Description: Four-pair, balanced-twisted pair cable, with internal spline, certified to meet transmission characteristics of Category 6 cable at frequencies up to 250MHz.
- B. Standard: Comply with NEMA WC 66/ICEA S-116-732 and TIA-568-C.2 for Category 6 cables.
- C. Conductors: 100-ohm, 23 AWG solid copper.
- D. Shielding/Screening: Unshielded twisted pairs (UTP)
- E. Cable Rating: Plenum.
- F. Jacket: Blue thermoplastic.

2.3 BALANCED TWISTED PAIR CABLE HARDWARE

- A. Description: Hardware designed to connect, splice, and terminate balanced twisted pair copper communications cable.
- B. General Requirements for Balanced Twisted Pair Cable Hardware:
 - 1. Comply with the performance requirements of Category 6.
 - 2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.
 - 3. Cables shall be terminated with connecting hardware of same category or higher.
- C. Source Limitations: Obtain balanced twisted pair cable hardware from single source from single manufacturer.
- D. Connecting Blocks: 110-style IDC for Category 6. Provide blocks for the number of cables terminated on the block, plus 25 percent spare, integral with connector bodies, including plugs and jacks where indicated.
- E. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.
 - 1. Number of Terminals per Field: One for each conductor in assigned cables.
- F. Patch Panel: Modular panels housing numbered jack units with IDC-type connectors at each jack location for permanent termination of pair groups of installed cables.
 - 1. Features:
 - a. Universal T568A and T568B wiring labels.
 - b. Labeling areas adjacent to conductors.
 - c. Replaceable connectors.
 - d. 24 or 48 ports.
 - 2. Construction: 16-gauge steel and mountable on 19-inch (483 mm) equipment racks.
 - 3. Number of Jacks per Field: One for each four-pair cable.
- G. Patch Cords: Factory-made, four-pair cables in 36-inch (900-mm) lengths; terminated with an eight-position modular plug at each end.
 - 1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure performance. Patch cords shall have latch guards to protect against snagging.
 - 2. Patch cords shall have color-coded boots for circuit identification.

H. Plugs and Plug Assemblies:

1. Male; eight position; color-coded modular telecommunications connector designed for termination of a single four-pair 100-ohm unshielded or shielded balanced twisted pair cable.
2. Comply with IEC 60603-7-1, IEC 60603-7-2, IEC 60603-7-3, IEC 60603-7-4, and IEC 60603-7.5.
3. Marked to indicate transmission performance.

I. Jacks and Jack Assemblies:

1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair 100-ohm unshielded or shielded balanced twisted pair cable.
2. Designed to snap-in to a patch panel or faceplate.
3. Standards:
 - a. Category 6, unshielded balanced twisted pair cable shall comply with IEC 60603-7-4.
 - b. Category 6, shielded balanced twisted pair cable shall comply with IEC 60603-7.5.
4. Marked to indicate transmission performance.

J. Faceplate:

1. Four port, vertical single-gang faceplates designed to mount to single-gang wall boxes.
2. Eight port, vertical double-gang faceplates designed to mount to double-gang wall boxes.
3. Plastic Faceplate: High-impact plastic. Coordinate color with Section 262726 "Wiring Devices."
4. Metal Faceplate: Stainless steel, complying with requirements in Section 262726 "Wiring Devices."
5. For use with snap-in jacks accommodating any combination of balanced twisted pair, optical fiber, and coaxial work area cords.
 - a. Flush mounting jacks, positioning the cord at a 45-degree angle.

K. Legend:

1. Machine printed, in the field, using adhesive-tape label.
2. Snap-in, clear-label covers and machine-printed paper inserts.

2.4 RS-485 CABLE

A. Standard Cable: NFPA 70, Type CMG.

1. Paired, one pair twisted, No. 22 AWG, stranded (7x30) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1685.

B. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, one pair No. 22 AWG, stranded (7x30) tinned-copper conductors.
2. Fluorinated ethylene propylene insulation.
3. Unshielded.
4. Fluorinated ethylene propylene jacket.
5. Flame Resistance: NFPA 262.

2.5 LOW-VOLTAGE CONTROL CABLE

A. Paired Cable: NFPA 70, Type CMG.

1. One pair, twisted, No. 18 AWG, stranded (19x30)] tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1685.

B. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.

1. One pair, twisted, No. 18 AWG, stranded (19x30) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with NFPA 262.

2.6 CONTROL-CIRCUIT CONDUCTORS

- A. Class 1 Control Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.
- B. Class 2 Control Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.

- C. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.
- D. Class 2 Control Circuits and Class 3 Remote-Control and Signal Circuits That Supply Critical Circuits: Circuit Integrity (CI) cable.
 - 1. Smoke control signaling and control circuits.

2.7 FIRE-ALARM WIRE AND CABLE

- A. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.
- B. Signaling Line Circuits: Twisted, shielded pair, not less than No. 18 AWG or as recommended by system manufacturer.
 - 1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire-alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a two-hour rating.
- C. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation, and complying with requirements in UL 2196 for a two-hour rating.
 - 1. Low-Voltage Circuits: No. 16 AWG, minimum, in pathway.
 - 2. Line-Voltage Circuits: No. 12 AWG, minimum, in pathway.
 - 3. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor with outer jacket with red identifier stripe, NRTL listed for fire-alarm and cable tray installation, plenum rated.

2.8 SOURCE QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to evaluate cables.
- B. Factory test twisted pair cables according to TIA-568-C.2.
- C. Cable will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Test cables on receipt at Project site.
 - 1. Test each pair of twisted pair cable for open and short circuits.

3.2 INSTALLATION OF RACEWAYS AND BOXES

- A. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for raceway selection and installation requirements for boxes, conduits, and wireways as supplemented or modified in this Section.
 - 1. Outlet boxes shall be no smaller than 2 inches (50 mm) wide, 3 inches (75 mm) high, and 2-1/2 inches (64 mm) deep.
 - 2. Outlet boxes for cables shall be no smaller than 4 inches (102 mm) square by [1-1/2 inches (38 mm)] [2-1/8 inches (53 mm)] deep with extension ring sized to bring edge of ring to within 1/8 inch (3.1 mm) of the finished wall surface.
 - 3. Flexible metal conduit shall not be used.
- B. Comply with TIA-569-D for pull-box sizing and length of conduit and number of bends between pull points.
- C. Install manufactured conduit sweeps and long-radius elbows if possible.
- D. Raceway Installation in Equipment Rooms:
 - 1. Position conduit ends adjacent to a corner on backboard if a single piece of plywood is installed, or in the corner of the room if multiple sheets of plywood are installed around perimeter walls of the room.
 - 2. Install cable trays to route cables if conduits cannot be located in these positions.
 - 3. Secure conduits to backboard if entering the room from overhead.
 - 4. Extend conduits 3 inches (75 mm) above finished floor.
 - 5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Comply with NECA 1.
- B. General Requirements for Cabling:

1. Comply with TIA-568-C Series of standards.
2. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems."
3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
4. Cables may not be spliced and shall be continuous from terminal to terminal. Do not splice cable between termination, tap, or junction points.
5. Cables serving a common system may be grouped in a common raceway. Install network cabling and control wiring and cable in separate raceway from power wiring. Do not group conductors from different systems or different voltages.
6. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Install lacing bars and distribution spools.
8. Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.
9. Cold-Weather Installation: Bring cable to room temperature before dereeling. Do not use heat lamps for heating.
10. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems." Monitor cable pull tensions.
11. Support: Do not allow cables to lie on removable ceiling tiles.
12. Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.
13. Provide strain relief.
14. Keep runs short. Allow extra length for connecting to terminals. Do not bend cables in a radius less than 10 times the cable OD. Use sleeves or grommets to protect cables from vibration at points where they pass around sharp corners and through penetrations.
15. Ground wire shall be copper, and grounding methods shall comply with IEEE C2. Demonstrate ground resistance.

C. Balanced Twisted Pair Cable Installation:

1. Comply with TIA-568-C.2.
2. Install termination hardware as specified in Section 271513 "Communications Copper Horizontal Cabling" unless otherwise indicated.
3. Do not untwist balanced twisted pair cables more than 1/2 inch (12 mm) at the point of termination to maintain cable geometry.

D. Installation of Control-Circuit Conductors:

1. Install wiring in raceways.
2. Use insulated spade lugs for wire and cable connection to screw terminals.
3. Comply with requirements specified in Section 260533 "Raceways and Boxes for Electrical Systems."

E. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend copper cable not in a wireway or pathway a minimum of 8 inches (200 mm) above ceilings by cable supports not more than 30 inches (760 mm) apart.
3. Cable shall not be run through or on structural members or in contact with pipes, ducts, or other potentially damaging items. Do not run cables between structural members and corrugated panels.

F. Separation from EMI Sources:

1. Comply with BICSI TDDMM and TIA-569-D recommendations for separating unshielded copper voice and data communications cable from potential EMI sources including electrical power lines and equipment.
2. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
 - b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
 - c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 12 inches (305 mm).
3. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - a. Electrical Equipment or Circuit Rating Less Than 2 kVA: No requirement.
 - b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 3 inches (75 mm).
 - c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 6 inches (150 mm).
4. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or 5 HP and Larger: A minimum of 48 inches (1200 mm).

5. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

3.4 REMOVAL OF CONDUCTORS AND CABLES

- A. Remove abandoned conductors and cables. Abandoned conductors and cables are those installed that are not terminated at equipment and are not identified with a tag for future use.

3.5 CONTROL-CIRCUIT CONDUCTORS

- A. Minimum Conductor Sizes:
 1. Class 1 remote-control and signal circuits; No 14 AWG.
 2. Class 2 low-energy, remote-control, and signal circuits; No. 16 AWG.
 3. Class 3 low-energy, remote-control, alarm, and signal circuits; No 12 AWG.

3.6 FIRESTOPPING

- A. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Comply with TIA-569-D, Annex A, "Firestopping."
- C. Comply with BICSI TDMM, "Firestopping" Chapter.

3.7 GROUNDING

- A. For data communication wiring, comply with TIA-607-B and with BICSI TDMM, "Bonding and Grounding (Earthing)" Chapter.
- B. For low-voltage control wiring and cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.8 IDENTIFICATION

- A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Identify data and communications system components, wiring, and cabling according to TIA-606-B; label printers shall use label stocks, laminating adhesives, and inks complying with UL 969.

- C. Identify each wire on each end and at each terminal with a number-coded identification tag. Each wire shall have a unique tag.

3.9 FIELD QUALITY CONTROL

- A. Perform tests and inspections with the assistance of a factory-authorized service representative.
- B. Tests and Inspections:
 - 1. Visually inspect cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA-568-C.1.
 - 2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
 - 3. Test cabling for direct-current loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination, but not after cross-connection.
 - a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in its "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in its "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
- C. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.
- D. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

END OF SECTION 260523

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SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Provide a complete grounding system in accordance with the Contract Documents and as specified herein.

1.2 SUBMITTALS

- A. Minimum 1/8" scale floor plan drawings depicting the building ground electrode system as to be installed.
- B. Detailed riser diagram depicting the building ground electrode system and bonding as to be installed.
- C. Product data sheets (cut sheets) for all ground bus bars and other components of the grounding system.
- D. Field test reports.

1.3 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Certified by NETA.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

2.2 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
 - 1. Solid Conductors: ASTM B 3.
 - 2. Stranded Conductors: ASTM B 8.
 - 3. Tinned Conductors: ASTM B 33.
 - 4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
 - 5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
 - 6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
 - 7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

2.3 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bus-Bar Connectors: Compression type, copper or copper alloy, with two wire terminals.
- C. Cable-to-Cable Connectors: Compression type, copper or copper alloy.
- D. Conduit Hubs: Mechanical type, terminal with threaded hub.
- E. Lay-in Lug Connector: Mechanical type, copper rated for direct burial terminal with set screw.
- F. Straps: Solid copper, copper lugs. Rated for 600 A.
- G. U-Bolt Clamps: Mechanical type, copper or copper alloy, terminal listed for direct burial.
 - 1. Mechanical type, two pieces with stainless-steel bolts.
 - a. Material: Die-cast zinc alloy.
 - b. Listed for direct burial.
 - 2. U-bolt type with malleable-iron clamp and copper ground connector.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No.8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
- B. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
 - 3. Connections to Ground Rods at Test Wells: Bolted connectors.

3.2 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Poles Supporting Outdoor Equipment: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors. Refer details on drawings.

3.3 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
 - 1. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections with the assistance of a factory-authorized service representative.
- B. Tests and Inspections:
 - 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.

2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
- C. Grounding system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.
- E. Report measured ground resistances that exceed the following values:
 1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.

Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Engineer promptly and include recommendations to reduce ground resistance.

END OF SECTION 260526

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Hangers and supports for electrical equipment and systems.

1.2 SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
 - a. Hangers.
 - b. Steel slotted support systems.
 - c. Nonmetallic support systems.
 - d. Trapeze hangers.
 - e. Clamps.
 - f. Turnbuckles.
 - g. Sockets.
 - h. Eye nuts.
 - i. Saddles.
 - j. Brackets.
2. Include rated capacities and furnished specialties and accessories.

B. Shop Drawings: For fabrication and installation details for electrical hangers and support systems.

1. Trapeze hangers. Include product data for components.
2. Steel slotted-channel systems.
3. Nonmetallic slotted-channel systems.
4. Equipment supports.

C. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Structural members to which hangers and supports will be attached.

3. Size and location of initial access modules for acoustical tile.
4. Items penetrating finished ceiling, including the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Projectors.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4 factory-fabricated components for field assembly.
 1. Channel Width: 1-5/8 inches.
 2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 5. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
 6. Channel Dimensions: Selected for applicable load criteria.
- B. Aluminum Slotted Support Systems: Comply with MFMA-4 factory-fabricated components for field assembly.
 1. Channel Width: 1-5/8 inches.
 2. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 3. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 4. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
 5. Channel Dimensions: Selected for applicable load criteria.
- C. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with minimum 13/32-inch-diameter holes at a maximum of 8 inches o.c., in at least one surface.
 1. Channel Width: 1-5/8 inches.

2. Fittings and Accessories: Products provided by channel and angle manufacturer and designed for use with those items.
 3. Fitting and Accessory Materials: Same as those for channels and angles, except metal items may be stainless steel.
 4. Rated Strength: Selected to suit applicable load criteria.
 5. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- D. Conduit and Cable Support Devices: Steel, Stainless-steel or Glass-fiber-resin hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.
- F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M steel plates, shapes, and bars; black and galvanized.
- G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
 5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 6. Toggle Bolts: Stainless-steel springhead type.
 7. Hanger Rods: Threaded steel.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems unless requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMTs, IMCs, and RMCs as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this article.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts.
 - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4. To Existing Concrete: Expansion anchor fasteners.
 - 5. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
 - 6. To Light Steel: Sheet metal screws.
 - 7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.

- D. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- B. Field Welding: Comply with AWS D1.1/D1.1M.

END OF SECTION 260529

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SECTION 260533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal conduits, tubing, and fittings.
2. Metal wireways and auxiliary gutters.
3. Surface raceways.
4. Boxes, enclosures, and cabinets.
5. Pull and junction boxes.
6. Floor Boxes.
7. Recessed Outlet Poke-Through Devices.

1.2 DEFINITIONS

- A. EMT: Electrical metallic tubing
- B. FMC: Flexible metal conduit
- C. GRC: Galvanized rigid steel conduit.
- D. MC: Metal Clad Cable
- E. LFMC: Liquid-tight flexible metal conduit
- F. RNC: Rigid nonmetallic conduit

1.3 SUBMITTALS

- A. Product Data: For Cable, conduit, surface raceways, wireways and fittings, pull boxes, floor boxes, hinged-cover enclosures, and cabinets.

PART 2 - PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

- A. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. GRC: Comply with ANSI C80.1 and UL 6.
- C. MC: Comply with UL 1569 and NEC article 330.
- D. EMT: Comply with ANSI C80.3 and UL 797.
- E. FMC: Comply with UL 1; single strip, continuous, flexible interlocked double-wrapped steel, galvanized inside and outside forming smooth internal wiring channel.
- F. LFMC: Flexible steel conduit with PVC jacket, UV stable, machine tool gray in color, lightweight aluminum core internal construction and complying with UL 360.
- G. Metal Fittings: Comply with NEMA FB 1 and UL 514:
 - 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
 - 2. Fittings for EMT:
 - a. Set-screw type.
 - b. In slab or concrete work, concrete tight fittings
 - 3. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
 - 4. Fittings for LFMC: Body, gland and lock nut shall be steel of malleable iron. Ground cone shall be steel, sealing ring and insulator shall be blue molded thermoplastic at 150°C (221°F) maximum.
 - 5. Fittings for GRC: Threaded rigid steel conduit fittings. Comply with NEMA FB 2.10.
- H. Joint Compound for GRC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.

1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- C. Wireway Covers: Hinged cover secured with captive screws unless otherwise indicated.
- D. Finish: Manufacturer's standard enamel finish NEMA 250 rated.

2.3 SURFACE RACEWAYS

- A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Surface Metal Raceways:
 1. Refer to drawings for location(s), type(s), and quantity(s) of surface metal raceway.
 - a. Surface finish: be satin, anodized #204 type clear, Class R1 mil-Spec with minimum anodized finish of .004" unless otherwise noted.

2.4 BOXES, ENCLOSURES, AND CABINETS

- A. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations. Provide the NEMA type listed below as required for the environment and use:
 1. Type 1: for indoor use to provide a degree of protection to personnel against access to hazardous parts and to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (falling dirt).
 2. Type 3R: for either indoor or outdoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (falling dirt); to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (rain, sleet, snow); and that will be undamaged by the external formation of ice on the enclosure.
 3. Type 12: for indoor use to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (falling dirt and

circulating dust, lint, fibers, and flyings); and to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (dripping and light splashing).

- B. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A. Galvanized steel, not less than 1-1/2" deep, 4" square or octagonal, with knockouts. Outlet boxes exposed to moisture, exterior, wet or damp locations shall be cadmium cast alloy complete with threaded hubs and gasketed screw fastened covers. Minimum box size shall be as indicated in Article 314 of the National Electrical Code for the conductors and devices installed. Boxes shall be approved for the environmental condition of the location where they will be installed.
- C. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy.
- D. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
- E. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.
- F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- G. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.
- H. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- I. Device Box Dimensions: 4 inches square by 2-1/8 inches deep.
- J. Gangable boxes are allowed.
- K. Cabinets:
 - 1. NEMA 250, Type 1 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 - 2. Hinged door in front cover with flush latch and concealed hinge.
 - 3. Key latch to match panelboards.
 - 4. Metal barriers to separate wiring of different systems and voltage.
 - 5. Accessory feet where required for freestanding equipment.
 - 6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.5 PULL AND JUNCTION BOXES

- A. Sheet Metal Boxes: NEMA OS 1, galvanized steel. Shall be constructed of not less than 14 gauge galvanized steel with trim for flush or surface mounting in accordance with the location to be installed. Provide screw-on type covers. Boxes installed in damp or wet locations shall be of raintight construction with gasketed cover and threaded conduit hubs. In no case shall boxes be sized smaller than as indicated in Article 314 of the National Electrical Code for conduit and conductor sizes installed. Boxes shall be approved for the environmental condition of the location where they will be installed.

2.6 FLOOR BOXES

- A. Classification and Use: Floor boxes shall have been examined and tested by Underwriters Laboratories Inc. to meet UL514A and/or UL514C and Canadian Standard C22.2, No. 18.1-04 and 18.2-06 and bear the U.S. and Canadian UL Listing Mark. Floor boxes shall also have been tested by Underwriters Laboratories Inc. and classified for fire resistance and bear the U.S. and Canadian UL Classification Mark. Devices shall be classified for use in 2-hour rated, unprotected reinforced concrete floors and 2-hour rated floors employing unprotected steel floor units and concrete toppings or concrete floors with suspended ceilings (fire resistive designs with suspended ceilings should have provisions for accessibility in the ceiling below the floor boxes). Floor boxes shall also conform to the standards set in Section 300-21 of the National Electrical Code. Floor boxes shall meet UL scrub water requirements, but are not suitable for wet or damp locations, or other areas subject to saturation with water or other liquids such as commercial kitchens. Floor boxes shall also have been evaluated by UL to meet the applicable U.S. and Canadian safety standards for scrub water exclusion when used on tile, bare concrete, terrazzo, wood, and carpet covered floors. Floor boxes shall be suitable for use in air handling spaces in accordance with Section 300-22 (C) of the National Electrical Code.
 - 1. Single Service Boxes: The four gang (unless otherwise specified) floor box shall be manufactured from stamped steel and be approved for use on above grade floors. The box shall be a minimum of 12-1/8" L x 8- 7/16" W x 5-7/8" H. There shall be two independent wiring compartments that allow capacity for up to two duplex receptacles and/or communication services. The box shall permit tunneling from end power compartment to end power compartment. Each of the two compartments shall have a minimum wiring capacity of 34 cu in each. The box shall provide the conduit knockouts ranging in size from 1" to 2" trade size. The box shall be fully adjustable, providing a maximum of 5-1/4" pre-pour adjustment, and a maximum of 3/4" after-pour adjustment. The box shall provide a series of device mounting and cover plates that will accept both duplex power devices, as well as plates that will accommodate open system devices. Provide with flush die cast aluminum cover assemblies with Aluminum polyester powder coat finish.

2.7 RECESSED OUTLET POKE-THRU DEVICES

- A. Poke-thru devices provide an interface between power, communication and audio/visual (A/V) cabling in an above grade concrete floor and the workstation or activation location where power, communication and/or A/V device outlets are required. These devices provide recessed device outlets that will not obstruct the floor area. Refer to the Drawings for types.
- B. Classification and Use: Poke-thru device shall have been examined and tested by Underwriters Laboratories Inc. to comply with UL514A and/or UL514C and Canadian Standard C22.2, No. 18-98 and bear the U.S. and Canadian UL Listing Mark. Poke-thru device shall also have been tested by UL and classified for fire resistance and bear the U.S. and Canadian UL Classification Mark. The poke-thru device shall conform to the standards set in the National Electrical Code, Section 300-21.
- C. Poke-thru devices shall be classified for use in 1, 1-1/2, or 2-hour rated floors and 1, 1-1/2, or 2 hour rated floors employing unprotected steel floor units and concrete toppings, or concrete floors with suspended ceilings. Fire resistive designs with suspended ceilings shall have provisions for accessibility in the ceiling below the poke-thru device fittings. Poke-thru device assemblies shall consist of an insert and an activation cover.
 - 1. Insert: Insert body shall recess the devices a minimum of 2-3/4 inches (69mm) and have a polyester based backing enamel finished interior; ivory color. Furnish with necessary channels to provide complete separation of power and communication services. Provide three (3) compartments that allow for up to three (3) duplex receptacles that can be wired as a standard receptacle or isolated ground and/or 12 communication ports. Body consists of an intumescent firestop material to maintain fire rating of the floor slab. Hold intumescent material securely in place in insert body. Intumescent material will not have to be adjusted to maintain fire rating of the unit and the floor slab. Provide insert with a retaining feature to hold the poke-thru device in the floor slab without additional fasteners. Poke-thru insert shall also consist of a 3/4-inch trade size conduit stub that is connected to the insert body and a 24.5 cu in (402ml) stamped steel junction box for wire splicing and connections. Stamped steel junction box shall also contain the means necessary to electrically ground the poke-thru device to the system ground.
 - 2. Activation Cover: Manufactured of die-cast aluminum alloy; finished in powder-coated [gray] [black] [brass] [nickel] [bronze]. Provide with two (2) gaskets (one (1) for surface and one (1) for flush) to go under the trim flange to maintain scrub water tightness. Activation cover is 7-1/4 inches (184mm) in diameter. Provide cover with spring-loaded slides to allow cables to egress out of the unit and maintain as small an egress opening as possible. Provide activation unit with three locations to mount communication connectors. Mount connectors using a

mounting bracket capable of accepting up to 12 Ortonics® TracJack™ Category 6 insert modules or TechChoice™ Category 6 discrete keystone connectors. Also provide unit with two (2) Category 6 discrete keystone connectors and two (2) industry standard keystones and accommodate a mechanism to permit protection of communication cabling. Fabricate mechanism from stamped steel construction. Mechanism shall accept both flexible and rigid 3/4-inch, 1-1/4-inch or two-inch trade size conduit.

2.8 MANUFACTURERS

- A. Raceway and Fitting Manufacturers: subject to compliance with requirements, provide products by one of the following (no exceptions):

1. Wheatland Tube
2. Allied Tube & Conduit
3. Thomas & Betts
4. Hubbell
5. Legrand
6. Calbond
7. Plasti Bond
8. Western Tube and Conduit
9. Republic Conduit
10. Crouse-Hinds

- B. Wireways, surface raceways, boxes, enclosure and cabinets Manufacturers: subject to compliance with requirements, provide products by one of the following (no exceptions):

1. Legrand
2. Hubbell
3. Thomas & Betts
4. Hoffman
5. OZ Gedney
6. Appleton Electric Company
7. Crouse-Hinds

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. The following application must be adhered to. Raceways installed not conforming to this listing must be removed and replaced with specified material at no additional expense.

Raceway Types	Applications
Galvanized Rigid Steel Conduit (GRC)	Where exposed to mechanical injury, where specifically required; indoors where exposed to moisture, where required by codes and for all circuits in excess of 600 volts. Outdoor locations, sump and ejector pits, elevator pits, loading docks, garages, rooftops, gymnasiums and Boiler/Mechanical Rooms/Main Electrical Rooms: exposed below 10'-0" AFF.
Electrical Metallic tubing (EMT)	Use in every instance except where another material is not specified.
Metal Clad Cable (MC)	Lighting and receptacle branch circuits concealed in dry hollow spaces of a building. May not be used in areas where it would be subjected to physical damage or prohibited by Code.
Flexible Metal Conduit (FMC)	Use in dry areas for connections to lighting fixtures in hung ceilings, connections to equipment installed in removable panels of hung ceilings; at all transformer or equipment raceway connections where sound and vibration isolation is required.
Liquid-Tight Flexible Metal Conduit (LFMC)	Use in areas subject to moisture where flexible metal conduit is unacceptable, at connections to all motors, and all raised floor areas.
Rigid Non-Metallic Conduit (RNC)	Schedule 40 - Where raceways are in a slab below grade levels; for raceway duct banks. Schedule 80 - For underground raceways outside of the building which are not encased in concrete.

Raceway Types	Applications
Wireways and Auxiliary Gutters	Where indicated on the Contract Documents and as otherwise specifically required.
Boxes and Enclosures	NEMA 250, Type 1, except use NEMA 250, Type 4 in kitchens and damp/or wet locations. Outdoors use NEMA 250, Type 3R.

- B. Provide separate raceways for all wiring systems, including security, data, paging, low voltage et al. All 480Y/277 volt wiring must be kept independent of 208Y/120 volt wiring. Emergency system wiring must be kept independent of the normal system wiring. Provide grounding conductor within all circuits. Minimum size 3/4-inch for home runs and 1-inch minimum for power distribution. Wiring of each type and system must be installed in separate raceways.
- C. Raceway Fittings: Compatible with raceways and suitable for use and location.
 - 1. Rigid Galvanized Steel Conduit (GRC): Use threaded rigid steel conduit fittings. Comply with NEMA FB 2.10.
 - 2. EMT: Use setscrew steel fittings. Comply with NEMA FB 2.10.
 - 3. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.
- D. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
- E. Install surface raceways only where indicated on Drawings.
- F. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

3.2 INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- C. Complete raceway installation before starting conductor installation.
- D. Install capped bushings on the raceways as soon as they are installed and remove only when cables are pulled. Securely tie embedded raceway in place prior to embedment.

- E. Arrange stub-ups so curved portions of bends are not visible above finished slab. Raceways installed below or in floor slabs must extend a minimum of 4 inches above the finished slab to the first connector.
- F. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- G. Install exposed raceways parallel or at right angles with building lines.
- H. Support conduit within 12 inches of enclosures to which attached.
- I. Provide one (1) empty 3/4 inch raceway for each three (3) spare unused poles or spaces of each flush-mounted panelboard. Terminate empty 3/4 inch conduits in a junction box, which after completion is accessible to facilitate future branch circuit extension. Provide pull lines in each raceway.
- J. Raceways in hung ceilings shall be installed on and secured to the slab or primary structural members of the ceiling, not to lathing channels or T-bars, Z-bars or other elements which are direct supports of the ceiling panels. Secure conduit firmly to the steel with clips and fittings designed for that purpose. Install as high as possible but not less than 1'-0" above the hung ceilings.
- K. Raceways Embedded in Slabs:
 - 1. Install no raceway in the concrete slab except with the permission of the Structural Engineer and written consent of the Owner.
 - 2. Do not install raceways larger than 1-1/4 inch size in structural concrete slabs.
 - 3. In no case will the installation of raceways be permitted to interfere with proper placement of principal reinforcement.
 - 4. Place raceways in the structural slabs between the upper and lower layers of reinforcing steel. Careful bending of the conduits is required.
 - 5. Space the raceways embedded in concrete slabs not less than eight (8) inches on centers and as widely spaced as possible where they converge at panels or junction boxes.
 - 6. Install raceways running parallel to slabs supports, such as beams, columns and structural walls, not less than 12 inches from such supporting elements.
 - 7. Secure saddle supports for conduit, outlet boxes, junction boxes, inserts, etc. with suitable adhesives during concrete pour of the slab to prevent displacement.
 - 8. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
- L. Stub-ups to Above Recessed Ceilings:
 - 1. Use EMT for raceways.

2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- M. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- N. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
- O. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- P. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
- Q. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
- R. Clear all raceways of all obstructions and dirt prior to pulling in cables. Use ball mandrel (diameter approximately 85% of the conduit inside diameter) followed by close fitting wire brush and wad of felt. This assembly may be pulled in together with, but ahead of any cable being installed. Clean all empty raceways similarly. Clear any raceway which rejects ball mandrel, then re-attempt mandrel application.
- S. Install labeled pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 5 feet of slack at each end of pull wire. Tag both ends of the cable denoting opposite and termination location with black India ink on flameproof linen tag. Cap underground raceways designated as spare above grade alongside raceways in use.
- T. Surface Raceways:
 1. Install surface raceway with a minimum 2-inch radius control at bend points.
 2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
- U. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a

flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.

- V. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
 - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 - 2. Where an underground service raceway enters a building or structure.
 - 3. Where otherwise required by NFPA 70.
- W. Comply with manufacturer's written instructions for solvent welding RNC and fittings.
- X. Expansion-Joint Fittings:
 - 1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
 - 2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
 - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
 - 3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
 - 4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
 - 5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
 - 6. Provide necessary bonding conductor for each raceway expansion joint.

- Y. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches flexible conduit for recessed and semi-recessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
1. Use LFMC in damp or wet locations subject to severe physical damage.
 2. Use LFNC in damp or wet locations not subject to severe physical damage.
- Z. OUTLET, JUNCTION, AND PULL BOXES
1. Provide outlet, junction, and pull boxes as indicated on the Contract Documents and as required for the complete installation of the various electrical systems, and to facilitate proper pulling of the cables. Size the junction boxes and pull boxes per the NEC. Size the boxes on any empty conduit systems as if containing conductors of No.4 AWG.
 2. Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes.
 3. The exact location of outlets and equipment is governed by the structural conditions and obstructions, or other equipment items. Verify locations of boxes and outlets prior to rough in. Thoroughly examine the architectural elevations and millwork shop drawings. When necessary, relocate outlets so that when fixtures or equipment are installed, they will be symmetrically located according to the room layout and will not interfere with other work or equipment. Verify final location of outlets, panels equipment, etc., with the Architect prior to installation.
 4. Back-to-back outlets in the same wall, or "thru-wall" type boxes are not permitted. Provide 12-inch minimum spacing for outlets shown on opposite sides of a common wall to minimize sound transmission.
 5. Fit outlet boxes in finished ceilings or walls with appropriate covers, set flush with the finished surface. Where more than one (1) switch or device is located at one (1) point, use gang boxes and covers unless otherwise indicated. Sectional switch boxes or utility boxes are not permitted. Provide tile box or 4 inch square box with tile ring in masonry walls not plastered or furred. Where drywall material is utilized, provide plaster ring. Provide outlet boxes of type and size suitable for the specific application. Where outlet boxes contain two (2) or more 277 volt devices, or where devices occur of different applied voltages, or where normal and emergency devices occur in the same box, provide suitable barrier(s).
 6. All outlet and device box depths shall have sufficient depth to prevent damage to the conductors when devices or utilization equipment are installed as intended in

7. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
8. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
9. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
10. Locate boxes so that cover or plate will not span different building finishes.
11. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
12. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
13. Floor outlet boxes shall be installed flush with finished floor, adjust level and tilt as required. Where finished floor is terrazzo, provide boxes specifically designed for installation in terrazzo. Where floors are to receive carpet, provide floor outlet with carpet flange.
14. Unless otherwise noted, mount devices and equipment at heights measured from finished floor to device/equipment centerline as follows:

a. Toggle switches	46"
b. Receptacle outlets	18"
c. Receptacle outlets, weatherproof, above-grade	24"
d. Data/Telephone outlets	18"
e. Fire alarm manual station	46"
f. Fire alarm audio/visual	80"
15. Types of Boxes and Fittings for Various Locations:

Location	Type
Outlet	Galvanized pressed steel
Outlet exposed to moisture or outdoors	Cast type conduit fitting
Splice	Galvanized pressed steel
Splice exposed to moisture or outdoors	Cast type conduit fitting or sheet metal (4½" x 5" x 3" minimum)
Pull or Junction	Cast type conduit fitting or sheet metal (4½" x 5" x 3" minimum)
Pull or Junction - Outdoors	Aluminum (4½" x 5" x 3" minimum)
Terminal	Sheet steel (6" x 6" x 3" minimum)
Terminal - Outdoors	Aluminum (6" x 6" x 3" minimum)

AA. PULL BOX SPACING

- Provide pull boxes so no individual conduit run contains more than the equivalent of four (4) quarter bends (360° total).
- Conduit Sizes 1¼" and Larger:
 - Provide boxes to prevent cable from being excessively twisted, stretched or flexed during installation.
 - Provide boxes so that maximum pulling tensions do not exceed the cable manufacturer's recommendations.
 - Provide support racks for boxes with multiple sets of conductors so that the conductors do not rest on any metal work inside the box.
- Conduit Sizes 1 inch and Smaller, provide boxes at every (Maximum Distances):

Distance	Run Type
150 feet	straight runs
100 feet	runs with one (1) 90° bend or equivalent
75 feet	runs with two (2) 90° bends or equivalent
50 feet	runs with three (3) or (4) four 90° bends or equivalent.

- Boxes shall be sized to permit pulling, racking and splicing of cables (if not indicated on the contract drawings). They shall be sized to avoid exceeding the manufacturer's minimum bending radius recommendations for conductors.

5. Provide access for the removal and replacement of the conductors, splices and equipment.
6. Minimum distance of boxes in runs of 1-1/2 inch or larger conduit:
 - a. Straight pulls: size length 8 times nominal diameter of the largest conduit.
 - b. Angle or U-pulls: size such that the distance between the conduit entry and the opposite wall of box is 6 times the nominal diameter of the largest conduit.
7. Covers: fasten to the flange or framework of the box with machine bolts, machine screws threaded into tapered holes or sheet metal screws as required.
8. Identification labels for all pull, splice and junction boxes in main feeder and sub-feeder runs, shall indicate nominal system voltage:
 - a. Apply labels after painting of any boxes, conduits, and surrounding areas are completed.
 - b. Clean surfaces before applying labels; clean aluminum surfaces with solvent wipe.
 - c. Apply labels on the cover and a minimum of 1 fixed side; 1 label visible from the floor where the boxes are installed exposed.

3.3 FIRESTOPPING

- A. Install firestopping at penetrations of all fire-rated floor and wall assemblies, per the project specifications.

3.4 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

END OF SECTION 260533

SECTION 260534 – MANHOLES AND HANDHOLES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section Includes the following:

1. Manholes
2. Handholes.
3. Accessories.

1.2 DEFINITIONS

- A. Direct Buried: Duct or a duct bank that is buried in the ground, without any additional casting materials such as concrete.
- B. Duct: A single duct or multiple ducts. Duct may be either installed singly or as a component of a duct bank.
- C. Duct Bank:
1. Two or more duct installed in parallel, with or without additional casting materials.
 2. Multiple duct banks.
- D. GRC: Galvanized rigid (steel) conduit.
- E. Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

1.3 SUBMITTALS

A. Product Data:

1. Manholes and handholes.
2. Accessories.
3. Warning tape.
4. Warning planks.

- B. Shop Drawings for Precast or Factory-Fabricated Underground Utility Structures: Include dimensioned plans, elevations, sections, details, attachments to other work, and

accessories, including frame and cover design, grounding detail, cable rack inserts, sumps and pulling irons.

1.4 QUALITY ASSURANCE

- A. Comply with the latest applicable provisions and latest recommendations of the governing codes and the Contract Documents.
- B. U.L. Listing of all products.

1.5 COORDINATION

- A. Coordinate layout and installation of manholes and handholes with the final arrangement of other utilities, site grading, and surface features as determined in the field.
- B. Coordinate elevations of manholes and handholes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features.

PART 2 - PRODUCTS

2.1 GENERAL

2.2 HANDHOLES (UNDERGROUND PULLBOXES)

- A. Description: Factory-fabricated, reinforced pre-cast concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of the enclosure and shall have a load rating consistent with that of a handhole.
 - 1. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing stainless-steel bolts.
 - 2. Frame and Cover: Weatherproof steel frame, with steel cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing stainless-steel bolts.
 - 3. Cover Legend: Molded lettering as indicated on the plans.
 - 4. Configuration: Units shall be designed for flush burial and have a closed bottom.
 - 5. Extensions and Slabs: Designed to mate with the bottom of enclosure. Same material as the enclosure.
 - 6. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.

- a. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
 - b. Window openings shall be framed with at least two (2) additional No. 4 steel reinforcing bars in concrete around each opening.
7. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
8. Handholes shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

B. Acceptable Manufacturers:

1. Quazite
2. Christy Concrete Products
3. Oldcastle Precast Group.
4. Utility Concrete Products, LLC.

2.3 HANDHOLES OTHER THAN PRECAST CONCRETE

A. Description: Comply with SCTE 77.

1. Configuration: Units shall be designed for flush burial and have closed bottom.
2. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with the enclosure.
3. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
4. Cover Legend: Molded lettering as indicated on the plans.
5. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings.
6. Duct Entrance Provisions: Duct-terminating fittings shall mate with the entering ducts for secure, fixed installation in the enclosure wall.
7. Handholes shall have factory-installed inserts for cable racks and pulling-in irons.

B. Polymer Concrete Handholes with Polymer Concrete Cover: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two. Handholes shall comply with the requirements of SCTE 7 Tier 22 loading.

1. Acceptable Manufacturers:
 - a. Quazite
 - b. Armorcast Products Company.
 - c. Oldcastle Enclosure Solutions
 - d. Hubbell Power Systems

2.4 SOURCE QUALITY CONTROL

- A. Test and inspect precast concrete utility structures according to ASTM C 1037 and SCTE 77.

PART 3 - EXECUTION

3.1 GENERAL

- A. Excavation, shoring, bracing, back-filling and grading provided by other section.
- B. Manholes shall be constructed as shown on the Contract Drawings. Manholes shall not be constructed until final conduit grading has been determined, including any field changes required by underground interferences. Shop drawings shall be submitted for all manhole details that differ in any way from those shown on the Contract Drawings.
- C. Cables to be secured with tie-wraps. Cable racks shall be fiber.
- D. Provide a copper clad steel ground rod, 3/8 inch by 10 feet long, in each manhole. All noncurrent-carrying metal parts in manholes and handholes including metallic sheaths of cables, shall be connected to the ground rod by a bare copper ground conductor. Install the ground rod with top protruding 4 inches above manhole floor.
- E. Provide a cast iron sump frame and cover for each manhole. Provide 12-by 12-by 6-inch deep sump. Excavate below sump 6 inches and fill sump bottom with clean gravel. Slope floor of manhole 1/8-inch per foot to the edge of the sump.
- F. Waterproof exterior surfaces, joints, and interruptions of manholes after concrete has cured 28 days minimum.
- G. Attach cable racks to inserts after manhole.
- H. Manholes and handholes are shown on the Contract Documents in approximate locations. The exact location shall be field determined after careful consideration of other utilities, grading, and paving.
- I. In paved areas, set top of frame and cover flush with finished surface. In unpaved areas, set top of frame and cover approximately 1/2 inch above finished grade.
- J. The installation of manholes shall be in an excavated area free of obstructions for a minimum 6 inches around outside perimeter, with a 6 inch compact gravel base of uniform thickness and level. The preparation of the base shall insure no settlement. Backfill shall consist of good compactable material, such as pea gravel, sand or clean earth fill. Backfilling should be done progressively from bottom to top surface. Minimum earth cover from roof of manhole to finished grade shall be 8 inches.

- K. Concrete encased duct banks entering wall may be cast in the concrete or enter through opening of suitable dimensions and arrangement. Where openings are provided, caulk the space between duct bank and walls tight with lead wool or other suitable material. Reinforce iron of the ductbank to be connected to the wall.
- L. Flush end bells shall be mounted on side walls where duct enters.
- M. Duct entrances shall be carefully planned via the field for best application of cable pulling and racked. All cables shall be secured with tie-wraps to porcelain saddles.
- N. Waterproofing shall be done in accordance with manufacturer's instructions.
- O. Collar shall be cast concrete rings, stacked to required height. Set height in field per final grade elevations.

3.2 UNDERGROUND ENCLOSURE APPLICATION

- A. Handholes for 600 V and Less, Including Telephone, Communications, and Data Wiring:
 - 1. Units in Roadways and Traffic Paths: Precast concrete.
 - 2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Polymer concrete, SCTE 77, Tier 22 structural load rating.

3.3 EARTHWORK

- A. Excavation and Backfill: Do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restore surface features at areas disturbed by excavation and reestablish original grades unless otherwise indicated on the Contract Documents. Replace removed sod immediately after backfilling is completed.

3.4 INSTALLATION OF CONCRETE MANHOLES AND HANDHOLES

- A. Precast Concrete Handhole and Manhole Installation:
 - 1. Comply with ASTM C 891 unless otherwise indicated.
 - 2. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
 - 3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel and compacted to same density as adjacent undisturbed earth.

- B. Elevations:
 - 1. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch above finished grade.
 - 2. Install handholes with bottom below the frost line.
 - 3. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch above finished grade.
- C. Drainage: Install drains in bottom of manholes where indicated.
- D. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms, and insulators, as required for installation and support of cables and conductors.
- E. Warning Sign: Install "Confined Space Hazard" warning sign on the inside surface of each manhole cover.

3.5 INSTALLATION OF HANDHOLES OTHER THAN PRECAST CONCRETE

- A. Install handholes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances. Use pull box extension if required to match depths of ducts, and seal joint between box and extension as recommended by the manufacturer.
- B. Unless otherwise indicated, support units on a level 6-inch- thick bed of crushed stone or gravel, graded and compacted to same density as adjacent undisturbed earth.
- C. Elevation: Set so cover surface will be flush with finished grade.
- D. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors.
- E. Field-cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.
- F. For enclosures installed in asphalt paving and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth.
 - 1. Concrete: 3000 psi (20 kPa), 28-day strength.
 - 2. Dimensions: 10 inches wide by 12 inches or as indicated.

3.6 GROUNDING

- A. Ground underground ducts and utility structures.

3.7 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Test manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in this division."
- B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.8 CLEANING

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.
- B. Clean internal surfaces of manholes, including sump. Remove foreign material.

END OF SECTION 260534

SECTION 260543 – UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

1. Underground Duct System
2. Conduits
3. Nonmetallic Ducts
4. Duct Accessories

1.2 DEFINITIONS

- A. Direct Buried: Duct or a duct bank that is buried in the ground, without any additional casing materials such as concrete.
- B. Duct: A single duct or multiple ducts. Duct may be either installed singly or as component of a duct bank.
- C. Duct Bank: Two or more ducts installed in parallel, with or without additional casing materials.
- D. GRC: Galvanized rigid (steel) conduit.
- E. RNC: Rigid nonmetallic Conduit.
- F. Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

1.3 SUBMITTALS

- A. Product Data:
 1. Duct bank materials, including separators and miscellaneous components.
 2. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
 3. Warning tape.
 4. Warning planks.
- B. Shop drawings for dimension underground structure: including plans, elevations, sections, details, attachments to other work, and accessories, including the following:
 1. Duct entry provisions, including locations and duct sizes.
 2. Reinforcement details.

3. Grounding details.
 4. Duct bank coordination drawings showing dimensioned duct profiles and coordination with other utilities and underground structures. Include plans and sections drawing to scale and show bends and locations of expansion fittings.
- C. Submittal results of field tests.
- D. Record documents: show dimensional locations of all underground ducts, handholes, and manholes.

PART 2 - PRODUCTS

2.1 UNDERGROUND DUCT SYSTEM

- A. Contractor shall furnish and install raceways and fittings for an underground duct system, as indicated on the Contract Drawings and specified herein.
- B. All bends at underground duct system shall be per the manufacturer's bending requirements.
- C. Raceways shall transform PVC to rigid galvanized steel conduit within 10 feet of any foundation walls.
- D. Where offsets are required to clear obstructions and other underground services, a maximum of 5° angle will be allowed at duct joints.
- E. Ducts shall be installed so as to drain to the manholes. Ducts entering into the point of entry (P.O.E.) room shall be installed with upward slope of minimum of 0.125 inch/foot.
- F. All raceways as previously described shall utilize a mandrel of sufficient size to thoroughly clear raceways of all obstructions prior to the installation of any wiring.
- G. All conduits penetrating into the buildings shall be totally sealed in order to prevent any migration of water through the ductbank into the building.
- H. Prior to backfilling of the underground duct system, provide conducting underground-line warning tape as specified in section 260553 "Identification for Electrical Systems". Bury tape 12 inches below grade for all ducts and ductbanks. Align tape parallel to and within 3 inches of centerline of duct bank. Provide an additional warning tape for each 12 inch increment of duct bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

2.2 CONDUITS

- A. Galvanized Rigid Steel Conduit (GRC): Comply with ANSI C80.1 and UL 6.
- B. Rigid nonmetallic conduit (RNC): Type EPC-80-PVC or Type EPC-40-PVC, as specified on the plans, complying NEMA TC 2 and UL 651, with matching fittings complying with NEMA TC 3 by the same manufacturer as the conduit.

2.3 NONMETALLIC DUCTS

- A. Schedule EPC-40-PVC conduit shall be used for all concrete encased duct banks.
- B. PVC conduits shall not be used within the building area unless otherwise noted.
- C. All penetrations through floor slabs or foundation walls shall be rigid steel conduits. No RNC conduit shall be used in or through any floor slab.
- D. PVC conduits shall not be allowed under paved areas, which are subjected to vehicular traffic. Concrete encased rigid steel conduit shall be used.

2.4 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Allied Tube & Conduit; a part of Atkore International.
 - 2. CANTEX INC.
 - 3. Western Tube and Conduit Corporation.
 - 4. Wheatland Tube Company.

PART 3 - EXECUTION

3.1 UNDERGROUND DUCT APPLICATION

- A. Ducts smaller than 2" trade size for Electrical Branch Circuits: NEMA Type EPC-40-PVC, in direct-buried duct bank unless otherwise indicated.

3.2 EARTHWORK

- A. Excavation and Backfill: Do not use heavy-duty, hydraulic-operated, compaction equipment.

- B. Restore surface features at areas disturbed by excavation and re-establish original grades unless otherwise indicated. Replace removed sod immediately after backfilling is completed.
- C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, frizzling, liming, seeding, sodding, springing, and mulching.
- D. Cut and patch existing pavement in path of underground duct, duct bank, and underground structures in accordance with "Cutting and Patching" Article in Section 017300 "Execution."
- E.

3.3 DUCT INSTALLATION

- A. Arrange multiple conduits as shown on the Contract Drawings. Make minor changes in location, or cross-sectional arrangement as necessary. Where conduit runs cannot be installed as shown because of conditions not discoverable prior to digging of trenches, request the Architect's instructions before further work is done. Coordinate this work with other outside service work.
- B. Slope: Pitch ducts a minimum slope of 0.125 inch/ft down toward the manholes and handholes and away from the buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.
- C. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 12 times the conduit diameter, both horizontally and vertically, at other locations unless otherwise indicated.
- D. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in the same plane.
- E. Duct Entrances to Manholes and Concrete/Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches on center for 5-inch ducts, and vary proportionately for other duct sizes.
- F. Building Wall Penetrations: Make a transition from underground duct to GRC at least 10 ft. outside the building wall without reducing duct line slope away from the building and without forming a trap in the line. Use fittings manufactured for RNC-to-GRC transition.

- G. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.
- H. Pulling Cord: Install 200-lbf test nylon cord in ducts, including spares. Label each line.
- I. Concrete-Encased Ducts And Duct Banks
 - 1. Excavate trench bottom to provide firm and uniform support for duct. Width: Excavate trench 3 inch (75 mm) wider than duct on each side. Depth: Install so top of duct envelope is at least 24 inch (600 mm) below finished grade in areas not subject to deliberate traffic, and at least 30 inch (750 mm) below finished grade in deliberate traffic paths for vehicles unless otherwise indicated. Install so top of duct envelope is below local frost line.
 - 2. Support duct on duct spacers coordinated with duct size, duct spacing, and outdoor temperature. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than four spacers per 20 ft (6 m) of duct. Place spacers within 24 inch (600 mm) of duct ends. Stagger spacers approximately 6 inch (150 mm) between tiers. Secure spacers to earth and to duct to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups. Minimum Space between Ducts: 3 inch (75 mm) between edge of duct and exterior envelope wall, 2 inch (50 mm) between ducts for like services, and 4 inch (100 mm) between power and communications ducts. Use manufactured duct elbows for stub-ups and at changes of direction in duct unless otherwise indicated. Extend encasement throughout length of elbow. Stub-ups to Outdoor Equipment: Extend concrete-encased steel raceway horizontally minimum of 60 inch (1500 mm) from edge of equipment base.
 - 3. Reinforcement Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms. Concrete Cover: Install minimum of 3 inch (75 mm) of concrete cover between edge of duct to exterior envelope wall, 2 inch (50 mm) between duct of like services, and 4 inch (100 mm) between power and communications ducts. Place minimum 6 inch (150 mm) of engineered fill above concrete encasement of ducts.
 - 4. Pouring Concrete: Comply with requirements in "Concrete Placement" Article in Section 033000 "Cast-in-Place Concrete." Place concrete carefully during pours to prevent voids under and between duct and at exterior surface of envelope. Do not allow heavy mass of concrete to fall directly onto ducts. Allow concrete to flow around duct and rise up in middle, uniformly filling open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-installation application.

3.4 Direct-Buried Duct and Duct Bank:

- A. Excavate trench bottom to provide firm and uniform support for duct bank.
- B. After installing first tier of ducts, backfill and compact. After placing last tier, hand-place backfill to 4 inches over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction. Place a minimum of 3 inches of sand as a bed for duct. Place sand to a minimum of 6 inches above top level of duct.
- C. Install ducts with a minimum of 3 inches between ducts for like services and 6 inches between power and communication ducts.
- D. Depth: Install top of duct bank at least 30 inches below finished grade unless otherwise indicated.
- E. Set elevation of bottom of duct bank below the frost line.
- F. Install manufactured GRC elbows for stub-ups at utility poles, equipment and at building entrances through the floor.
 - 1. Couple RNC to GRC with adapters designed for this purpose and encase coupling with 3 inches of concrete.
 - 2. For equipment mounted on outdoor concrete bases, extend GRC horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

3.5 GROUNDING

- A. Ground underground ducts in accordance with the "260526 - Grounding and Bonding of Electrical System" specification section.

3.6 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Demonstrate capability and compliance with requirements on the completion of installation of underground ducts and utility structures.

3.7 CLEANING

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts

END OF SECTION 260543

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SECTION 260544 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Silicone sealants.

1.2 SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

- B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. Sleeves for Rectangular Openings:

1. Material: Galvanized sheet steel.
2. Minimum Metal Thickness:

- a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
- b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE-SEAL FITTINGS

- A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

2.3 GROUT

- A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.4 SILICONE SEALANTS

- A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
- B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

2.5 MANUFACTURERS

- A. Manufacturers subject to compliance with requirements, provide products by one of the following (no exceptions):
 1. BWM Company
 2. Flexicraft Industries.
 3. GPT Industries

4. Metraflex Company (The).
5. Proco Products, Inc.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.
- C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
 - a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
 - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.
 4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
 5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.
- D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
 1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
 2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
- E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

- F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe 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.
- G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 260544

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Color and legend requirements for raceways, conductors, warning labels and signs.
2. Labels.
3. Tapes and stencils.
4. Cable ties.

1.2 SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for electrical identification products.

B. Identification Schedule: For each piece of electrical equipment and electrical system components to be an index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Comply with ASME A13.1 and IEEE C2.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

- F. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

- 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 COLOR AND LEGEND REQUIREMENTS

- A. Raceways and Cables Carrying Circuits at 600 V or Less:

- 1. Black letters on an orange field.
 - 2. Legend: Indicate voltage and system or service type.

- B. Color-Coding for Phase and Voltage-Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder and branch-circuit conductors.

- 1. Color shall be factory applied.
 - 2. Colors for 208/120-V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.
 - d. Neutral: White.
 - e. Color for Equipment Grounds: Green.
 - 3. Colors for 480/277-V Circuits:
 - a. Phase A: Brown.
 - b. Phase B: Orange.
 - c. Phase C: Yellow.
 - d. Color for Neutral: White.
 - e. Color for Equipment Grounds: Green

- C. Warning Label Colors:

- 1. Identify system voltage with black letters on an orange background.

- D. Equipment Identification labels:

- 1. Black Letters on a white field unless otherwise noted.
 - 2. Equipment supplied by the emergency system shall be white letters on a red field.

2.3 LABELS

- A. Self-Adhesive Wraparound Labels: Preprinted, 3-mil-thick, polyester or vinyl flexible label with acrylic pressure-sensitive adhesive.

1. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over the legend. Labels sized such that the clear shield overlaps the entire printed legend.
2. Marker for Labels: Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.

2.4 TAPES AND STENCILS

- A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
- B. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mils thick by 1 to 2 inches wide; compounded for outdoor use.
- C. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

2.5 CABLE TIES

- A. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
 1. Minimum Width: 3/16 inch.
 2. Tensile Strength at 73 Deg F according to ASTM D 638: 12,000 psi.
 3. Temperature Range: Minus 40 to plus 185 deg F.
 4. Color: Black, except where used for color-coding.
- B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
 1. Minimum Width: 3/16 inch.
 2. Tensile Strength at 73 Deg F according to ASTM D 638: 12,000 psi.
 3. Temperature Range: Minus 40 to plus 185 deg F.
 4. Color: Black.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 INSTALLATION

- A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.
- B. Install identifying devices before installing acoustical ceilings and similar concealment.
- C. Verify identity of each item before installing identification products.
- D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
- E. Apply identification devices to surfaces that require finish after completing finish work.
- F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.
- G. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
- H. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.
- I. Accessible Fittings for Raceways: Identify the covers of each junction and pull box of the following systems with the wiring system legend and system voltage. System legends shall be as follows:
 - 1. "POWER."
- J. Self-Adhesive Wraparound Labels: Secure tight to surface at a location with high visibility and accessibility.
- K. Marker Tapes: Secure tight to surface at a location with high visibility and accessibility.
- L. Self-Adhesive Vinyl Tape: Secure tight to surface at a location with high visibility and accessibility.
- M. Cable Ties: General purpose, for attaching tags, except as listed below:
 - 1. Outdoors: UV-stabilized nylon.
 - 2. In Spaces Handling Environmental Air: Plenum rated.

3.3 IDENTIFICATION SCHEDULE

- A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.
- B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.
- C. Accessible Fittings for Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive labels containing the wiring system legend and system voltage. System legends shall be as follows:
 - 1. "POWER."
- D. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use nonmetallic preprinted cable tags to identify each conductor. Tags shall indicate the load served, type, and size of cable the overcurrent device protecting the cable.
- E. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source.
- F. Instructional Signs: Self-adhesive labels, including the color code for grounded and ungrounded conductors.
- G. Operating Instruction Signs: Self-adhesive labels.
- H. Equipment Identification Labels:
 - 1. Laminated acrylic.
 - 2. Enclosed disconnect switches and circuit breakers: nameplate engraved with equipment designation.

END OF SECTION 260553

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SECTION 260573 - ELECTRICAL POWER SYSTEM STUDY

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish an Electrical Power System Study for electrical distribution system modifications performed by the work of this project as defined herein.
- B. The study shall begin at the point of power source connection and include all downstream distribution and branch panelboards, motor control centers and significant motor locations (20HP and larger) included in the scope of work for this project. In addition, all equipment that is required to be rated for the available fault current shall be evaluated in the study including but not limited to transformers, enclosed switches, individual motor controllers, contactors, variable speed drives, and enclosed circuit breakers.
- C. Where any part of the electrical system is served by multiple power sources, the system configuration that delivers the highest level of fault current shall be used for the evaluation.

1.2 SUBMITTALS

- A. The final report shall be indexed and contain individual, tabbed sections. The tabbed sections shall contain the information as outlined in Part 2 of this document including the following:
 - 1. Firm Name, Address, Phone Number and Professional Engineer's signature and seal of the registered professional Engineer that performed the study,
 - 2. Method used to perform the study and analysis,
 - 3. Short-circuit analysis with protective device evaluation,
 - 4. Protective device coordination study,
 - 5. Arc Flash Analysis,
 - 6. Input Data,
 - 7. One-line diagram.

1.3 REFERENCE STANDARDS

- A. All studies shall be performed in accordance with the latest applicable industry standards including the following:
 - 1. IEEE/ANSI Std 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
 - 2. NEMA AB 3 – AB 3 Molded Case Circuit Breakers and their Application
 - 3. NFPA 70 – National Electrical Code
 - 4. NFPA 70E – Standard for Electrical Safety in the Workplace

1.4 QUALITY ASSURANCE

- A. Preparer Qualifications: Firm experienced in the analysis, evaluation, and coordination of electrical distribution systems.
- B. Short-Circuit Analysis, Arc Flash Analysis and Coordination Study shall be performed by a New York State registered Professional Engineer. Study shall be signed and sealed by the Engineer. The Engineer shall have a minimum of eight years' experience in the analysis, evaluation, and coordination of electrical distribution systems.

PART 2 - PRODUCTS

2.1 MANUFACTURER

- A. If it complies with the specifications, the engineering study specified herein shall be prepared by the manufacturer providing the electrical switchboards and panelboards for this project or manufacturer's authorized engineer.

2.2 SHORT-CIRCUIT ANALYSIS WITH PROTECTIVE DEVICE EVALUATION

- A. The study shall be submitted with the electrical service and distribution equipment submittal and shall indicate where device substitutions are being made in order to achieve adequate interrupting capacity ratings for each piece of equipment.
- B. The study shall include recommended settings of adjustable overcurrent and ground fault devices.
- C. Provide overcurrent protective devices of suitable type and rating to meet or exceed the available short circuit currents indicated in the short circuit study.

- D. Interrupting capacities shall be based on a fully rated protection system where all overcurrent protection devices are rated for the full prospective short circuit current (as indicated in the final short circuit submittal). Series-rated panelboards are not permitted.
- E. Obtain from the utility company (and confirm in writing) the short circuit current available at the utility company's transformer secondary.
- F. Systematically calculate fault currents based on the available fault current at the facility service entrance. Study preparer shall obtain the maximum available fault current and power factor or X/R ratio of the fault current at the service entrance from the local utility.
- G. Motor contribution for motors 50HP and larger shall be incorporated in determining fault levels.
- H. Evaluate the distribution device and equipment ratings compared to the calculated fault current and make recommendations where equipment is overdutied. Analyze the short-circuit currents by preparing a tabulation comparing the fault levels to the device interrupting ratings. Indicate equipment in which series ratings are utilized.
- I. When the power factor or X/R ratio of the maximum symmetrical fault calculated at the device location is determined to be more inductive than that used to establish the device interrupting rating adjust the available short circuit current in accordance with ANSI/IEEE standard 242.
- J. Calculations shall be presented in tabular form and shall include:
 - 1. Location identification
 - 2. Voltage
 - 3. Manufacturer and type of equipment
 - 4. Equipment short-circuit current rating
 - 5. Calculated short-circuit current (and adjustments due to high X/R ratio where required)
 - 6. Calculated X/R ratio of the fault
 - 7. Indicate if series ratings are used
 - 8. Recommendations where equipment is calculated to be overdutied

2.3 PROTECTIVE DEVICE COORDINATION STUDY

- A. Prepare coordination time-current characteristic curves to determine the required settings of the protective devices to achieve selectivity. The utility upstream

protective device feeding the facility shall be maintained as the upper limit for coordination. These settings shall be obtained by the preparer, along with any other protective device setting requirements. The coordination curves shall be prepared on log-log paper and illustrate adequate clearing times between series devices. The curves provided shall reflect actual protective devices (manufacturer and model number) to be installed. Adequate time-current curves shall be generated to depict coordination.

- B. The study shall include recommended settings of adjustable overcurrent and ground fault devices.
- C. The coordination study shall include ground fault protection coordination and recommended device settings for the devices provided with ground fault protection.
- D. Protective device characteristics shall be plotted to reflect calculated short-circuit levels at the location.
- E. A narrative analysis shall accompany each coordination curve sheet and describe the coordination and protection. All curve sheets shall be multi-color or use hatching for improved clarity. Areas lacking complete coordination shall be highlighted and reasons provided for allowing condition to remain or provide recommendations to improve coordination.
- F. The following information shall be provided on all curve sheets.
 - 1. Device identification and associated settings/size.
 - 2. Voltage at which curves are plotted.
 - 3. Current multiplier.
 - 4. ANSI frequent fault damage curve.
 - 5. Cable insulation damage curves.
 - 6. Transformer inrush point.
 - 7. Single-line for the portion of the system.
 - 8. Motor starting profiles (where applicable).
- G. The recommended device settings shall be provided in tabular form and shall include:
 - 1. Location Identification
 - 2. Voltage
 - 3. Device Manufacturer
 - 4. Device catalog number/series

5. Adjustable long time pickup and delay
6. Adjustable short time pickup and delay
7. Adjustable ground fault pickup and delay
8. Adjustable instantaneous pickup

2.4 ARC FLASH ANALYSIS

- A. An arc flash analysis shall be performed based on the short circuit values and device settings in conjunction with a short circuit and coordination study. The results from the short circuit and coordination study shall be used to determine arc energy levels at each power distribution location in the facility where work could be performed on energized parts.
- B. Where any part of the electrical system is served by multiple power sources the system configuration that delivers the highest level of arc flash incident energy shall be used for the evaluation. Include significant motor contribution in the calculations.
- C. For each location with a main device, the line and load side fault contributions shall be included in the calculations.
- D. Arc Flash Calculation results shall be presented in tabular form and shall include:
 1. Location identification
 2. Voltage
 3. Arcing fault magnitude
 4. Protective device clearing time
 5. Duration of arc
 6. Arc flash boundary
 7. Working distance
 8. Incident energy
 9. Hazard Risk Category

2.5 ARC FLASH WARNING LABELS

- A. Arch Flash warning labels shall be provided as part of the report. Labels shall be self-adhesive Polyester, thermal, transfer-printer, 3-mil-thick, multicolor, weather and UV-resistant in accordance with ANSI Z535.4. Produce a minimum 3.5-by-5-inch self-adhesive equipment label for each work location included in the analysis.

- B. The label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:
 - 1. Location designation
 - 2. Nominal voltage
 - 3. Flash protection boundary
 - 4. Hazard risk category
 - 5. Incident energy
 - 6. Working distance
 - 7. Engineering report number, revision number, and issue date.
- C. Labels shall be machine painted, with no field-applied markings.

2.6 INPUT DATA

- A. The study shall be conducted based on the equipment and conductors being installed. Input data for the report shall be compiled from the contractor, manufacturers, and codes and standards as required providing the studies and conducting a proper evaluation.
- B. Conductor lengths, sizes, material, and raceway information shall be provided by the Electrical Subcontractor to the engineer performing the study so that the study is performed based on the final installation.
- C. Input data used for the studies shall be provided in the final report. The input data for the report shall include supporting data from the manufacturer used for the evaluation, lengths of all feeders provided by the contractor, transformer data, motor data, utility company and motor generator data and any other supporting data to the report.

2.7 SINGLE-LINE DIAGRAM

- A. The final report shall include a single-line diagram of the electrical distribution system within the scope of the project. The single-line shall include:
 - 1. Transformer rating, voltage ratio, impedance, and winding connection.
 - 2. Feeder cables per phase, neutral and ground sizes, length of cable, conductor material, and conduit size and type.
 - 3. Switchboards, panelboards, MCC's, individual motor controllers, variable speed drives, fuses, circuit breakers, ATS's and enclosed switches.

4. Protective relays with appropriate device numbers and CT's and PT's with associated ratios.
5. Motor identification and horsepower used in the evaluation.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The electrical equipment and protective devices shall not be installed prior to confirmation of adequate equipment fault ratings as specified herein.

3.2 FIELD SETTINGS

- A. Adjustments shall be made to the protective devices as required for placing the equipment in final operating condition. The settings shall be in accordance with the approved short circuit study and protective device evaluation / coordination study.
- B. Arc Flash Labels shall be affixed to the equipment after the study is approved by the Engineer.
 1. One label shall be affixed at a height and location that is clearly visible on the front of panelboards, switchboards, switchgear, motor control centers and other electrical equipment that is less than 8 feet in length unless otherwise noted.
 2. Switchboards, motor control centers, and switchgear that are longer than 6 feet shall have labels affixed at a height and location that is clearly visible on the front of the equipment at each end of the equipment.
 3. Transformers shall be labeled based on the high voltage side of the transformer.
 4. Labels shall be affixed at similar locations on each type of equipment. For example, multiple panelboards of similar size shall have labels located at the same location on the front of each panelboard cover.
 5. Where multiple labels are affixed to equipment, the labels shall be identical and identify the worse case information for that equipment.
 6. Where equipment is rear connected affix labels on both the front and rear of the equipment. Locate the labels on the rear at a similar height and location as on the front.
 7. Label each plug-in section of busway. Affixed at a height and location that is clearly visible. Labels shall be affixed on both sides of the busway.

- C. Device settings and adjustments and affixing of Arc Flash Hazard Labels shall be by the manufacturer or the manufacturer's authorized service and testing organization.

END OF SECTION 260573

SECTION 260923 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Switchbox-mounted occupancy sensors.
 - 2. Wall Station Controllers.
 - 3. Standalone daylight-harvesting dimming controls.
 - 4. Indoor occupancy and vacancy sensors.
 - 5. Lighting contactors.
 - 6. Conductors and cables.

1.2 SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
 - 1. Show installation details for the following:
 - a. Occupancy sensors.
 - b. Vacancy sensors.
 - c. Daylight-harvesting dimming controls.
 - 2. Interconnection diagrams showing field-installed wiring.
 - 3. Include diagrams for power, signal, and control wiring.

1.3 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of lighting control device to include in operation and maintenance manuals.

1.4 WARRANTY

- A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace lighting control devices that fail(s) in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Faulty operation of lighting control devices.
 - 2. Warranty Period: Five (5) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

- A. General Requirements for Sensors: Automatic-wall-switch occupancy sensor with manual on-off switch, suitable for mounting in a single gang switchbox.
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Occupancy Sensor Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn lights off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 30 minutes.
 - 3. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.
 - 4. Sensing Technology – Dual Technology.

2.2 DAYLIGHT-HARVESTING DIMMING CONTROLS

- A. System Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, the lights are dimmed.
 - 1. Lighting control set point is based on two lighting conditions:
 - a. When no daylight is present (target level).
 - b. When significant daylight is present.
 - 2. System programming is done with two hand-held, remote-control tools.
 - a. Initial setup tool.
 - b. Tool for occupants to adjust the target levels by increasing the set point up to 25 percent, or by minimizing the electric lighting level.
- B. Ceiling-Mounted Dimming Controls: Solid-state, light-level sensor unit, with integrated or separate power pack mounted on luminaire, to detect changes in indoor lighting levels that are perceived by the eye.
- C. Electrical Components, Devices, and Accessories:
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Sensor Output: 0- to 10-V dc to operate luminaires. Sensor is powered by controller unit.
 - 3. Light-Level Sensor Set-Point Adjustment Range: 20 to 60 fc.
- D. Power Pack: Dry contacts rated for 20A ballast or LED load at 120V and 277V AC, for 13A tungsten at 120V AC, and for 1 HP at 120V AC. Sensor has 24V DC, 150mA, Class 2 power source, as defined by NFPA 70.

1. LED status lights to indicate load status.
 2. Plenum rated.
- E. Power Pack: Digital controller capable of accepting 3 RJ45 inputs with two outputs rated for 20A incandescent or LED load at 120V and 277V AC, for 16A ballast load or LED at 120V and 277V AC, and for 1 HP at 120V AC. Sensor has 24V DC Class 2 power source, as defined by NFPA 70.
1. With integral current monitoring
 2. Compatible with digital addressable lighting interface.
 3. Plenum rated.

2.3 INDOOR OCCUPANCY AND VACANCY SENSORS

A. General Requirements for Sensors:

1. Wall and Ceiling-mounted, solid-state indoor occupancy and vacancy sensors.
2. Dual technology.
3. Integrated or Separate power pack.
4. Hardwired or Wireless connection to switch and BAS; and BAS and lighting control system.
5. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
6. Operation:
 - a. Occupancy Sensor: Unless otherwise indicated, turn lights and receptacles on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 30 minutes.
 - b. Vacancy Sensor: Unless otherwise indicated, lights are manually turned on and sensor turns lights off when the room is unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 30 minutes.
 - c. Combination Sensor: Unless otherwise indicated, sensor shall be programmed to turn lights on when coverage area is occupied and turn them off when unoccupied, or to turn off lights that have been manually turned on; with a time delay for turning lights off, adjustable over a minimum range of 1 to 30 minutes.
7. Power: Low voltage or Line voltage.
8. Mounting:
 - a. Sensor: Suitable for mounting in any position on a standard outlet box.
 - b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
 - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

9. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
 10. Bypass Switch: Override the "on" function in case of sensor failure.
 11. Automatic Light-Level Sensor: Adjustable from 2 to 100 fc; turn lights off when selected lighting level is present.
- B. Dual-Technology Type: Wall or Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.
1. Sensitivity Adjustment: Separate for each sensing technology.
 2. Detector Sensitivity: Detect occurrences of 6-inch-minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
 3. Detection Coverage: Select sensor(s) to provide full coverage of room and detect occupancy anywhere within the room where installed.

2.4 WALL STATION CONTROLLERS

- A. Description:
1. Listed and labeled as defined in NFPA 70 and marked for intended location and application.
 2. Controller shall be a completely self-contained control system that replaces the standard toggle switch. It shall have a ground wire and ground strap for safety. Switching mechanism shall be a latching air gap relay.
 3. Zero Crossing Circuitry shall be used to increase the relay life, protect from the effects of inrush current, and increase the switch's longevity.
 4. Controller shall be compatible with all electronic ballasts, motor loads, compact fluorescent, LED and inductive loads. Triac and other harmonic generating devices shall not be allowed.
 5. Controller shall have no minimum load requirement and shall be capable of controlling all types of light sources.
 6. Refer to Drawing Lighting Sequence of Operation for building specific operational requirements.
- B. Lighting Contactors: Description: 120–480VAC 60 Hz with 120VAC control coil voltage. Electrically operated and mechanically held, combination-type lighting contactors, complying with NEMA ICS 2 and UL 508.

1. Current Rating for Switching: 60 amp 3-pole – 3 x SPST. Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less THD of normal load current).
2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.

2.5 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.
- B. Examine walls and ceilings for suitable conditions where lighting control devices will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF CONTROL PANELS

- A. Mount panels with elastomeric isolator pads to eliminate structure-borne vibration unless integral lighting contactors are installed in an enclosure with factory-installed vibration isolators.

3.3 INSTALLATION OF WIRING

- A. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- B. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.
- C. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.4 IDENTIFICATION

- A. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."
 - 1. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.
- B. Label time switches and contactors with a unique designation.

3.5 SENSOR INSTALLATION

- A. Comply with NECA 1.
- B. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.
- C. Install and aim sensors in locations to achieve not less than 90-percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.6 LIGHTING SYSTEM FUNCTIONAL TESTING

- A. The lighting control system manufacturer, manufacturer's authorized representative, or a qualified testing agency shall perform all functional testing required by the 2015 International Energy Conservation Code, Section C408.
- B. Functional Testing:
 - 1. Prior to passing final inspection, the manufacturer's authorized representative shall provide evidence that the lighting control systems have been tested to ensure that control hardware and software are calibrated, adjusted, programmed

and in proper working condition in accordance with the construction documents and manufacturer's instructions.

C. Occupancy Sensor Controls:

1. Certify that the occupancy sensors have been located and aimed in accordance with manufacturer recommendations.
 - a. For projects with seven or fewer sensors, each sensor shall be tested.
2. For occupancy sensor controls to be tested, verify the following:
 - a. Where occupancy sensor controls include status indicators, verify correct operation.
 - b. The controlled lights turn off or down to the permitted level within the required time.
 - c. For auto-on sensors, the lights turn on to the permitted level when an occupant enters the space.
 - d. For manual-on sensors, the lights turn on only when manually activated.

D. Time Switch Controls:

1. Where time switch controls are provided, the following procedures shall be performed:
 - a. Confirm that the time-switch control is programmed with accurate weekday, weekend and holiday schedules.
 - b. Provide documentation to the owner of time switch controls programming including weekday, weekend, holiday schedules, and set-up and preference program settings.
 - c. Verify the correct time and date in the time switch.
 - d. Verify that any battery backup is installed and energized.
 - e. Verify that the override time limit is set to not more than 2 hours.
2. Simulate occupied condition. Verify and document the following:
 - a. All lights can be turned on and off by their respective area control switch.
 - b. The switch only operates lighting in the enclosed space in which the switch is located.
3. Simulate unoccupied condition. Verify and document the following:
 - a. Nonexempt lighting turns off.

- b. Manual override switch allows only the lights in the enclosed space where the override switch is located to turn on or remain on until the next scheduled shutoff occurs.

E. Daylight Responsive Controls:

- 1. Where daylight responsive controls are provided, the following shall be verified:
 - a. Control devices have been properly located, field calibrated and set for accurate set points and threshold light levels.
 - b. Daylight controlled lighting loads adjust to light level set points in response to available daylight.
 - c. The locations of calibration adjustment equipment are readily accessible only to authorized personnel.

F. Documentation Requirements:

- 1. Documents certifying that the lighting controls meet documented performance criteria of the IECC are to be provided to the building owner within 90 days from the date of receipt of the certificate of occupancy.

3.7 TRAINING

- A. The lighting control system manufacturer or the manufacturer's authorized representative shall conduct formal training for all users of the automatic lighting control systems.

END OF SECTION 260923

SECTION 262200 - LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Distribution dry-type transformers rated 600 V and less, with capacities up to 1500 kVA.

1.2 SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type and size of transformer.
 - 2. Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer.
- B. Shop Drawings:
 - 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. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.
 - 3. Include diagrams for power, signal, and control wiring.

1.3 FACTORY TESTING

- A. Ratio tests at the rated voltage connection and at all tap locations.
- B. Polarity and phase relation tests on the rated voltage connection.
- C. Applied and induced potential tests.
- D. No-load and excitation current at rated voltage on the rated voltage connection.
- E. Sufficient information on the vibration isolators for the design to be checked for approval.

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Accredited by NETA.
 - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions 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.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Acme Electric Corporation.
 - 2. Eaton.
 - 3. General Electric Company.
 - 4. Hammond Power Solutions Inc.
 - 5. Siemens Industry, Inc., Energy Management Division.
 - 6. Square D; by Schneider Electric.
- B. Source Limitations: Obtain each transformer type from single source manufacturer.

2.2 GENERAL TRANSFORMER REQUIREMENTS

- A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Efficiency: Transformers Rated 15 kVA and larger must comply with DOE 2016 Efficiency energy-efficiency levels and be marked as compliant with DOE 2016 efficiency levels by an NRTL.
 - 1. Minimum of 220 degrees C insulation system with degree C rise rating as indicated on the drawings and ventilated design.

- D. Shipping Restraints: Paint or otherwise color code bolts, wedges, blocks, and other restraints that are to be removed after installation and before energizing. Use fluorescent colors that are easily identifiable inside the transformer enclosure.

2.3 DISTRIBUTION TRANSFORMERS

- A. Comply with NFPA 70, and list and label as complying with UL 1561.
- B. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.
 - 1. One leg per phase.
 - 2. Core volume shall allow efficient transformer operation at 10 percent above the nominal tap voltage.
 - 3. Grounded to enclosure.
- C. Coils: Continuous windings without splices except for taps.
 - 1. Coil Material: Aluminum.
 - 2. Internal Coil Connections: Brazed or pressure type.
 - 3. Terminal connections Welded.
- D. Encapsulation: Transformers smaller than 30 kVA shall have core and coils completely resin encapsulated.
- E. Enclosure: Ventilated.
 - 1. NEMA 250, Type 2: Core and coil shall be encapsulated within resin compound to seal out moisture and air.
 - 2. KVA Ratings: Based on convection cooling only and not relying on auxiliary fans.
- F. Transformer Enclosure Finish: Comply with NEMA 250.
 - 1. Finish Color: NSF/ANSI 61 gray weather-resistant enamel.
- G. Transformer Enclosure Finish: Comply with NEMA 250.
 - 1. Finish Color: NSF/ANSI 61 gray weather-resistant enamel.
- H. Wall mounting bracket kits, OSHPD certified. Furnished by transformer manufacturer and installed where indicated on the drawings.
- I. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.

- J. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity. For step up transformers provide two 2.5 percent taps above and two 2.5 percent below normal full capacity.
- K. Insulation Class, 30 kVA and Larger: 220 deg C, UL-component-recognized insulation system with a maximum of 115-deg C rise above 40-deg C ambient temperature.
- L. Grounding: Provide ground-bar kit or a ground bar installed on the inside of transformer enclosure.
- M. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for non-sinusoidal load current-handling capability to the degree defined by designated K-factor.
 - 1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor, without exceeding the indicated insulation class in a 40 deg C maximum ambient and a 24-hour average ambient of 30 deg C.
 - 2. Indicate value of K-factor on transformer nameplate.
 - 3. Unit shall comply with requirements of DOE 2016 efficiency levels when tested according to NEMA TP 2 with a K-factor equal to one.
 - 4. Neutral: rated 200 percent of full load current for K-factor-rated transformers.
- N. Low-Sound-Level Requirements: Maximum sound levels when factory tested according to IEEE C57.12.91, as follows:
 - 1. Up to 50 kVA: 45dB.
 - 2. 51 to 150 kVA: 50dB.
 - 3. 151 to 300 kVA: 55dB.
 - 4. 301 to 500 kVA: 60dB.
 - 5. 501 to 700 kVA: 62dB.
 - 6. 701 to 1000 kVA: 64dB
- O. Vibration Isolation:
 - 1. All transformers shall have vibration isolation that isolates the enclosure from the core and the coil assembly. Additional vibration isolators shall be provided between trapeze or universal hangers of suspended transformer and its case and between transformer enclosure and floor for floor mounted units.
 - 2. Each dry type transformer shall be resiliently suspended on double deflection neoprene in the shear hanger rod isolator assemblies, capable of providing a minimum of 3/8 inch static deflection.

2.4 IDENTIFICATION DEVICES

- A. Nameplates: Engraved, laminated-plastic or metal nameplate for each distribution and buck-boost transformer, mounted with corrosion-resistant screws.

2.5 SOURCE QUALITY CONTROL

- A. Test and inspect transformers according to IEEE C57.12.01 and IEEE C57.12.91.
 - 1. Resistance measurements of all windings at the rated voltage connections and at all tap connections.
 - 2. Ratio tests at the rated voltage connections and at all tap connections.
 - 3. Phase relation and polarity tests at the rated voltage connections.
 - 4. No load losses, and excitation current and rated voltage at the rated voltage connections.
 - 5. Impedance and load losses at rated current and rated frequency at the rated voltage connections.
 - 6. Applied and induced tensile tests.
 - 7. Regulation and efficiency at rated load and voltage.
 - 8. Insulation Resistance Tests:
 - a. High-voltage to ground.
 - b. Low-voltage to ground.
 - c. High-voltage to low-voltage.
 - 9. Temperature tests.
- B. Factory Sound-Level Tests: Conduct prototype sound-level tests on production-line products.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.
- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

- D. Verify that ground connections are in place and requirements in the project specifications have been met. Maximum ground resistance shall be 5 ohms at location of transformer.
- E. Environment: Enclosures shall be rated for the environment in which they are located. Covers for NEMA 250, Type 4X enclosures shall not cause accessibility problems.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install wall-mounted transformers level and plumb with wall brackets fabricated by transformer manufacturer.
 - 1. Coordinate installation of wall-mounted and structure-hanging supports with actual transformer provided.
- B. Install transformers level and plumb on a concrete base with vibration-dampening supports. Locate transformers away from corners and not parallel to adjacent wall surface.
- C. Construct concrete bases according to the contract documents and anchor floor-mounted transformers according to manufacturer's written instructions.
 - 1. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
- D. Secure transformer to concrete base according to manufacturer's written instructions.
- E. Secure covers to enclosure and tighten all bolts to manufacturer-recommended torques to reduce noise generation.
- F. Remove shipping bolts, blocking, and wedges.

3.3 CONNECTIONS

- A. Ground equipment according to the project specifications.
- B. Connect wiring according to the project specifications.
- C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

- D. Provide flexible connections at all conduit and conductor terminations and supports to eliminate sound and vibration transmission to the building structure.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Dry-Type Transformer Field Tests:
 - 1. Visual and Mechanical Inspection.
 - a. Inspect physical and mechanical condition.
 - b. Inspect anchorage, alignment, and grounding.
 - c. Verify that resilient mounts are free and that any shipping brackets have been removed.
 - d. Verify the unit is clean.
 - e. Verify that as-left tap connections are as specified.
 - 2. Electrical Tests:
 - a. Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: the value of the index shall not be less than 1.0.
 - b. Verify correct Primary and secondary voltages, phase-to-phase and phase-to-neutral, after energization and prior to loading.
- C. Remove and replace units that do not pass tests or inspections and retest as specified above.
- D. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.5 ADJUSTING

- A. 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 5 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

- B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.6 CLEANING

- A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 262213

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Distribution panelboards.
 - 2. Lighting and appliance branch-circuit panelboards.

1.2 DEFINITIONS

- A. ATS: Acceptance testing specification.
- B. GFCI: Ground-fault circuit interrupter.
- C. GFEP: Ground-fault equipment protection.
- D. HID: High-intensity discharge.
- E. MCCB: Molded-case circuit breaker.
- F. SPD: Surge protective device.
- G. VPR: Voltage protection rating.
- H. I-nominal: Nominal discharge current.
- I. MCOV: Maximum continuous operating voltage.
- J. Mode(s), also Modes of Protection: The pair of electrical connections where the VPR applies.
- K. MOV: Metal-oxide varistor; an electronic component with a significant non-ohmic current-voltage characteristic.
- L. OCPD: Overcurrent protective device.

1.3 SUBMITTALS

- A. Product Data: For each type of panelboard.

1. Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.
 2. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
 3. SPD's: Copy of UL Category Code VZCA certification, as a minimum, listing the tested values for VPRs, I-nominal ratings, MCOVs, type designations, OCPD requirements, model numbers, system voltages, and modes of protection.
- B. Shop Drawings: For each panelboard and related equipment.
1. Include dimensioned plans, elevations, sections, and details.
 2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.
 3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
 4. Detail bus configuration, current, and voltage ratings.
 5. Short-circuit current rating of panelboards and overcurrent protective devices.
 6. Include evidence of NRTL listing for SPD as installed in panelboard (where applicable).
 7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 8. Include wiring diagrams for power, signal, and control wiring.
 9. Key interlock scheme drawing and sequence of operations.
 10. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device. Include an Internet link for electronic access to downloadable PDF of the coordination curves.
- C. Qualification Data: For testing agency.
- D. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.
- E. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals.
1. In addition to items specified in other sections, include the following:
 - a. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 - b. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Keys: Two spares for each type of panelboard cabinet lock.
 - 2. Circuit Breakers Including GFCI and GFEP Types: Two spares for each panelboard.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: ISO 9001 or 9002 certified.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Handle and prepare panelboards for installation according to NEMA PB 1.

1.7 FIELD CONDITIONS

- A. Environmental Limitations:
 - 1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
 - 2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not exceeding 23 deg F to plus 104 deg F.
 - b. Altitude: Not exceeding 6600 feet.
- B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify Construction manager and Owner no fewer than five business days in advance of proposed interruption of electric service.
 - 2. Do not proceed with interruption of electric service without Owner's written permission.
 - 3. Comply with NFPA 70E.

1.8 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace panelboards that fail in materials or workmanship within specified warranty period.
 - 1. Panelboard Warranty Period: 18 months from the date of Substantial Completion.
- B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace SPD that fails in materials or workmanship within specified warranty period.
 - 1. SPD Warranty Period: 3 years from the date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PANELBOARDS AND LOAD CENTERS COMMON REQUIREMENTS

- A. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NEMA PB 1.
- D. Comply with NFPA 70.
- E. SPD with Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- F. Enclosures: Flush and Surface-mounted, dead-front cabinets.
 - 1. Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
 - b. Kitchen and Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
 - c. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
 - d. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
 - 2. Height: 84 inches maximum.
 - 3. Front: Front-hinged-to-box door. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Trims shall cover all live parts and shall have no exposed hardware.

4. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
 5. Finishes:
 - a. Panels and Trim: Galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
 - b. Back Boxes: Galvanized steel.
 - c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.
- G. Incoming Mains:
1. Location: Convertible between top and bottom.
 2. Main Breaker: Main lug interiors up to 400 amperes shall be field convertible to main breaker.
- H. Phase, Neutral, and Ground Buses:
1. Material: Hard-drawn copper, 98 percent conductivity, depending on rating of panelboard.
 - a. Plating shall run entire length of bus.
 - b. Bus shall be fully rated the entire length.
 2. Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors.
 3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
 4. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure. Do not mount neutral bus in gutter.
 5. Split Bus: Vertical buses divided into individual vertical sections.
- I. Conductor Connectors: Suitable for use with conductor material and sizes.
1. Material: Hard-drawn copper, 98 percent conductivity.
 2. Terminations shall allow use of 75 deg C rated conductors without derating.
 3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
 4. Main and Neutral Lugs: Mechanical type, with a lug on the neutral bar for each pole in the panelboard.
 5. Ground Lugs and Bus-Configured Terminators: Mechanical type, with a lug on the bar for each pole in the panelboard.
 6. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.

7. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate on load side of main device unless otherwise noted on plans.
8. Gutter-Tap Lugs: Mechanical type suitable for use with conductor material and with matching insulating covers. Locate at same end of bus as incoming lugs or main device.
- J. NRTL Label: Panelboards or load centers shall be labeled by an NRTL acceptable to authority having jurisdiction for use as service equipment with one or more main service disconnecting and overcurrent protective devices. Panelboards or load centers shall have meter enclosures, wiring, connections, and other provisions for utility metering. Coordinate with utility company for exact requirements.
- K. Future Devices: Panelboards or load centers shall have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
 1. Percentage of Future Space Capacity: See drawings.
- L. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed by an NRTL for 100 percent interrupting capacity.
 1. Panelboards and overcurrent protective devices rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.
 2. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V shall have short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.

2.2 SPD's PERFORMANCE REQUIREMENTS

- A. Surge Suppression: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD Type 1 or Type 2. Comply with UL 1283.
 1. Include LED indicator lights for power and protection status.
 2. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
 3. Include Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
 4. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 200 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.
 5. SCCR: Equal or exceed 100 kA.
 6. I-nominal Rating: 20 kA.

- B. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V or 208Y/120 V, three-phase, four-wire circuits shall not exceed the following:
 - 1. Line to Neutral: 1200 V for 480Y/277 V; 700 V for 208Y/120 V.
 - 2. Line to Ground: 1200 V for 480Y/277 V; 700 V for 208Y/120 V.
 - 3. Neutral to Ground: 1200 V for 480Y/277 V; 700 V for 208Y/120 V.
 - 4. Line to Line: 2000 V for 480Y/277 V; 1200 V for 208Y/120 V.

2.3 DISTRIBUTION PANELBOARDS

- A. Approved manufactures:
 - 1. Square D: I-Line
 - 2. Eaton: Pow-R-Line 4,
 - 3. Siemens: Type P4/P5
 - 4. General Electric: Spectra Series
- B. Panelboards: NEMA PB 1, distribution type.
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
 - 1. For doors more than 36 inches high, provide two latches, keyed alike.
- D. Mains: Circuit breaker.
- E. Branch Overcurrent Protective Devices for Circuit-Breaker: Bolt-on circuit breakers.
- F. Contactors in Main Bus: NEMA ICS 2, Class A, mechanically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.
 - 1. External Control-Power Source: control circuit voltage as indicated on the drawings.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Approved manufacturers:
 - 1. Eaton
 - 2. Square D
 - 3. Siemens
 - 4. General Electric
- B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- C. Mains: Circuit breaker or lugs only.
- D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

- E. Contactors in Main Bus: NEMA ICS 2, Class A, mechanically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.
 - 1. External Control-Power Source: control circuit voltage as indicated on the drawings.
- F. Doors: Door-in-door construction with concealed hinges; secured with multipoint latch with tumbler lock; keyed alike. Outer door shall permit full access to the panel interior. Inner door shall permit access to breaker operating handles and labeling, but current carrying terminals and bus shall remain concealed.
- G. Buses:
 - 1. Copper phase and neutral buses; 200 percent capacity neutral bus and lugs.
 - 2. Copper equipment and isolated ground buses.

2.5 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.
 - 1. Electronic Trip Circuit Breakers – Main and Branch Circuit Breakers 400 Amp Frame and Above:
 - a. 100 percent rated.
 - b. RMS sensing.
 - c. Field-replaceable rating plug or electronic trip.
 - d. Digital display of settings, trip targets, and indicated metering displays.
 - e. Multi-button keypad to access programmable functions and monitored data.
 - f. Ten-event, trip-history log. Each trip event shall be recorded with type, phase, and magnitude of fault that caused the trip.
 - g. Integral test jack for connection to portable test set or laptop computer.
 - h. Field-Adjustable Settings:
 - 1) Instantaneous trip.
 - 2) Long- and short-time pickup levels.
 - 3) Long and short time adjustments.
 - 4) Ground-fault pickup level, time delay, and I squared T response.
 - 2. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
 - 3. GFEP Circuit Breakers: Class B ground-fault protection (30-mA trip).
 - 4. Arc-Fault Circuit Interrupter Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
 - 5. Subfeed Circuit Breakers: Vertically mounted.
 - 6. MCCB Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Breaker handle indicates tripped status.

- c. UL listed for reverse connection without restrictive line or load ratings.
- d. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
- e. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and HID lighting circuits.
- f. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
- g. Communication Capability: Circuit-breaker-mounted or integral communication module with functions and features compatible with power monitoring and control system.
- h. Shunt Trip: 24-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
- i. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
- j. Rating Plugs: Three-pole breakers with ampere ratings greater than 150 amperes shall have interchangeable rating plugs or electronic adjustable trip units.
- k. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
- l. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
- m. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function with other upstream or downstream devices.
- n. Multipole units enclosed in a single housing with a single handle or factory assembled to operate as a single unit.
- o. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in off position.

2.6 IDENTIFICATION

- A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.
- B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.
- C. Circuit Directory: Computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.
 - 1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.
- B. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.
- C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.
- D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Install panelboards and accessories according to NEMA PB 1.1.
- C. Equipment Mounting:
 - 1. Attach panelboard to the vertical finished or structural surface behind the panelboard.
- D. Mount top of trim 84 inches (2134 mm) above finished floor unless otherwise indicated.
- E. Mount panelboard cabinet plumb and rigid without distortion of box.
- F. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- G. Mount surface-mounted panelboards to steel slotted supports 5/8 inch (16 mm) in depth. Orient steel slotted supports vertically.
- H. Install overcurrent protective devices and controllers not already factory installed.

1. Set field-adjustable, circuit-breaker trip ranges.
 2. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written instructions.
-
- I. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.
 - J. Install filler plates in unused spaces.
 - K. Stub four 1-inch (25 mm) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch (25 mm) empty conduits into raised floor space or below slab not on grade.
 - L. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.
 - M. Mount spare fuse cabinet in accessible location.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- D. Device Nameplates: Label each branch circuit device in power panelboards with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- E. Install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems" identifying source of remote circuit.

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers and low-voltage surge arrestors stated in NETA ATS, Paragraph 7.6 Circuit Breakers and Paragraph 7.19.1 Surge Arrestors, Low-Voltage. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

D. Panelboards will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results, with comparisons of the two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573.16 "Coordination Studies."
- C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes. Prior to making circuit changes to achieve load balancing, inform Architect of effect on phase color coding.
 1. Measure loads during period of normal facility operations.
 2. Perform circuit changes to achieve load balancing outside normal facility operation schedule or at times directed by the Architect. Avoid disrupting services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
 3. After changing circuits to achieve load balancing, recheck loads during normal facility operations. Record load readings before and after changing circuits to achieve load balancing.
 4. Tolerance: Maximum difference between phase loads, within a panelboard, shall not exceed 20 percent.

3.6 PROTECTION

- A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 262416

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SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Standard-Grade receptacles.
2. GFCI receptacles.
3. Twist-locking receptacles.
4. Toggle switches.
5. Wall plates.
6. Floor service outlets.
7. Poke-through assemblies
8. Exterior power device pedestals.
9. Boiler Emergency Stop Pushbutton Stations.
10. Spring-driven commercial/industrial-use cord reels.

1.2 SUBMITTALS

- A. Product Data: For each type of product. Highlight exact model being proposed in each submittal.

1.3 WARRANTY

- A. Provide five (5) year manufacturer's warranty on all components.

PART 2 - PRODUCTS

2.1 GENERAL WIRING-DEVICE REQUIREMENTS

- A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.
- C. Devices for Owner-Furnished Equipment:

1. Receptacles: Match plug configurations.
 2. Cord and Plug Sets: Match equipment requirements.
- D. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 STANDARD-GRADE RECEPTACLES

A. Simplex or Duplex Receptacles: 125 V, 20 A:

1. Description: Two pole, three wire, Tamper-Resistant and self-grounding.
2. Configuration: NEMA WD 6, Configuration 5-20R.
3. Standards: Comply with NEMA WD 1, UL498, and FS W-C-596.

B. Weather-Resistant Duplex Receptacles: 125 V, 20 A:

1. Description: Two pole, three wire, and self-grounding. Integral shutters that operate only when a plug is inserted in the receptacle. Square face.
2. Configuration: NEMA WD 6, Configuration 5-20R.
3. Standards: Comply with NEMA WD 1, UL498.
4. Marking: Listed and labeled as complying with NFPA 70, "Receptacles in Damp or Wet Locations" Article.

2.3 GFCI RECEPTACLES

A. Duplex GFCI Receptacles: 125 V, 20 A:

1. Description: Integral GFCI with "Test" and "Reset" buttons. Two pole, three wire, and self-grounding, Feed Through type.
2. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.
3. GFCI shall interrupt ground leak currents between 4-6 mA with a tripping time of .025 seconds.
4. Configuration: NEMA WD 6, Configuration 5-20R.
5. Standards: Comply with NEMA WD 1, UL498, UL 943 Class A, and FS W-C-596.

2.4 TWIST-LOCKING RECEPTACLES

- A. Twist-Lock, Single Convenience Receptacles: comply with NEMA WD 1, NEMA WD 6 Configurations and UL 498. Refer to contract drawings for voltage rating, ampere rating and plug configuration.

2.5 CORD AND PLUG SETS

A. Description:

1. Match voltage and current ratings and number of conductors to requirements of equipment being connected.
2. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and ampacity of at least 130 percent of the equipment rating.
3. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.6 TOGGLE SWITCHES

A. Comply with NEMA WD 1, UL 20, and FS W-S-896.

B. Switches, 120/277 V, 20 A, Single pole:

C. Key-Operated Switches: 120/277 V, 20 A.

1. Description: Single pole, with factory-supplied key in lieu of switch handle.

D. Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches: 120/277 V, 20 A; for use with mechanically held lighting contactors.

E. Key-Operated, Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches: 120/277 V, 20 A; for use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.

2.7 WALL PLATES

A. Single and combination types shall match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: As selected by the Architect.
3. Material for Unfinished Spaces: Galvanized steel.
4. Material for Damp Locations: Cast aluminum with spring-loaded lift gasketed cover, and listed and labeled for use in wet and damp locations (Mechanical rooms, pool rooms, garages etc).

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.

2.8 FLOOR SERVICE FITTINGS

- A. Acceptable Manufacturers: Hubbell Inc, Legrand North America LLC and Leviton Manufacturing Co.
- B. Type: Modular, flush-type or flap-type, dual-service units suitable for wiring method used.
- C. Compartments: Barrier separates power from voice and data communication cabling.
- D. Service Plate: Rectangular, die-cast aluminum with satin finish.
- E. Power Receptacle: NEMA WD 6 Configuration 5-20R, gray finish, unless otherwise indicated.
- F. Data Communication Outlet: Blank cover with bushed cable opening.

2.9 POKE-THROUGH ASSEMBLIES

- A. Acceptable Manufacturers: Hubbell Inc, Legrand North America LLC and Leviton Manufacturing Co.
- B. Description:
 - 1. Factory-fabricated and -wired assembly of below-floor junction box with multi-channeled, through-floor raceway/firestop unit and detachable matching floor service-outlet assembly.
 - 2. Comply with UL 514 scrub water exclusion requirements.
 - 3. Type as indicated on the drawings.
 - 4. Size: Selected to fit nominal 3-inch (75-mm) or 4-inch (100-mm) cored holes in floor and matched to floor thickness. Core hole size as indicated on the drawings.
 - 5. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.
 - 6. Closure Plug: Arranged to close unused 3-inch (75-mm) or 4-inch (100-mm) cored openings and reestablish fire rating of floor.

2.10 DEVICE FINISHES

- A. Device Color:
 - 1. All normal Wiring Devices: As selected by Architect unless otherwise indicated.

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

1. Pass & Seymour/Legrand.
2. Hubbell
3. Leviton

2.12 EXTERIOR POWER DEVICE PEDESTALS

- A. 5.00" x 2.50" x 24" high one gang hinged top outlet box with integral base. 14 gauge stainless steel pedestal and cover (welded to pedestal). 7 gauge stainless steel baseplate (welded to pedestal).
1. Basis of Design: Pedoc Power Solutions Model # 1P24-C-V-G.
 2. UL Listed, NEMA 3R – suitable for wet locations while in use - rated enclosure, 20 amp, 120 volt.
 3. Provided with integral ground studs.
 4. Hinged cover lockable while in use.
 5. Open base for conduit entries: (2) – 1.0" maximum each.
 6. Removable one gang device mounting insert plate: (1) – 20 amp, GFCI duplex receptacle.
 7. Base mounting hardware: (4) – anchors, washers and acorn nuts.
 8. Painted Gray finish.

2.13 BOILER EMERGENCY STOP PUSHBUTTON STATIONS

- A. Acceptable Manufacturers: Schneider Electric Harmony XB4, Eaton Cutler-Hammer or Allen Bradley – Rockwell Automation.
- B. Emergency Stop and Switching Off Pushbutton with triggering action and mechanical latching.
1. 40 mm red hemispherical mushroom with push-pull reset and (1) – NO/(1) – NC contacts.
 2. NEMA Type 13 enclosure with yellow guarded type cover.

2.14 SPRING-DRIVEN COMMERCIAL/INDUSTRIAL-USE CORD REELS

- A. Description: Cord reels shall be rated for severe use in factories, commercial garages, construction sites, and similar locations requiring a harder service type cord. Reel equipped with, or intended for use with, length of flexible cord, providing means for cord to be unwound by user as desired, providing spring take-up mechanism to rewind cord on reel. Provide reels with spring take-up retraction mechanism and latch to restrain action of spring take-up mechanism while cord reel is in use.

- B. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction and marked for intended location and application. Reference Standards: UL Category Control Number SBCV and UL 355.
- C. Spring-Driven Commercial/Industrial-Use Cord Reel:
 - 1. Electrical Rating with Cable: 600 V, 12 amp minimum.
 - 2. No. 12 AWG Cooper Conductors.
 - 3. Color: Yellow.
 - 4. Enclosure Degree of Protection: NEMA Type 2.
 - 5. Ball stop with pivot base.
 - 6. Spool Capacity: No 12 AWG, two wires and equipment ground, 25 ft.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated. See table below for reference.

TYPICAL MOUNTING HEIGHTS	
DEVICE	MOUNTING HEIGHT
Wall switches, card readers	48 inches above finished floor to center
Receptacle outlets, data outlets, CATV outlets	18 inches above finished floor to center
Receptacle outlets – above counter	42 inches above finished floor to center, or 8 inches to center above countertops

- B. Coordination with Other Trades:
 - 1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
 - 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
 - 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
 - 4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:
 - a. Cut back and pigtail, or replace all damaged conductors.
 - b. Straighten conductors that remain and remove corrosion and foreign matter.
 - c. Pigtailing existing conductors is permitted, provided the outlet box is large enough.

D. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the right.

- F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.
- G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical. Group adjacent switches under single, multigang wall plates.
- H. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.
- I. Switch Installation:
 - 1. Install all switches vertically with the "ON" position on top, unless otherwise noted or specified.
 - 2. Where switches are indicated near doors, corner walls, etc. install not less than two (2) inches and not more than twelve (12) inches from the trim.
 - 3. Carefully coordinate location of switches to insure locations are at the strike side of the doors.

3.2 GFCI RECEPTACLES

- A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.
- B. Swab all conduits and outlet boxes clear of moisture.
- C. Do not combine GFCI protected circuits with other circuits in the same raceway: only one (1) GFCI circuit per raceway.
- D. Do not substitute GFCI circuit breakers for GFCI receptacles.
- E. All GFCI receptacles shall be installed in a ready accessible location per the NEC.

3.3 EXTERIOR POWER DEVICE PEDESTALS

- A. Provide roof curb for mounting of pedestal base with (2) – 1" conduit entry attachments oriented per manufacturer's installation specifications.
- B. Attach branch circuit raceways through roof structure to base.
- C. Attach pedestal to base. Provide connection of wiring devices as indicated on the Drawings.

3.4 SPRING-DRIVEN COMMERCIAL/INDUSTRIAL-USE CORD REELS

- A. Examine roughing-in for cord reel mounting and power connections to verify actual locations of mounts and power connections before cord reel installation. Examine walls, floors, and ceilings for suitable conditions where cord reel will be installed. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. Comply with manufacturer's installation instructions. Adjust spring mechanisms and moving parts of cord reel and fittings to function smoothly and lubricate as recommended in writing by manufacturer.
- C. After installation, protect cord reels and fittings from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

3.5 IDENTIFICATION

- A. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.6 FIELD QUALITY CONTROL

- A. Test Instruments: Use instruments that comply with UL 1436.
- B. Test Instrument for Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.
- C. Tests for Receptacles:
 - 1. Line Voltage: Acceptable range is 105 to 132 V.
 - 2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
 - 3. Ground Impedance: Values of up to 2 ohms are acceptable.
 - 4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
 - 5. Using the test plug, verify that the device and its outlet box are securely mounted.
 - 6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.
- D. Wiring device will be considered defective if it does not pass tests and inspections.

3.7 SPARE PARTS

- A. Provide Five (5) spare devices for each type used on the project. Turn over to owner after project completion.

END OF SECTION 262726

SECTION 262813 - FUSES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cartridge fuses rated 600 V ac and less for use in the following:
 - a. Enclosed controllers.
 - b. Enclosed switches.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:

1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
 - a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
 - b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
3. Current-limitation curves for fuses with current-limiting characteristics.
4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse. Submit in PDF format.
5. Coordination charts and tables and related data.

1.3 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Bussmann
 - 2. Mersen
 - 3. Littelfuse
- B. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, current-limiting, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.
 - 1. Type RK-1: 600-V, zero- to 600-A rating, 200 kAIC, time delay.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NEMA FU 1 for cartridge fuses.
- D. Comply with NFPA 70.
- E. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.
- B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.
- C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

- D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

- A. Cartridge Fuses:
 - 1. Motor Branch Circuits: Class RK1, time delay.
 - 2. Other Branch Circuits: Class RK1, time delay.
 - 3. Provide open-fuse indicator fuses or fuse covers with open fuse indication.

3.3 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.
- B. Install spare-fuse cabinet(s) in location shown on the Drawings or as indicated in the field by Owner.

3.4 IDENTIFICATION

- A. Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information inside of door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 262813

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SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Nonfusible switches.
3. Molded-case circuit breakers (MCCBs).
4. Enclosures.

1.2 SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current ratings (interrupting and withstand, as appropriate).
4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
5. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF electronic format.

B. Shop Drawings: For enclosed switches and circuit breakers.

1. Include plans, elevations, sections, details, and attachments to other work.
2. Include wiring diagrams for power, signal, and control wiring.

1.3 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
2. Fuse Pullers: Two for each size and type.

1.4 FIELD CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - 1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
 - 2. Altitude: Not exceeding 6600 feet.

1.5 WARRANTY

- A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within specified warranty period.
 - 1. Warranty period: 2 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Approved manufacturers:
 - 1. Square D
 - 2. Siemens
 - 3. General Electric
- B. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.
- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- E. Comply with NFPA 70.

2.2 FUSIBLE SWITCHES

- A. Manufacturer shall be the same as the switchboards and panelboards.

B. Type HD, Heavy Duty:

1. Single throw.
2. Three or six pole. Provide six pole for connection to motors requiring six motor leads.
3. 600-V ac.
4. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses.
5. Lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
6. Amperage rating as indicated on the drawings.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper neutral conductors.
3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
4. Lugs: Mechanical type, suitable for number, size, and copper conductors.
5. Service-Rated Switches: Labeled for use as service equipment.

2.3 NONFUSIBLE SWITCHES

A. Manufacturer shall be the same as the switchboards and panelboards.

B. Type HD, Heavy Duty, Three Pole, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Type HD, Heavy Duty, Six Pole, Single Throw, 600-V ac, 200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position. Provide six pole switch for connection to motors requiring six motor leads.

D. Refer to drawings for amperage rating of switch(es).

E. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and neutral conductors.

3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
4. Lugs: Mechanical type, suitable for number, size, and copper conductors.
5. Service-Rated Switches: Labeled for use as service equipment.

2.4 MOLDED-CASE CIRCUIT BREAKERS

- A. Manufacturer shall be the same as the switchboards and panelboards.
- B. Circuit breakers shall be constructed using glass-reinforced insulating material. Current carrying components shall be completely isolated from the handle and the accessory mounting area.
- C. Circuit breakers shall have a toggle operating mechanism with common tripping of all poles, which provides quick-make, quick-break contact action. The circuit-breaker handle shall be over center, be trip free, and reside in a tripped position between on and off to provide local trip indication. Circuit-breaker escutcheon shall be clearly marked on and off in addition to providing international I/O markings. Equip circuit breaker with a push-to-trip button, located on the face of the circuit breaker to mechanically operate the circuit-breaker tripping mechanism for maintenance and testing purposes.
- D. The maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings shall be clearly marked on face of circuit breaker. Circuit breakers shall be 100 percent rated.
- E. MCCBs shall be equipped with a device for locking in the isolated position.
- F. Lugs shall be suitable for 194 deg F rated wire, sized according to the 167 deg F (75 deg C) temperature rating in NFPA 70.
- G. Standards: Comply with UL 489 and NEMA AB 3, with interrupting capacity to comply with available fault currents.
- H. Thermal-Magnetic Circuit Breakers: Inverse time-current thermal element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- I. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
- J. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
 1. Instantaneous trip.

2. Long- and short-time pickup levels.
 3. Long- and short-time time adjustments.
 4. Ground-fault pickup level, time delay, and I-squared t response.
- K. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.
- L. Ground-Fault Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).
- M. Features and Accessories:
1. Standard frame sizes, trip ratings, and number of poles.
 2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
 3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
 4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
 5. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.

2.5 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
- B. Enclosure Finish: The enclosure shall be finished with gray baked enamel paint, electrodeposited on cleaned, phosphatized steel (NEMA 250 Type 1) gray baked enamel paint, electrodeposited on cleaned, phosphatized galvanized steel (NEMA 250 Types 3R, 12) a brush finish on Type 304 stainless steel (NEMA 250 Type 4-4X stainless steel).
- C. Conduit Entry: NEMA 250 Types 4, 4X, and 12 enclosures shall contain no knockouts. NEMA 250 Types 7 and 9 enclosures shall be provided with threaded conduit openings in both endwalls.
- D. Enclosures designated as NEMA 250 Type 4, 4X stainless steel, 12, or 12K shall have a dual cover interlock mechanism to prevent unintentional opening of the enclosure cover when the circuit breaker is ON and to prevent turning the circuit breaker ON when the enclosure cover is open.

- E. NEMA 250 Type 7/9 enclosures shall be furnished with a breather and drain kit to allow their use in outdoor and wet location applications.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
 - 1. Commencement of work shall indicate Installer's acceptance of the areas and conditions as satisfactory.

3.2 PREPARATION

- A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify Owner no fewer than five business days in advance of proposed interruption of electric service.
 - 2. Indicate method of providing temporary electric service.
 - 3. Do not proceed with interruption of electric service without Owner's written permission.
 - 4. Comply with NFPA 70E.

3.3 ENCLOSURE ENVIRONMENTAL RATING APPLICATIONS

- A. Enclosed Switches and Circuit Breakers: Provide enclosures at installed locations with the following environmental ratings.
 - 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
 - 2. Outdoor Locations: NEMA 250, Type 3R.
 - 3. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
 - 4. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

3.4 INSTALLATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain code required workspace clearances and required clearances for equipment access doors and panels, regardless of location indicated on the drawings.
- B. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- C. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- D. Install fuses in fusible devices.
- E. Comply with NFPA 70 and NECA 1.

3.5 IDENTIFICATION

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.6 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in the Coordination studies, required per specification section 260573.16 and furnished by the Electrical Contractor.

END OF SECTION 262816

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SECTION 265119 - LED INTERIOR LIGHTING

PART 1 - PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes the following types of LED luminaires:
 - 1. Lighting Fixtures.
 - 2. Materials.
 - 3. Finishes.
 - 4. Fixture support.

1.2 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color Rendering Index.
- C. Fixture: See "Luminaire."
- D. IP: International Protection or Ingress Protection Rating.
- E. LED: Light-emitting diode.
- F. Lumen: Measured output of lamp and luminaire, or both.
- G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.3 SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Arrange in order of luminaire designation.
 - 2. Include data on features, accessories, and finishes.
 - 3. Include physical description and dimensions of luminaires.
 - 4. Include emergency lighting units, including batteries and chargers.
 - 5. Include life, output (lumens, CCT, and CRI), and energy efficiency data.
 - 6. Photometric data and adjustment factors based on laboratory tests, complying with IES Lighting Measurements Testing and Calculation Guides, of each luminaire type. The adjustment factors shall be for lamps and accessories identical to those indicated for the luminaire as applied in this Project IES LM-79 and IES LM-80.

- a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. Shop Drawings: For nonstandard or custom luminaires.
 - 1. Include plans, elevations, sections, and mounting and attachment details.
 - 2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.
- C. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

1.4 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.
- B. Provide luminaires from a single manufacturer for each luminaire type.
- C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.6 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

PART 2 - PRODUCTS

2.1 PRODUCTS

- A. Refer to the Lighting Fixture Schedule on the drawings for the specified fixtures and options.

2.2 LUMINAIRE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Standards:
 - 1. ENERGY STAR certified.
 - 2. California Title 24 compliant.
 - 3. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.
 - 4. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
 - 5. UL Listing: Listed for damp location.
 - 6. Recessed luminaires shall comply with NEMA LE 4.
- C. CRI as indicated on the drawings. CCT as indicated on the drawings.
- D. Rated lamp life of minimum 50,000 hours to L80.
- E. Lamps dimmable from 100 percent to 0 percent of maximum light output.
- F. Internal driver.

2.3 MATERIALS

- A. Metal Parts:
 - 1. Free of burrs and sharp corners and edges.
 - 2. Sheet metal components shall be steel unless otherwise indicated.
 - 3. Form and support to prevent warping and sagging.
- B. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- C. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
 - 1. Label shall include the following lamp characteristics:
 - a. "USE ONLY" and include specific lamp type.
 - b. Lamp diameter, shape, size, wattage, and coating.
 - c. CCT and CRI for all luminaires.

2.4 METAL FINISHES

- A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.5 LUMINAIRE SUPPORT

- A. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.
- B. Wires: ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, 12 gage.
- C. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- D. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with NECA 1.
- B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- C. Install lamps in each luminaire.
- D. Supports:
 - 1. Sized and rated for luminaire weight.
 - 2. Able to maintain luminaire position after cleaning and relamping.
 - 3. Provide support for luminaire without causing deflection of ceiling or wall.

4. Luminaire mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and vertical force of 400 percent of luminaire weight.

E. Flush-Mounted Luminaire Support:

1. Secured to outlet box.
2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
3. Trim ring flush with finished surface.

F. Ceiling-Mounted Luminaire Support:

1. Ceiling mount with minimum two 5/32-inch- diameter aircraft cable supports adjustable to 120 inches in length.
2. Pendant mount with 5/32-inch- diameter aircraft cable supports adjustable to 120 inches in length.
3. Ceiling mount with hook mount.

G. Ceiling-Grid-Mounted Luminaires:

1. Secure to any required outlet box.
2. Secure luminaire to the luminaire opening using approved fasteners (UL Listed support clips) in a minimum of four locations, spaced near corners of luminaire.
3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire. Connect support wires or rods to building structure.

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

3.4 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.
 - 1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
 - 2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

END OF SECTION 265119

SECTION 265219 - EMERGENCY AND EXIT LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Emergency lighting units.
 - 2. Exit signs.
 - 3. Luminaire supports.

1.2 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color Rendering Index.
- C. Emergency Lighting Unit: A lighting unit with internal or external emergency battery powered supply and the means for controlling and charging the battery and unit operation.
- D. Fixture: See "Luminaire" Paragraph.
- E. Lumen: Measured output of lamp and luminaire, or both.
- F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.3 SUBMITTALS

- A. Product Data: For each type of emergency lighting unit, exit sign, and emergency lighting support.
 - 1. Include data on features, accessories, and finishes.
 - 2. Include physical description of the unit and dimensions.
 - 3. Battery and charger for light units.
 - 4. Include life, output of luminaire (lumens, CCT, and CRI), and energy-efficiency data.
 - 5. Include photometric data and adjustment factors based on laboratory tests, complying with IES LM-45, for each luminaire type.
 - a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

- B. Shop Drawings: For nonstandard or custom luminaires.
 - 1. Include plans, elevations, sections, and mounting and attachment details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.
- C. Product Schedule:
 - 1. For emergency lighting units. Use same designations indicated on Drawings.
 - 2. For exit signs. Use same designations indicated on Drawings.

1.4 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.6 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
- B. Special Warranty for Emergency Lighting Batteries: 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.

PART 2 - PRODUCTS

2.1 PRODUCTS

- A. Refer to Lighting Fixture Schedule on the drawings for the specified fixtures and options.

2.2 GENERAL REQUIREMENTS FOR EMERGENCY LIGHTING

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. NRTL Compliance: Fabricate and label emergency lighting units, exit signs, and batteries to comply with UL 924.
- C. Comply with NFPA 70 and NFPA 101.
- D. Comply with NEMA LE 4 for recessed luminaires.
- E. Lamp Base: Comply with ANSI C81.61 or IEC 60061-1.
- F. Bulb Shape: Complying with ANSI C79.1.
- G. Internal Type Emergency Power Unit: Self-contained, modular, battery-inverter unit, factory mounted within luminaire body and compatible with ballast.
 - 1. Emergency Connection: Operate lamp(s) continuously full lumen output upon loss of normal power. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire ballast.
 - 2. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 - 3. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Less than 0 deg F or exceeding 104 deg F, with an average value exceeding 95 deg F over a 24-hour period.
 - b. Ambient Storage Temperature: Not less than minus 4 deg F and not exceeding 140 deg F.
 - c. Humidity: More than 95 percent (condensing).
 - d. Altitude: Exceeding 3300 feet.
 - 4. Test Push-Button and Indicator Light: Visible and accessible without opening luminaire or entering ceiling space.
 - a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 - 5. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.

6. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.3 EMERGENCY LIGHTING

- A. General Requirements for Emergency Lighting Units: Self-contained units.
- B. Emergency Luminaires: as indicated on the drawings.
- C. Emergency Lighting Unit: as indicated on the drawings.
- D. Remote Emergency Lighting Units: as indicated on the drawings.

2.4 EXIT SIGNS

- A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:
 1. Lamps for AC Operation: LED; 50,000 hours minimum rated lamp life.
 2. Self-Powered Exit Signs (Battery Type): Internal emergency power unit.

2.5 MATERIALS

- A. Metal Parts:
 1. Free of burrs and sharp corners and edges.
 2. Sheet metal components shall be steel unless otherwise indicated.
 3. Form and support to prevent warping and sagging.
- B. Doors, Frames, and Other Internal Access:
 1. Smooth operating, free of light leakage under operating conditions.
 2. Designed to permit relamping without use of tools.
 3. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- C. Housings:
 1. As indicated on the drawings.
- D. Conduit: Electrical metallic tubing, minimum 3/4 inch in diameter.

2.6 METAL FINISHES

- A. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for conditions affecting performance of luminaires.
- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.
- C. Examine walls, floors, roofs, and ceilings for suitable conditions where emergency lighting luminaires will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with NECA 1.
- B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- C. Supports:
 - 1. Sized and rated for luminaire and emergency power unit weight.
 - 2. Able to maintain luminaire position when testing emergency power unit.
 - 3. Provide support for luminaire and emergency power unit without causing deflection of ceiling or wall.
 - 4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire and emergency power unit weight and vertical force of 400 percent of luminaire weight.
- D. Wall-Mounted Luminaire Support:
 - 1. Do not attach luminaires directly to gypsum board.
- E. Ceiling Grid Mounted Luminaires:
 - 1. Secure to any required outlet box.

2. Secure emergency power unit using approved fasteners in a minimum of four locations, spaced near corners of emergency power unit.
3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

3.3 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 1. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.
- B. Luminaire will be considered defective if it does not pass operation tests and inspections.
- C. Prepare test and inspection reports.

3.4 STARTUP SERVICE

- A. Perform startup service:
 1. Charge emergency power units and batteries minimum of 24 hours and conduct one-hour discharge test.

END OF SECTION 265219

SECTION 270526 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Selection and installation of communications busbars.
2. Selection and installation of communications bonding conductors.
3. Selection of signal reference grids.
4. Installation of grounding and bonding for antennas.

1.2 DEFINITIONS

- A. BBC: Backbone bonding conductor, for connecting multiple TBBs serving the same floor.
- B. PBB: Primary bonding busbar, located in main distribution frame room, ideally near electrical service entrance.
- C. RBB: Rack bonding busbar, located in equipment cabinets and racks.
- D. SBB: Secondary bonding busbar, located in intermediate distribution frame rooms.
- E. TBB: Telecommunications bonding backbone, for connecting SBBs to PBB.
- F. TBC: Telecommunications bonding conductor, for connecting PBB to intersystem bonding termination device or busbar at electrical service entrance.
- G. TEBC: Telecommunications equipment bonding conductor, for connecting RBBs to SBBs or PBB.
- H. UBC: Unit bonding conductor, for connecting individual communications equipment to RBBs or SBBs.

1.3 ACTION SUBMITTALS

A. Shop Drawings:

1. For communications equipment room signal reference grid.
2. Include plans, elevations, sections, details, and attachments to other work.

B. Field Quality-Control Submittals:

1. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

A. Manufacturers' Published Instructions: Record copy of official installation instructions issued to Installer by manufacturer for the following:

1. Installing wire connector on conductor.
2. Recommended torque values.

1.5 CLOSEOUT SUBMITTALS

A. Record Documentation: Project record documents in accordance with Section 017839 "Project Record Documents" must include locations of PBB and SBBs, and routing of TBC, TBBs, and BBCs.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine facility's grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of electrical system.
- B. Inspect test results of grounding system measured at point of TBC connection.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- D. Proceed with connection of TBC only after unsatisfactory conditions have been corrected.

3.2 SELECTION OF COMMUNICATIONS BUSBARS

- A. Unless otherwise indicated in this Section or on Drawings, provide products specified in Section 260526 "Grounding and Bonding for Electrical Systems."
- B. PBB:

1. Dimensions: 1/4 inch thick by 4 inch high (6.3 mm thick by 100 mm high).
2. Stand-Off Distance: 2 inch (50 mm).

C. SBB:

1. Dimensions: [1/4 inch thick by 4 inch high (6.3 mm thick by 100 mm high).
2. Stand-Off Distance: 2 inch (50 mm).

3.3 SELECTION OF COMMUNICATIONS BONDING CONDUCTORS

A. Unless otherwise indicated in this Section or on Drawings, provide products specified in Section 260526 "Grounding and Bonding for Electrical Systems."

B. Communications Busbar Connections:

1. TBC: Not smaller than 1/0 AWG and no smaller than largest TBB.
2. TBB: Not smaller than 2 kcmil per linear ft of conductor length, but not larger than 750 kcmil, unless otherwise indicated on Drawings.
3. BBC: Not smaller than largest TBB to which it is connected unless otherwise indicated on Drawings.
4. TEBC: Not smaller than 2 AWG unless otherwise indicated on Drawings. Provide bolted connectors.
5. UBC: Not smaller than 6 AWG unless otherwise indicated on Drawings. Provide bolted connectors.
6. Bonding Conductors to Structural Steel: Not smaller than 6 AWG unless otherwise indicated on Drawings. Provide bolted clamp connectors.

C. Cable Tray Connections:

1. Cable Tray Equipment Grounding Conductor: 6 AWG.
2. Cable Tray Bonding Jumper: If not supplied by cable manufacturer, provide bonding jumper not smaller than 6 AWG and not longer than 12 inch (300 mm). If jumper is wire, it must be terminated with lug having one hole and standard barrel for one crimp. If jumper is flexible braid, it must be terminated with one-hole ferrule. Attach with bonding screw or connector provided by cable tray manufacturer.

3.4 SELECTION OF SIGNAL REFERENCE GRIDS

A. Unless otherwise indicated in this Section or on Drawings, provide products specified in Section 260526 "Grounding and Bonding for Electrical Systems."

3.5 INSTALLATION OF BONDING FOR COMMUNICATIONS

- A. Comply with manufacturer's published instructions.
- B. Reference Standards:
 - 1. Bonding of Communications: Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with BICSI N3.
 - 2. Consult Architect for resolution of conflicting requirements.
 - 3. Conductors:
 - a. Stacking of conductors under a single bolt is not permitted when connecting to busbars.
 - b. Assemble wire connector to conductor, complying with manufacturer's published instructions and as follows:
 - 1) Use crimping tool and die specific to connector.
 - 2) Pretwist conductor.
 - 3) Apply antioxidant compound to bolted and compression connections.
 - c. Install in straightest and shortest route between origination and termination point, and no longer than required. Bend radius must not be smaller than 10 times diameter of conductor. No single bend may exceed 90 degrees.
 - d. Install without splices.
 - e. Support conductors at not more than 36 inch (900 mm) intervals.
 - f. Outside telecommunications rooms, install conductors in metric designator 21 (trade size 3/4) PVC-80 conduit until conduit enters telecommunications room.
 - 4. Provide TBC and terminate ends to PBB and intersystem bonding termination device at electrical service entrance in accordance with Section 250.94, "Bonding for Communication Systems," of NFPA 70.
 - 5. Busbar Interconnections: Bond SBBs to PBB with TBBs. If more than one TBB is installed, bond TBBs together BBCs where required by TIA-607.
 - 6. Structural Steel: Where structural steel of steel frame building is readily accessible within room or space, bond each SBB and PBB to vertical steel of building frame.
 - 7. Communications Enclosures: Bond metallic enclosures of telecommunications equipment with UBCs to nearest SBB or PBB.
 - 8. Equipment Racks: Bond metallic components of enclosures to RBB using UBCs. Provide top-mounted RBB if not provided by enclosure or rack manufacturer. Bond RBB to SBB with TEBC. Power connection must comply with NFPA 70;

equipment grounding conductor in power cord of cord- and plug-connected equipment must be considered supplemental to bonding requirements in this Section.

9. Shielded Cable: Bond shield of shielded cable to SBB in communications rooms and spaces. Comply with TIA-568.1 and TIA-568.2 when grounding shielded balanced twisted-pair cables.
10. Primary Protector: Bond to PBB with insulated bonding conductor.
11. Electrical Power Panelboards: Where electrical panelboards for communications equipment are located in same room or space, bond each ground bar of panelboard to SBB.
12. Cable Trays: Provide continuous electrical path by installing bonding clips and jumpers. Bond each end to nearest SBB.

3.6 IDENTIFICATION

- A. Comply with Section 270553 "Identification for Communications Systems."
- B. Labels must be preprinted or computer-printed type.
 1. Label PBB(s) with "ts-PBB," where "ts" is telecommunications space identifier for location of PBB.
 2. Label SBB(s) with "ts-SBB," where "ts" is telecommunications space identifier for location of SBB.
 3. Label TBC, TBBs, and BBCs at attachment points with legend: "WARNING! COMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!"

3.7 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with calibrated torque wrench according to manufacturer's published instructions.
 2. Test bonding connections of system using AC earth ground-resistance tester, taking two-point bonding measurements in each telecommunications equipment room containing PBB or SBB, using process recommended by BICSI N1. Conduct tests with facility in operation.
 - a. Measure resistance between PBB and electrical service intersystem termination point. Maximum acceptable value is 100 m Ω .

- 1) If measured resistance from electrical service equipment to ground exceeds 5Ω , notify Architect and include recommendations to reduce resistance to ground.
 - b. Measure resistance between SBBs and PBB. Maximum acceptable value is $100 \text{ m}\Omega$.
3. Test for ground loop currents using digital clamp-on ammeter, with full scale not more than 10 A, displaying current in increments of 0.01 A at accuracy of plus or minus 2.0 percent.
 - a. With grounding infrastructure completed and communications system electronics operating, measure current in bonding conductors connected to PBB. Maximum acceptable AC current level is 1 A.
- B. Nonconforming Work:
 1. Communications bonding will be considered defective if it does not pass tests and inspections.
 2. Remove and replace defective units and retest.
- C. Collect, assemble, and submit test and inspection reports.

3.8 PROTECTION

- A. After installation, protect busbars and conductors from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

END OF SECTION 270526

SECTION 270528 – PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Metal conduits and fittings.
 - 2. Metal wireways and auxiliary gutters.
 - 3. Metallic surface pathways.
 - 4. Hooks.
 - 5. Boxes, enclosures, and cabinets.
 - 6. Metal Ladder Type Cable Tray.

1.3 ACTION SUBMITTALS

- A. Product data for the following:
 - 1. Surface pathways
 - 2. Cable trays, Wireways and fittings.
 - 3. Boxes, enclosures, and cabinets.
- B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Pathway routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
 - 1. Structural members in paths of pathway groups with common supports.

2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

- A. Description: Metal raceway of circular cross section with manufacturer-fabricated fittings.
- B. General Requirements for Metal Conduits and Fittings:
 1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
 2. Comply with TIA-569-D.
- C. GRC: Comply with ANSI C80.1 and UL 6.
- D. IMC: Comply with ANSI C80.6 and UL 1242.
- E. EMT: Comply with ANSI C80.3 and UL 797.
- F. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
 1. Fittings for EMT:
 - a. Material: Steel.
 - b. Type: Set screw.
- G. Joint Compound for IMC or GRC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Description: Sheet metal trough of rectangular cross section fabricated to required size and shape, without holes or knockouts, and with hinged or removable covers.
- B. General Requirements for Metal Wireways and Auxiliary Gutters:
 1. Comply with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.
 2. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

3. Comply with TIA-569-D.

- C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- D. Wireway Covers: Screw-cover type unless otherwise indicated.
- E. Finish: Manufacturer's standard enamel finish.

2.3 SURFACE METAL PATHWAYS

- A. Description: Galvanized steel with snap-on covers, complying with UL 5.
- B. Finish: Manufacturer's standard enamel finish in color selected by Architect.
- C. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- D. Comply with TIA-569-D.

2.4 HOOKS

- A. Description: Prefabricated sheet metal cable supports for telecommunications cable.
- B. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- C. Comply with TIA-569-D.
- D. Galvanized steel.
- E. J shape.

2.5 BOXES, ENCLOSURES, AND CABINETS

- A. Description: Enclosures for communications.
- B. General Requirements for Boxes, Enclosures, and Cabinets:
 - 1. Comply with TIA-569-D.
 - 2. Boxes, enclosures, and cabinets installed in wet locations shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for use in wet locations.

3. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- D. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- E. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1, with continuous-hinge cover with flush latch unless otherwise indicated.
 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- F. Cabinets:
 1. NEMA 250, Type 1 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 2. Hinged door in front cover with flush latch and concealed hinge.
 3. Key latch to match panelboards.
 4. Metal barriers to separate wiring of different systems and voltage.
 5. Accessory feet where required for freestanding equipment.

2.6 CABLE TRAYS

- A. Description: Metal cable trays and metal cable tray systems intended for field assembly and for use in accordance with Article 392 of NFPA 70.
- B. Listed and labeled in accordance with NFPA 70, by qualified electrical testing laboratory recognized by authorities having jurisdiction, marked for intended location and application.
- C. Listing Criteria: UL CCN CYNW; including NEMA VE 1 and suitability for use as equipment grounding conductors in accordance with Sections 392.60(A) and 392.60(B) of NFPA 70.
- D. Ladder Type Cable Tray
 1. Configuration: Two longitudinal side rails with transverse rungs swaged or welded to side rails, complying with NEMA VE 1.
 2. 12 inch wide with 4 inch minimum usable load depth and 9 inch rung spacing. Radius-Fitting Rung Spacing: 9 inch (225 mm) at center of tray's width.

3. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200 lb. (90 kg) concentrated load, when tested in accordance with NEMA VE 1. No portion of the rungs must protrude below the bottom plane of side rails.
4. Splicing Assemblies: Bolted type using serrated flange locknuts. Splice-Plate Capacity: Splices located within support span must not diminish rated loading capacity of cable tray.
5. Materials and Finishes (Steel): Hot-dip galvanized after fabrication, complying with ASTM A123/A123M, Class B2, with chromium-zinc plated, ASTM F1136 hardware.
6. Class Designation: Comply with NEMA VE 1, Class 8B.

PART 3 - EXECUTION

3.1 PATHWAY APPLICATION

- A. Indoors: Apply pathway products as specified below unless otherwise indicated:
 1. Exposed, Not Subject to Physical Damage: EMT.
 2. Exposed, Not Subject to Severe Physical Damage: EMT.
 3. Exposed and Subject to Severe Physical Damage: GRC or IMC. Pathway locations include the following:
 - a. Loading dock.
 - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
 - c. Mechanical rooms.
 - d. Gymnasiums
 4. Concealed in Ceilings and Interior Walls and Partitions: EMT or innerduct.
 5. Damp or Wet Locations: GRC or IMC].
 6. Pathways for Communications Cable in Spaces Used for Environmental Air: Plenum-type, communications-cable pathway: EMT.
 7. Pathways for Concealed General-Purpose Distribution of Communications Cable: General-use, communications-cable pathway: EMT.
- B. Minimum Pathway Size: 3/4-inch (21-mm) trade size for copper and aluminum cables, and 1 inch (25 mm) for optical-fiber cables.
- C. Pathway Fittings: Compatible with pathways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
 2. EMT: Use set-screw steel fittings. Comply with NEMA FB 2.10.
- D. Install surface pathways only where indicated on Drawings.

3.2 INSTALLATION

- A. Comply with the following standards for installation requirements except where requirements on Drawings or in this Section are stricter:
1. NECA 1.
 2. NECA/BICSI 568.
 3. TIA-569-D.
 4. NECA 101
 5. NECA 105.
- B. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.
- C. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- D. Comply with requirements in Section 270529 "Hangers and Supports for Communications Systems" for hangers and supports.
- E. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling" for sleeves and sleeve seals for communications.
- F. Keep pathways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.
- G. Complete pathway installation before starting conductor installation.
- H. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- I. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches (300 mm) of changes in direction.
- J. Conceal rigid conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

- K. Support conduit within 12 inches (300 mm) of enclosures to which attached.
- L. Stub-ups to Above Recessed Ceilings:
 - 1. Use EMT, IMC, or RMC for pathways.
 - 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- M. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.
- N. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.
- O. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus one additional quarter-turn.
- P. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure, to assure a continuous ground path.
- Q. Cut conduit perpendicular to the length. For conduits of 2-inch (50-mm) trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.
- R. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Secure pull wire, so it cannot fall into conduit. Cap pathways designated as spare alongside pathways in use.
- S. Surface Pathways:
 - 1. Install surface pathway for surface telecommunications outlet boxes only where indicated on Drawings.
 - 2. Install surface pathway with a minimum 2-inch (50-mm) radius control at bend points.
 - 3. Secure surface pathway with screws or other anchor-type devices at intervals not exceeding 48 inches (1200 mm) and with no less than two supports per straight pathway section. Support surface pathway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
- T. Install devices to seal pathway interiors at accessible locations. Locate seals, so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service pathway enters a building or structure.
3. Where otherwise required by NFPA 70.

U. Expansion-Joint Fittings:

1. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
2. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

V. Hooks:

1. Size to allow a minimum of 25 percent future capacity without exceeding design capacity limits.
2. Shall be supported by dedicated support wires. Do not use ceiling grid support wire or support rods.
3. Hook spacing shall allow no more than 6 inches (150 mm) of slack. The lowest point of the cables shall be no less than 6 inches (150 mm) adjacent to ceilings, mechanical ductwork and fittings, luminaires, power conduits, power and telecommunications outlets, and other electrical and communications equipment.
4. Space hooks no more than 5 feet (1.5 m) o.c.
5. Provide a hook at each change in direction.

W. INSTALLATION OF CABLE TRAYS

1. Install cable tray and support systems in accordance with NEMA VE 2.
2. Install cable tray as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.
3. Support cable trays with trapeze hangers and wall brackets as required for plan configuration.
4. Ground cable trays in accordance with NFPA 70 unless additional grounding is specified.
5. Install cable trays with enough workspace to permit adequate access for installing cables.
6. Fasten cables on vertical runs to cable trays every 18 inch (450 mm).
7. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure must be no more than 72 inch (1800 mm).

- X. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
- Y. Horizontally separate boxes mounted on opposite sides of walls, so they are not in the same vertical channel.
- Z. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

3.3 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR COMMUNICATIONS PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.4 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

END OF SECTION 270528

SECTION 271100 - COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Backboards.
 - 2. Boxes, enclosures, and cabinets.
 - 3. Power strips.
- B. Related Requirements:
 - 1. Section 271323 "Communications Optical Fiber Backbone Cabling" for optical-fiber data cabling associated with system panels and devices.
 - 2. Section 271513 "Communications Copper Horizontal Cabling" for copper data cabling associated with system panels and devices.

1.3 DEFINITIONS

- A. Access Provider: An operator that provides a circuit path or facility between the service provider and user. An access provider can also be a service provider.
- B. BICSI: Building Industry Consulting Service International.
- C. RCDD: Registered communications distribution designer.
- D. Service Provider: The operator of a telecommunications transmission service delivered through access provider facilities.
- E. TGB: Telecommunications grounding bus bar.
- F. TMGB: Telecommunications main grounding bus bar.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For communications equipment room fittings. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
 - 3. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.
- B. Seismic Qualification Data: Certificates, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions. Base certification on the maximum number of components capable of being mounted in each rack type. Identify components on which certification is based.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling installer must have personnel certified by BICSI on staff.
 - 1. Layout Responsibility: Preparation of Shop Drawings shall be under direct supervision of Technician.

2. Installation Supervision: Installation shall be under direct supervision of Installer 2, Copper or Fiber, who shall be present at all times when Work of this Section is performed at Project site.
3. Field Inspector: Currently registered by BICSI as Technician to perform the on-site inspection.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Equipment shall withstand the effects of earthquake motions determined according to requirements for Zone 2A Seismic Earthquake Environments.
 1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified."

2.2 BACKBOARDS

- A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches (19 by 1220 by 2440 mm).
- B. Backboard Paint: Light-colored interior latex paint.

2.3 BOXES, ENCLOSURES, AND CABINETS

- A. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets shall be listed and labeled for intended location and use.
- B. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- C. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, Type FD, aluminum, with gasketed cover.
- D. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
- E. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- F. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.
- G. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

- H. Device Box Dimensions: 4 inches square by 2-1/8 inches deep (100 mm square by 60 mm deep).
- I. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 3R with continuous-hinge cover with flush latch unless otherwise indicated.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 - 2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- J. Cabinets:
 - 1. NEMA 250, Type 1 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 - 2. Hinged door in front cover with flush latch and concealed hinge.
 - 3. Key latch to match panelboards.
 - 4. Metal barriers to separate wiring of different systems and voltage.
 - 5. Accessory feet where required for freestanding equipment.
 - 6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.4 POWER STRIPS

- A. Power Strips: Comply with UL 1363.
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Rack mounting, with integral flanges.
 - 3. Height: 1 RU.
 - 4. Housing: Metal.
 - 5. Six, 15-A, 120-V ac, NEMA WD 6, Configuration 5-15R receptacles.
 - 6. Front-facing receptacles.
 - 7. LED indicator lights for power and protection status.
 - 8. LED indicator lights for reverse polarity and open outlet ground.
 - 9. Circuit Breaker and Thermal Fusing:
 - a. When protection is lost, circuit opens and cannot be reset.
 - 10. Cord connected with 15-foot (4.5-m)] line cord.
 - 11. Rocker-type on-off switch, illuminated when in on position.
 - 12. Surge Protection: UL 1449, Type 3.
 - a. Maximum Surge Current, Line to Neutral: 27 kA.

- b. Protection modes shall be line to neutral, line to ground, and neutral to ground.
- c. UL 1449 Voltage Protection Rating for line to neutral and line to ground shall be 600 V for neutral to ground.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1.
- B. Comply with BICSI's "Telecommunications Distribution Methods Manual" for layout of communications equipment spaces.
- C. Comply with BICSI's "Information Technology Systems Installation Methods Manual" for installation of equipment in communications equipment spaces.
- D. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
- E. Coordinate layout and installation of communications equipment in tracks and in room. Coordinate service entrance configuration with service provider.
 - 1. Meet jointly with systems providers, equipment suppliers, and Owner to exchange information and agree on details of equipment configurations and installation interfaces.
 - 2. Record agreements reached in meetings and distribute them to other participants.
 - 3. Adjust configurations and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize configurations and space requirements of communications equipment.
 - 4. Adjust configurations and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in equipment room.
- F. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.
- G. Backboards:
 - 1. Install from 6 inches (150 mm) to 8 feet, 6 inches (2588 mm) above finished floor. If plywood is fire rated, ensure that fire-rating stamp is visible after installation.

2. Paint all sides of backboard with two coats of paint.
3. Comply with requirements for backboard installation in BICSI's "Information Technology Systems Installation Methods Manual" and TIA-569-D.

3.2 SLEEVE AND SLEEVE SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.3 FIRESTOPPING

- A. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Comply with TIA-569-D, Annex A, "Firestopping."
- C. Comply with BICSI's "Information Technology Systems Installation Methods Manual," "Firestopping Practices" Ch.

END OF SECTION 271100

SECTION 271323 – COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract including all General Conditions, Supplementary Conditions, Division 1 specification sections as well as Information to Bidders requirements that are included in the project documents, apply to the work of this Contract.

1.2 WORK INCLUDED

- A. Labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents.
- B. Multimode and single mode fiber optic backbone cable
- C. Provide backbone cable from incoming telephone service equipment to MDF-1. Extend and connect from MDF-1 to IDF-1, IDF-2, IDF-3 and IDF-4.

1.3 QUALITY ASSURANCE

- A. All cable shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the Owner's Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.
- B. Materials and work specified herein shall comply with the applicable requirements of:
 - 1. ANSI/TIA/EIA – 568B.X (current edition)
 - 2. ANSI/TIA/EIA – 569A (current edition)
 - 3. NFPA 70 - 2002
 - 4. BICSI Telecommunications Distribution Methods Manual (current edition).
 - 5. FCC 47 CFR 68
 - 6. NEMA - 250

7. NEC - Articles 725, 760, 770 and 800
 8. IEEE C2 National Electrical Safety Code
 9. ISO/IEC 11801
 10. ANSI-J-STD-607-A
 11. ANSI/TIA/EIA 606-A (current edition)
 12. ANSK/NECA/BICSI 568 (current edition)
 13. Inside-Outside Plant Mechanical Properties: ICEA S-104-696
- C. If this document and any of the documents listed above are in conflict, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to the most recent release when developing the proposal for installation.

1.4 SUBMITTALS

- A. Manufacturers catalog sheets, specifications and installation instructions for all cable, connecting hardware and patch cables.
- B. Termination details for all cable types.
- C. List of three (3) installations of equivalent or larger systems that have been installed within the past two (2) years and have been operating satisfactorily for a minimum of one year. (Include names and phone numbers of references).
- D. Cable Test Reports (at substantial completion).
- E. Cable tension reports for optical fiber pulls backbone pulls over 200'.

PART 2 – PRODUCTS

2.1 FIBER OPTIC CABLE INDOOR/OUTDOOR

- A. Unless noted otherwise provide 12/12 multimode/single mode fiber optic cables.
- B. Cable shall be Loose Tube Gel-Free Plenum type. Cable shall have water-swallowable yarn eliminating the need for gel-filling
- C. Flame-retardant outer jacket , UV-resistant allowing direct exposure to sunlight.
- D. Meeting the requirements of the National Electrical Code® (NEC®) Article 770, the cables are also OFNP and FT-6 listed.
- E. All fibers in the cable must be usable fibers and meet required specifications.

- F. All optical fibers shall be sufficiently free of surface imperfections and inclusions to meet the optical, mechanical, and environmental requirements of this specification.
- G. Each optical fiber shall consist of a doped silica core surrounded by a concentric glass cladding. The fiber shall be a matched clad design.
- H. All optical fibers shall be proof tested by the fiber manufacturer at a minimum of 100 kpsi.
- I. The fiber shall be coated with a dual layer acrylate protective coating. The coating shall be in physical contact with the cladding surface.
- J. The coated fiber shall have a layer of Teflon* placed between the dual layer acrylate coating of the optical fiber and the thermoplastic buffer. The diameter of the thermoplastic buffer coating shall be 900 ± 50 μ m.
- K. The fiber coating and buffer shall be removable with commercially available stripping tools in a single pass.
- L. The multimode fiber utilized shall be 50 micron. laser optimized extended 10G distance (OM4)
 - 1. Core diameter: 50 ± 3.0 μ m.
 - 2. Cladding diameter: 125.0 ± 2.0 μ m.
 - 3. Core-to-Cladding Offset: ± 3.0 μ m.
 - 4. Cladding non-circularity: ± 2.0 %.
 - 5. Core non-circularity: 6.0 %.
 - 6. Coating Diameter: 245 ± 10 μ m
 - 7. Graded index
 - 8. Numerical Aperture: 0.275 ± 0.015 .
 - 9. Attenuation Uniformity: There shall be no point discontinuities greater than 0.2 dB at either 850 nm or 1300 nm
 - 10. 4700 MHz EMB bandwidth
- M. The non-dispersion shifted single-mode fiber utilized in the cable specified herein shall conform to the following specifications:
 - 1. Typical Core Diameter: 8.3 μ m.
 - 2. Cladding Diameter: 125.0 ± 1.0 μ m.
 - 3. Core-to-Cladding Offset: 0.6 μ m.
 - 4. Cladding Non-Circularity: 1.0%.
 - 5. Coating Diameter: 245 ± 10 μ m.
 - 6. Attenuation Uniformity- No point discontinuity greater than 0.1 dB at either 1310 nm or 1550 nm.
 - 7. Attenuation at the Water Peak- The attenuation at 1383 ± 3 nm shall not exceed

- 2.1 dB/km.
 8. Cutoff Wavelength- The cabled fiber cutoff wavelength shall be < 1260 nm.
 9. Mode Field Diameter: 9.30 ± 0.50 μm at 1310 nm, 10.50 ± 1.00 μm at 1550 nm
 10. Zero Dispersion Wavelength (λ_0)- 1301.5 nm - 1321.5 nm.
 11. Zero Dispersion Slope (S_0)- $0.092 \text{ ps}/(\text{nm}^2 \cdot \text{km})$.
 12. Fiber Curl: > 4.0 m radius of curvature.
- N. The attenuation of the cabled fiber shall be uniformly distributed throughout its length such that there are no discontinuities greater than 0.1 dB at 1310 nm/1550 nm (single- mode) or 0.2 dB at 850 nm/1300 nm (multimode) in any one kilometer length of fiber.
- O. The cable shall withstand a minimum compressive load of 890 N/cm (500 lbf/in) applied uniformly over the length of the compression plate. The cable shall have an aluminum or steel interlock armor that increases the crush resistance at least ten times that of standard fiber cable, typically 89 N/cm (50 lbf/in). The cable shall be tested in accordance with FOTP-41, "Compressive Loading Resistance of Fiber Optic Cables." While under compressive load, the fibers shall not experience an attenuation change greater than 0.4 dB at 1550 nm (single-mode) or greater than 0.6 dB at 1300 nm (multimode). After the compressive load is removed, the fibers shall not experience an attenuation change greater than 0.2 dB at 1550 nm (single-mode) or greater than 0.4 dB at 1300 nm (multimode).
- P. The cable shall withstand a minimum of 20 impact cycles. The cable shall be tested in accordance with FOTP-25, "Repeated Impact Testing of Fiber Optic Cables and Cable Assemblies." The fibers shall not experience an attenuation change greater than 0.2 dB at 1550 nm (single mode) or greater than 0.4 dB at 1300 nm (multimode).
- Q. The cable shall withstand 25 mechanical flexing cycles at a rate of 30 ± 1 cycles per minute. The cable shall be tested in accordance with FOTP-104, "Fiber Optic Cable Cyclic Flexing Test." The fibers shall not experience an attenuation change greater than 0.2 dB at 1550 nm (single mode) or greater than 0.4 dB at 1300 nm (multimode).
- R. Design Make: Corning Cable Systems Interlocking Armored FREEDM®
- S. Acceptable Manufacturers:
1. Belden
 2. OCC
 3. AMP

2.2 OPTICAL FIBER CABLE CONNECTORS

- A. High-precision connectors with insert loss – 0.1 dB typical/0.5 dB maximum

per connector pair for multimode, 0.2 dB typical/0.5 dB maximum per connector pair for single-mode.

B. 50 Micron Multimode Fiber Connectivity (OM 4)

1. The optical fiber field-installable connector shall be LC, for installation onto multimode a laser optimized 50/125-micron fiber.
2. The optical fiber field-installable connector shall be compatible with 900-micron buffered fibers.
3. The optical fiber field-installable connector shall meet or exceed the performance criteria found in ANSI/TIA-568-C.3.
4. The optical fiber field-installable connector shall have a maximum Loss of 0.5 dB.
5. The optical fiber adapter module that occupies the faceplate shall be equipped with zirconia ceramic sleeve.
6. Laser optimized multimode fiber connector color shall be aqua.

C. Singlemode Fiber Connectivity (OS 2)

1. The optical fiber field-installable connector shall be LC, for installation onto singlemode 8.3/125-micron fiber.
2. The optical fiber field-installable connector shall meet or exceed the performance criteria found in ANSI/TIA-568-C.3.
3. The optical fiber field-installable connector shall be compatible with 900-micron buffered fibers or 250-micron loose-tube fibers.
4. The preferred method of terminating loose-tube singlemode fiber is pigtail splicing into a rack mounted optical fiber panel or wall-mounted enclosure. Pigtails shall be factory terminated and 3 meters in length. A fiber enclosure with slack storage trays must be used when pigtail-splicing method is used.
5. The splice loss through each connector pair shall not exceed 0.50 dB.
6. The optical fiber adapter module that occupies the faceplate shall be equipped with zirconia ceramic sleeve.
7. Singlemode fiber connector color shall be blue.

D. Design Make: Corning Cable Systems UniCam High performance LC.

E. Acceptable Manufacturers

1. AMP
2. OCC
3. Leviton

2.3 FIBER ENCLOSURE

A. Shall be rack mounted

- B. Front and rear transparent polycarbonate doors and chassis covers
- C. Magnified label holders to clearly identify fiber connections
- D. Shall be constructed with 16 gauge steel.
- E. Housings have sliding tray (01U and 02U) or open top at front (03U and 04U)
- F. Meets ANSI/TIA/EIA-568A and 606
- G. 17" enclosure depth
- H. Fiber management rings that are adjustable and stackable for optimized fiber slack organization
- I. Mounting provisions for buffer tube fan-out kits
- J. Provide IC connector housing panels as required to accommodate all fiber called for.
- K. Shall accommodate 12, 24, 48, 72 or 96 fibers.
- L. Design Make: Corning CCH series

PART 3 – EXECUTION

3.1 OPTICAL INSTALLATION OF OPTICAL FIBER BACKBONE CABLES

- A. Optical fiber backbone cabling system must provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.
- B. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters may not be used as part of backbone cabling.
- C. Comply with BICSI N1, NECA NEIS 1, and NECA NEIS 301.
- D. Backbone cabling system must comply with transmission standards in TIA-568.1.
- E. Telecommunications Pathways and Spaces: Comply with TIA-569.

3.2 OPTICAL FIBER

A. Bending Radius

1. Do not exceed the cable's minimum bend radius. Bending cable tighter than the minimum bend radius may result in increased optical fiber attenuation, optical fiber breakage, or the development of microfractures.
2. Nonconductive backbone optical fiber cables shall have a minimum bend radius of 10 times the cable outside diameter when under no load and 15 times the cable outside diameter when being pulled.
3. Conductive backbone optical fiber cables shall have a minimum bend radius of 10 times the cable outside diameter when under no load and 20 times the cable outside diameter when being pulled. Check manufacturer's specifications on the cable bend radius requirements.

B. Furnish Strain relief at top of vertical rise.

C. Innerduct shall be provided for all interior building optical fiber cables, in a minimum of 1" diameter. Place innerduct inside EMT conduits or provide plenum rated. Place a spare pull-line in during installation of the innerduct.

D. Optical Fiber splices are not allowed. Should fiber be broken during installation the entire run shall be replaced.

E. Interior cable installed in accessible ceilings shall be installed in open top cable hangers 4 foot on center or in cable tray. Install the cables as close to the ceiling deck as possible in a segregated pathway. Do not install with UTP or coax cables.

F. Provide tie wraps to close top of cable hangers after installation is complete.

G. Exterior cable shall be installed in one of the following methods:

1. Underground ductbank with Inner duct.

H. Maintain polarization for entire system as described in ANSI/EIA/TIA-568-A section 12.7.1.

END OF SECTION 271300

SECTION 271500 HORIZONTAL CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract including all General Conditions, Supplementary Conditions, Division 1 specification sections as well as Information to Bidders requirements that are included in the project documents, apply to the work of this Contract.

1.2 SCOPE OF WORK

- A. Provide labor, materials, equipment, and services to perform the work required for a complete installation as required in the Contract Documents.
- B. Work specified in this section is included in the cabling contract.
- C. This section shall include the following:
 - 1. Category 6 and 6A cable
 - 2. Patch Panels
 - 3. Communications Faceplates
 - 4. Termination Jacks

1.3 REFERENCES

- A. The products and work herein specified shall comply with the current additions of the following publications and standards.
 - 1. UL - Underwriter Laboratory
 - 2. NEC – National Electric Code
 - a. Article 725
 - b. Article 770
 - c. Article 800
 - 3. NFPA – National Fire Protection Association
 - 4. NECA - Standard of Installation
 - 5. ANSI – American National Standards Institute
 - 6. NEMA – National Electrical Manufacturers Association
 - a. Article 250
 - 7. EIA – Electronic Industries Alliance
 - a. ANSI/TIA/EIA-568-C.2.
 - b. ANSI/EIA/TIA 569B

- c. ANSI/EIA/TIA 606A
 - d. ANSI-J-STD-607-A
 - e. ANSI/TIA/EIA-606-A
 - 8. TIA – Telecommunications Industry Association
 - 9. IEEE C2 National Electrical Safety Code
 - 10. FCC - Federal Communications Commission
 - a. CFR 68
 - 11. BICSI – Building Industry Consulting Services International
 - a. Distribution Methods Manual
 - b. ANSK/NECA/BICSI 568
 - 12. ISO/IEC 11801
- B. If this document and any of the documents listed above are in conflict, then the more stringent requirement shall apply. All documents listed are believed to be the most current releases of the documents. The Contractor has the responsibility to determine and adhere to the most recent release when developing the proposal for installation.

1.4 QUALITY ASSURANCE

- A. All work shall be provided in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents, shall be provided in accordance with industry standards and shall be subject to the control and approval of the Owners representative.
- B. Equipment and materials shall be of the quality and manufactures indicated. The equipment specified is based on the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in everyway to that of the equipment specified, and subject to the approval of the Engineer.
- C. Strictly adhere to all Category 6 (BICSI and TIA) and manufacturer recommended installation practices when installing high performance cabling.
- D. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.
- E. The contractor shall furnish a list of three (3) installations of equivalent or larger systems that have been installed within the past two (2) years and have been operating satisfactorily for a minimum of one year. (Include names and phone numbers of references) with bid.

1.5 SUBMITTALS

- A. Provide manufacturer's cutsheets, specifications, and installation instructions

for the products herein specified.

1. Category 6 cable
2. Category 6 Patch Panels
3. Communications Faceplates
4. Wall Phone Faceplates
5. Modular Jacks

B. Termination details for all cable types.

PART 2 PRODUCTS

2.1 CATEGORY 6 100 OHM UNSHIELDED TWISTED PAIR CABLE

- A. The horizontal balanced twisted pair cable shall exceed the Category 6 transmission characteristics per issue of ANSI/TIA/EIA-568-C.2.
- B. Shall be independently verified to comply with ANSI/TIA/EIA-568-C.2.
- C. An ISO 9002 Certified Manufacturer shall make the cable.
- D. Cable shall be UL LISTED.
- E. Cable shall be plenum rated
- F. Physical Characteristics:
 1. Shall be CMP (plenum rated) rated and meet applicable requirements of ANSI/ICEA S-80-576 and NEC.
 2. Conductor shall be 24 AWG solid bare annealed copper.
 3. Outer jacket colors shall be green for wireless access points, Blue for Data or voice outlets.
 4. Category marking shall be printed every one foot. Footage indicators shall also be provide on jacket.
 5. The diameter of the insulated conductor shall be .023 in. maximum.
 6. Shall consist of (4) 24 AWG twisted pairs.
 7. Shall be suitable for the environment in which they are to be installed.
 8. The color coding of pairs shall be:

Pair 1	W-BL; BL
Pair 2	W-O; O
Pair 3	W-G; G
Pair 4	W-BR; BR

9. The ultimate breaking strength measured in accordance with ASTM D 4565 shall be 400 N minimum.
10. Cable shall withstand a bend radius of 1 inch at -20 degrees Celsius without jacket or insulation cracking.

G. Compliance:

1. ANSI/TIA-568-C.2
2. U.L. 444
3. U.L. 1666
4. NFPA 262

H. Impedence - 100 Ohm +/- 15

I. Cable Electrical Table 1:

Freq. (MHz)	Max Insertion Loss (dB/100m)	Min. PSNEXT (dB)	Min. PSACR (dB)	Min. PSACRF (dB)	Min. Return Loss (dB)	Min. Balance TCL (dB)	Min. Balance ELTCTL (dB)
1	1.8	80.3	78.4	72.8	20.0	40.0	35.0
4	3.5	71.3	67.8	60.8	23.0	40.0	23.0
8	4.9	66.8	61.8	54.7	24.5	40.0	16.9
10	5.5	65.3	59.8	52.8	25.0	40.0	15.0
16	7.0	62.2	55.3	48.7	25.0	38.0	10.9
20	7.8	60.8	53.0	46.8	25.0	37.0	9.025
25	8.7	59.3	50.6	44.8	22.5	36.0	7.0
31.25	9.8	57.9	48.1	42.9	24.3	35.1	-----
62.5	14.1	53.4	39.3	36.9	22.2	32.0	-----
100	18.0	50.3	32.3	32.8	20.8	30.0	-----
200	26.2	45.8	19.6	26.8	18.7	27.0	-----
250	29.6	44.3	14.8	24.8	18.0	26.0	-----
300	32.7	43.2	10.4	23.3	17.5	-----	-----
350	35.6	42.2	6.5	21.9	17.0	-----	-----
400	38.4	41.3	2.9	20.8	16.6	-----	-----
450	41.0	40.5	0	19.7	16.2	-----	-----
500	43.6	39.8	-----	18.8	15.9	-----	-----
550	46.0	39.2	-----	18.0	15.6	-----	-----
600	48.4	38.6	-----	17.2	15.4	-----	-----
650	50.6	36.1	-----	15.5	15.1	-----	-----
750	55.0	35.2	-----	14.3	14.6	-----	-----
860	59.6	34.3	-----	13.1	14.3	-----	-----

Cable Electrical Table 2:

Freq.	Input (Unfitted)	Fitted	Min.	Min.
1	100 ± 15	100 ± 15	70.8	67.8
4	100 ± 15	100 ± 15	58.8	55.8
8	100 ± 15	100 ± 15	52.7	49.7
10	100 ± 15	100 ± 15	50.8	47.8
16	100 ± 15	100 ± 15	46.7	43.7
20	100 ± 15	100 ± 15	44.8	41.8
25	100 ± 15	100 ± 15	42.8	39.8
31.25	100 ± 15	100 ± 15	40.9	37.9
62.5	100 ± 15	100 ± 15	34.9	31.9
100	100 ± 15	100 ± 15	30.8	27.8
155	100 ± 22	100 ± 15	27.0	24.0
200	100 ± 22	100 ± 15	24.8	21.8
250	100 ± 32	100 ± 15	22.8	19.8
300	100 ± 32	100 ± 15	21.3	18.3
350	100 ± 32	100 ± 15	19.9	16.9
400	100 ± 32	100 ± 15	18.8	15.8
450	100 ± 32	100 ± 15	17.7	14.7
500	100 ± 32	100 ± 15	16.8	13.8
550	100 ± 32	100 ± 15	16.0	13.0

J. Design Make: Belden 4800

K. Acceptable Manufacturers:

1. Commscope
2. Berktek
3. Amp

2.2 CATEGORY 6 CONNECTING HARDWARE

A. Category 6 compliant modular jacks

B. Performance terminated on a 100M length of cable shall match requirements listed for Category 6 cable

C. Physical Characteristics

1. Jacks shall be 8 position un-keyed

2. Each jack shall be an individually constructed unit and shall snap mount in an industry standard keystone opening (.760" x 580")
3. Jack housings shall be high impact 94 V-0 rated thermoplastic
4. Jacks shall have a temperature rating of -10 °C (14°F) to 60°C (140 °F) in conformance with ANSI/TIA/EIA-568-A
5. Jacks shall utilize a 2 layer printed circuit board to control NEXT
6. Jack housings shall fully encase and protect printed circuit boards and IDC fields.
7. Housing shall be ultrasonically welded for tamper resistance.
8. Modular jack contacts shall accept a minimum of 2500 mating cycles without degradation of electrical or mechanical performance.
9. Contacts will maintain a minimum vertical deflection force of 100 grams over deflection window.
10. Modular jack contact wires shall be formed flat for increased surface contact with mated plugs.
11. Contacts shall be arranged on the PC board in 2 staggered arrays, one array has 6 contacts and the other array has 2 contacts.
12. Modular jack contacts shall be constructed of Beryllium copper for maximum spring force and resilience.
13. Contact Plating shall be a minimum of 50 micro inches of hard gold in the contact area over 50 micro-inch of nickel.
14. Jack termination shall follow the industry standard 110 IDC.
15. IDC contact termination towers shall be paired and angled at 29.5 degrees.
16. IDC contacts shall be laid out in staggered arrays of 4 sets of 2 contacts.
17. Jacks shall have a designation indicating Category 6 on the nose which can be plainly seen from the front of the faceplate. Bottom of jack shall have date code and an abbreviated catalog number.
18. Jacks shall utilize a paired punch down sequence. Cable pair twists shall be maintained up to the IDC, terminating all conductors adjacent to its pair mate to better maintain pair characteristics designed by the cable manufacturer.
19. 110 IDC shall utilize 100 micro-inch tin lead plated (60% tin/40%lead) over phosphor bronze over nickel.
20. Jacks shall terminate 22-26 AWG stranded or solid conductors.
21. Jacks shall terminate insulated conductors with outside diameters up to .050"
22. Jacks shall be compatible with single conductor 110 impact termination tools.

23. Jacks shall include translucent wire retention stuffer cap, that hold terminated wires in place and allow the conductors to be visually inspected in the IDC housing.
24. Stuffer cap shall have a positive locking latch to provide conductor strain relief.
25. Stuffer cap used for wire termination with channel lock style pliers.
26. Jacks shall be compatible with TIA/EIA 606 color code labeling
27. Jacks shall accept snap on icons for identification or designation of applications.
28. Jacks shall be available in 6 colors for identification or designation of applications at the workstation or telecommunication room.
29. Jacks shall have universal wiring designation.
30. Jacks shall be marked with the T-568A wiring scheme.
31. Jacks shall have an attached color coded wiring instruction label housed between the IDC termination towers.
32. Jacks shall be manufactured in the USA
33. Jacks shall be designed for 100 Ohm UTP cable termination
34. Jacks shall be UL LISTED 1863 and CSA certified.
35. Jacks shall be made by an ISO 9002 Certified Manufacturer.

D. Design Make: Belden Cat6+

E. Acceptable Manufacturers:

1. Panduit
2. Amp
3. Hubbell

2.3 CATEGORY 6A (625MHZ) 4-PAIR UNSHIELDED TWISTED PAIR CABLE

- L. The horizontal balanced twisted pair cable shall exceed the Category 6A transmission characteristics per issue of ANSI/TIA/EIA 568-C.2 Category 6A. Tested to 625MHz.
- M. Shall be comply with the following:
1. Category 6A - TIA 568.C.2
 2. ISO/IEC 11801 ed 2.1 (2008) Class EA
- N. An ISO 9002 Certified Manufacturer shall make the cable.
- O. Cable shall be UL LISTED.

- P. Physical Characteristics:
1. Cable shall be plenum rated and meet NFPA 262 Plenum Flame Test (UL910)(FT6).
 2. Conductor shall be 23 AWG solid bare annealed copper.
 3. Nominal Outside Diameter - 0.269 in.
 4. Minimum Bend Radius/Minor Axis: 1.200 in.
 5. Minimum Bend/Installation: 2.7 in.
 6. Maximum Pulling Tension - 40 lbs.
 7. Category marking shall be printed every one foot. Footage indicators shall also be provided on jacket.
 8. The color coding of pairs shall be:
 - a. Pair 1 White/Blue Stripe & Blue
 - b. Pair 2 White/Orange Stripe & Orange
 - c. Pair 3 White/Green Stripe & Green
 - d. Pair 4 White/Brown Stripe & Brown
- Q. Electrical Characteristics Overall
1. Capacitance (pF/ft) – 17.00
 2. Nominal Velocity of Propagation: 68.00%
 3. Maximum Delay (ns/100 m) - 537 @ 100MHz
 4. Typical Delay Skew (ns/ft)- 35
 5. Maximum Delay Skew (ns/100 m) – 45
 6. Maximum Conductor DC Resistance @ 20°C (Ohm/100 m) – 7.4
 7. Maximum Operating Voltage - UL: 300 V RMS
 8. Maximum DCR Unbalanced @ 20°C (%) : 3.000

Electrical Characteristics (Continued)

Frequency (MHz)	Input (Unfitted) Imp. (Ohms)	Fitted Impedance	Min. PSACRF (dB)
1	100+/- 15	100+/- 10	68.8
4	100+/- 15	100+/- 10	56.8
8	100+/- 15	100+/- 10	50.7
10	100+/- 15	100+/- 10	48.8
16	100+/- 15	100+/- 10	44.7
20	100+/- 15	100+/- 10	42.8
25	100+/- 15	100+/- 10	40.8
31.25	100+/- 15	100+/- 10	38.9
62.5	100+/- 15	100+/- 10	32.9
100	100+/- 15	100+/- 10	28.8
200	100+/- 22	100+/- 10	22.8
250	100+/- 22	100+/- 10	20.8
300	100+/- 22	100+/- 10	19.3
350	100+/- 22	100+/- 10	17.9
400	100+/- 22	100+/- 10	16.8
450	100+/- 22	100+/- 10	15.7
500	100+/- 22	100+/- 10	14.8
550	100+/- 22	100+/- 10	14.0
600	100+/- 22	100+/- 10	13.2
625	100+/- 22	100+/- 10	12.9
750			11.3
860			10.1

Frequency (MHz)	Min. PSANEXT (dB)	Min. PSAACRF (dB)	Min. TCL (dB)	Min. ELTCTL (dB)
1.000	67.000	67.100	40.000	35.000
4.000	67.000	67.100	40.000	23.000
8.000	67.000	61.100	40.000	16.900
10.000	67.000	59.200	40.000	15.000
16.000	67.000	55.100	38.000	10.900
20.000	67.000	53.200	37.000	9.000
25.000	67.000	51.200	32.000	7.000
31.250	67.000	49.300	35.100	
62.500	66.600	43.300	32.000	
100.000	63.500	39.200	30.300	
200.000	59.000	33.200	27.000	
250.000	57.500	31.200	26.000	
300.000	56.300	29.700	25.200	
350.000	55.300	28.300	24.600	
400.000	54.500	27.200	24.000	
450.000	53.700	26.100	23.500	
500.000	53.000	25.200	23.000	
550.000	52.400	24.400		
600.000	51.800	23.600		
625.000	51.600	23.300		
750.000	50.400	21.700		
860.000	49.500	20.500		

Frequency (MHz)	Max. Attenuation (dB/100 m)	Min. PSNEXT (dB)	Min. PSACR (dB)	Min. RL (dB)
1	2.100	73.3	71.2	20.000
4	3.800	64.3	60.5	23.000
8	5.300	59.8	54.4	24.500
10	5.900	58.3	52.4	25.000
16	7.500	55.2	47.8	25.000
20	8.400	53.8	45.4	25.000
25	9.400	52.3	43	24.300
31.25	10.500	50.9	40.4	23.600
62.5	15.000	46.4	31.4	21.500
100	19.100	43.3	24.2	20.100
200	27.600	38.8	11.2	18.000
250	31.100	37.3	6.3	17.300
300	34.300	36.1	1.9	16.800
350	37.200	35.1		16.300
400	40.100	34.3		15.900
450	42.700	33.5		15.500
500	45.300	32.8		15.200
550	47.700	32.2		14.900
600	50.100	31.6		14.700
625	51.200	31.4		14.500
750	56.700	30.2		14.000
860	61.200	29.3		13.600

- R. Applications
 - 1. 10GBASE-T Full Power Implementation (IEEE 802.3an).
 - 2. 10GBASE-T Low Power Implementation (Short Reach Mode) (IEEE 802.3an).
 - 3. 1000BASE-T Applications (IEEE 802.3ab).
 - 4. Power Over Ethernet Plus - 2 pairs, up to 30 Watts or 4-pairs, up to 60 Watts (IEEE 802.3at).
 - 5. Power Over Ethernet - 2 pairs, up to 12.95 Watts (IEEE 802.3af).
 - 6. Broadband Video (CATV) & High-Speed Internet (DOCSIS) over UTP up to 860 MHz.
 - 7. High Temperature performance up to 50°C without length de-rating for 1000BASE-T and 100BASE-TX.
- S. Design Make: Belden 10GXS13
- T. Acceptable Manufacturers:
 - 1. Commscope
 - 2. Berktek
 - 3. Amp

2.4 CATEGORY 6A MODULAR JACKS

- A. ETL - Verified Category 6A
- B. Performance terminated on a 100M length of cable shall match requirements listed for Category 6A cable
- C. Physical Characteristics:
 - a. Color as determined by owner and matching attached cable color. Provide different colors for each of the following:
 - i. Wireless Access Points
 - ii. Desktop Data and VoIP
 - iii. Security
 - iv. Wall mounted VoIP
 - b. Front Connection Flexible PCB with 50u inch Gold over Nickel.
 - c. Rear Connection IDC Phosphor Bronze with Tin Plating over Nickel.
 - d. Connector Body N/A Plastic - UL940V-0
 - e. Mechanical Characteristics: Footprint/Type: KeyConnect
 - f. Plug / Jack Compatibility: RJ45,
 - g. Cable/Connector Retention: 15 lbs.
 - h. Standards Compliance:

- a. FCC Part 68, Subpart F
- b. IEC 60603-7
- c. ISO/IEC 11801:2002 Amendment 2
- d. ACA, Bi-national Standard Listed
- i. Electrical Characteristics:

Frequency (MHz)	Max. Insertion Loss TIA* (dB)	Max. Insertion Loss Belden** (dB)	Min. NEXT TIA* (dB)	Min. NEXT Belden** (dB)	Min. FEXT TIA* (dB)	Min. FEXT Belden** (dB)
1.000	0.100	0.050	75.000	77.000	75.000	80.000
4.000	0.100	0.050	75.000	77.000	71.100	75.100
8.000	0.100	0.050	75.000	77.000	65.000	69.000
10.000	0.100	0.050	74.000	77.000	63.100	67.100
16.000	0.100	0.060	69.900	72.900	59.000	63.000
20.000	0.100	0.070	68.000	71.000	57.100	61.100
25.000	0.100	0.080	66.000	69.000	55.100	59.100
31.250	0.110	0.090	64.100	67.100	53.200	57.200
62.500	0.160	0.140	58.100	61.100	47.200	51.200
100.000	0.200	0.180	54.000	57.000	43.100	47.100
200.000	0.280	0.260	48.000	51.000	37.100	41.100
250.000	0.320	0.300	46.000	49.000	35.100	39.100
300.000	0.350	0.330	42.900	46.700	33.600	37.600
400.000	0.400	0.380	37.900	42.900	31.100	35.100
500.000	0.450	0.430	34.000	40.000	29.100	33.100
625.000		0.480		37.100		31.200
Mated Connection Table - Footnote: *TIA/EIA-568-B.2-10-2008 Category 6A Standard.						
**Worst-case performance for a 10GX mated connection using 10GX modular plugs.						

Frequency (MHz)	Max. Return Loss TIA* (dB)	Max. Return Loss Belden** (dB)	Min. PSANEXT TIA* (dB)	Min. PSANEXT Belden** (dB)	Min. PSAACRF TIA* (dB)	Min. PSAACRF Belden** (dB)	Min. Balanced TCL TIA* (dB)	Min. Balanced TCL Belden** (dB)
1.000	30.000	34.100	70.500	72.000	67.000	72.000	40.000	45.000
4.000	30.000	34.100	70.500	72.000	67.000	72.000	40.000	45.000
8.000	30.000	34.100	70.500	72.000	67.000	72.000	40.000	45.000
10.000	30.000	34.100	70.500	72.000	67.000	72.000	40.000	45.000
16.000	30.000	34.100	70.500	72.000	67.000	72.000	40.000	45.000
20.000	30.000	34.100	70.500	72.000	67.000	72.000	40.000	45.000
25.000	30.000	34.100	70.500	72.000	67.000	72.000	40.000	45.000
31.250	30.000	34.100	70.500	72.000	67.000	72.000	38.100	45.000
62.500	30.000	34.100	70.500	72.000	67.000	72.000	32.100	39.100
100.000	28.000	30.000	70.500	72.000	67.000	72.000	28.000	35.000
200.000	22.000	24.000	64.500	66.000	61.000	66.000	22.000	29.000
250.000	20.000	22.000	62.500	64.000	59.000	64.000	20.000	27.000
300.000	18.500	20.500	61.000	62.500	57.500	62.500	18.500	25.500
400.000	16.000	18.000	58.500	60.000	55.000	60.000	16.000	23.000
500.000	14.000	16.000	56.500	58.000	53.000	58.000	14.000	21.000
625.000		13.000		56.100		56.100		19.100
Dielectric Strength: 1,000 V RMS @ 60 Hz for 1 minute								
Current Rating: 1.500 A								
Insulation Resistance: 50 M-Ohm Minimum								
Max. Contact Resistance: 20 m-Ohm								
Termination Resistance: 2.5 m -OHM								

- j. Design Make: Belden 10GX Modular Jack, Category 6A, RJ45, Key Connect style.
- k. Acceptable Manufacturers:
 - a. Commscope
 - b. Berktek
 - c. Amp

2.5 CATEGORY 6A UTP PATCH PANELS

- A. Characteristics:
 - 1. Steel housing
 - 2. 24 or 48 ports as required by the installation
 - 3. Shall be Blank modular panels to accept snap in RJ-45 COLOR CODED jacks as specified in this specification, color to match the attached data cable.
 - 4. Plug / Jack Compatibility - RJ45
 - 5. Refer to modular jack specification for transmission Characteristics.
- B. Standards:
 - 1. FCC Part 68, Subpart F, IEC 60603-7
 - 2. ISO/IEC 11801:2002 Amendment 2
- C. Design Make: Belden 10GX Patch Panel - KeyConnect
- D. Acceptable Manufacturers:

1. Commscope
2. Berktek
3. Amp

2.6 FACE PLATES

- A. Provide angled entry faceplates low profile and strain relief.
- B. Configured to fit standard single gang outlet box.
- C. Accepts all IC107 modules.
- D. Rugged and durable ABS plastic construction.
- E. UL listed.
- F. Acceptable Manufacturers:
 1. ICC
 2. Belden
 3. Panduit

2.7 CABLE IDENTIFICATION:

- A. All cables terminated in classrooms and wiring closets shall be identified with laser wire markers. Wire markers shall be factory printed on vinyl cloth or film with a self adhesive, self-laminating wrap or permanent locking cable tie. Wrap type markers shall be minimum 1-1/2" long.
- B. Contractor shall submit to Engineer product data and samples of wire markers intended for use on this project.
- C. Cable identification shall be 6 digit numbers corresponding to wiring closet, patch panel, port number and drop number, refer to Drawing Legend.
- D. Furnish Laser Printable Labels (PLL) with lamination Panduit Co.; or equal.
- E. Identification numbers hand written by marking pen directly on cable jacket are not acceptable!!!
- F. Wrap type markers shall be completely wrapped around cable OD. Application of markers using "tabbed" or "flagged" methods are not acceptable.

PART 3 - INSTALLATION

HORIZONTAL CABLING

3.1 GENERAL

A. Firestop conduit openings after the cable installation is complete.

B. Separation from Electromagnetic Interference:

<u>Condition</u>	<u>Minimum Separation Distance</u>
Unshielded power lines or electrical equipment in proximity to open or nonmetal pathways.	610 mm (24 in)
Unshielded power lines or electrical equipment in proximity to a grounded metal conduit pathway.	305 mm (12 in)
Power lines enclosed in a grounded metal conduit (or equivalent shielding) in proximity to a grounded metal pathway.	152 mm (6 in)
Electrical motors and transformers.	1194 mm (47 in)

C. Installing cables above suspended ceilings

1. Pull or place cables into the zone pathway.
2. Leave sufficient slack in the ceiling to reach any telecommunications outlet/connector within the zone.
3. Where zone pathways are not provided, divide the floor area into direct-run telecommunications zones.
4. Run all the cables to the center point of their zones.
5. From the center point of each zone, distribute the cables to work areas within that zone.
6. At the center point of each telecommunications zone, support all cables with a cable tie or similar device. Tightly cinched cable ties may have a detrimental effect on transmission performance and should be avoided.
7. Coil in a figure eight any cable that is not in service back to the end of the zone pathway. When required, cable-tie these coiled cables.
8. Label the cables and pathways for easy recognition and establish a working database for ongoing identification and maintenance of horizontal cables and pathways.
9. If a J-hook or trapeze system is used to support cable bundles all horizontal cables shall be supported at a maximum of 48 inch intervals. At no point shall cable(s) rest on acoustic ceiling grids or panels.

- D. Cable raceways shall not be filled greater than the ANSI/TIA/EIA-569-B maximum fill.
- E. Riser rated cable shall be installed in metallic conduit when installed in a plenum space.
- F. Cables shall be dressed and terminated in accordance with the recommendations made in the ANSI/TIA/EIA-568-C.2 document, manufacturer's recommendations and best industry practices.

3.2 UTP CABLE

- A. Cables shall be dressed and terminated in accordance with the recommendations made in the ANSI/TIA/EIA-568-C.2 document, manufacturer's recommendations and best industry practices.
- B. All wiring concealed in new walls or soffits shall be installed in metal conduits.
- C. Wiring in existing walls with hollow cavities may be installed loose.
- D. All exposed wiring shall be installed in surface metal raceway.
- E. All wiring above ceilings shall be installed in cable tray or open top cable hangers with brackets.
- F. Cable hangers above accessible ceilings shall be installed 4' on center attached to building structure. If cables have more than 12" of sag, provide additional hangers.
- G. Do not untwist cable pairs more than 0.5 in. when terminating.
- H. The Contractor shall be responsible for replacing all cables that do not pass required bandwidth and throughput tests.
- I. Maximum length shall be 90 meters. (295 ft).
- J. Maximum patch cable shall be 5 meters (16 ft).
- K. Provide 10 ft service loop in the communications equipment room. Provide 3 foot service loop in ceiling above outlet. Slack should not be stored in bundled loops. Cable slack should be stored in an extended loop or in a figure-eight configuration to alleviate stress.
- L. Cable shall have no physical defects such as cuts, tears or bulges in the outer jacket. Cables with defects shall be replaced.

- M. Install cable in neat and workmanlike manner. Neatly bundle and tie all cable in closets. Leave sufficient cable for 90 degree sweeps at all vertical drops.
- N. Do not tie-rap cable to a perpendicular support. Tie-raps shall be used to secure cables to other like cables or to an approved tie mount. Do not over tighten cable ties.
- O. Install category 6 cable in a separate open cable hanger segment. Do not install with coaxial, optical fiber cable or any other cable type.
- P. Do not install UTP cable with more than 110N (25 lbs) pull force, as specified in EIA/TIA and BICSI TDDM practices. Utilize appropriate cable lubricant in sufficient quantity to reduce pulling friction to acceptable levels.
- Q. Care must be taken so that the cable does not bend at any location to a radius less than ten times the diameter of the cable. A cable feeder guide of suitable dimensions should be used between the cable reel and the face of the duct to protect the cable.
- R. Kinks and/or other irregularities in the cable sheath should be removed or corrected as directed by the engineer.
- S. A plastic or nylon pull cord with a minimum test rating of 90 Kg (200 lb.) shall be installed with all cable in conduit.
- T. Horizontal distribution cables shall be bundled in groups of no more than 50 cables. Cable bundle quantities in excess of 50 cables may cause deformation of the bottom cables within the bundle and degrade cable performance.
- U. Cable shall be installed above fire-sprinkler systems and shall not be attached to the system or any ancillary equipment or hardware. The cable system and support hardware shall be installed so that it does not obscure any valves, fire alarm conduit, boxes, or other control devices.
- V. Cables shall not be attached to ceiling grid or lighting fixture wires. Where support for horizontal cable is required, the Contractor shall install appropriate carriers to support the cabling.
- W. Any cable damaged during installation shall be replaced by the Contractor prior to final acceptance at no cost to the Owner.
- X. Leave a minimum of 12" of slack for twisted pair cables at the outlet. Cables shall be coiled in the in-wall box, surface-mount box or modular furniture raceway if adequate space is present to house the cable coil without exceeding the manufacturers bend radius. Excess slack shall be loosely coiled and stored in the

ceiling above each drop location when there is not enough space present in the outlet box to store slack cable.

- Y. Cables shall be neatly bundled and dressed to their respective termination device. Each terminating device shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.
- Z. Each cable shall be clearly labeled on the cable jacket behind the termination device at a location that can be viewed without removing the bundle support ties.

3.3 UTP MODULAR JACKS

- A. All cables shall be terminated with modular jacks that snap into a faceplate mounted on a wall outlet box, surface raceways or power pole.
- B. Outlet boxes shall be secured to building with mechanical fasteners. Adhesive fasteners are not allowed.
- C. Jacks shall be installed to provide minimal signal impairment by preserving wire pair twists as close as possible to the point of mechanical termination. The amount of untwisted in a pair as a result of termination to the jack shall be no greater than 0.5 inches (13mm).
- D. Jacks shall be installed according to manufacturer's instructions and properly mounted in plates, frames, housings or other appropriate mounting device.
- E. Jacks shall be installed such that cables terminated to the jacks maintain minimum bend radius of at least 4 times the cable diameter into the IDC contacts. Cables shall be terminated on jacks such that there is no tension on the conductors in the termination contacts.
- F. All extra openings to be filled with blank inserts.
- G. Terminate cable per EIA/TIA T-568B standard pin assignments.
- H. Remove only as much cable jacket as is required for termination and trimming. Follow the manufacturer's instructions for mounting, termination, and cable management. Minimize the amount of untwisting in a pair as a result of termination to connecting hardware. For untwisting cabling, maintain pair twists as close as possible to the termination point. The amount of untwisting must not exceed 12.7 mm (0.5 in) for category 5e and higher cables.

3.4 COMPLETION AND ACCEPTANCE

- A. In all spaces that have had floor or wall penetrations, hammer drilling, or core

boring activities - a through brooming, vacuuming, and wet mopping/sponging shall be preformed. Cleaning shall include floors, walls, ladder trays, tops of cabinets/racks, existing/new passive and active components, per manufacturer recommendations.

- B. Submit copies of the following:
 - 1. Cable Test Reports (at substantial completion).

3.5 PATCH PANELS.

- A. Panels shall be installed to provide minimal signal impairment by preserving wire pair twists as closely as possible to the point of mechanical termination. The amount of untwisting in a pair as a result of termination to the patch panel shall be no greater than 0.5 inches (13 mm).
- B. Panels shall be installed according to manufacturer's instructions and properly mounted to a rack, cabinet, bracket or other appropriate mounting device.
- C. Panels shall be installed such that cables terminated to the panel can maintain minimum bend radius of at least 4 times the cable diameter into the IDC contacts.
- D. Cables shall be terminated on the panels such that there is no tension on the conductors in the termination contacts. Panels shall be properly labeled on front and back with the cable number and port connections for each port, as per cable schedule drawings.
- E. All cables shall be neatly "dressed out" in equipment rooms. Cables to be neatly bundled and dressed to their respective panels or blocks. Each panel or block shall be fed by an individual bundle separated and dressed back to the point of cable entrance into the rack or frame.
- F. Each cable shall be clearly labeled on the cable jacket behind the patch panel at a location that can be viewed without removing the bundle support ties. Cables labeled within a bundle, where the label is obscured from view shall not be acceptable.
- G. Install factory supplied patch panel labels, in the corresponding T568B configuration, in all UTP patch panels, BEFORE beginning to terminate cables. Cables terminated onto a patch panel without said port label strip shall not be acceptable.
- H. The cable jacket shall be maintained as close as possible to the termination point.

3.6 COLOR CODING

- A. Prior to submitting cable and connector cuts for approval confirm with the owners IT director the required cable and jack colors.

3.7 CEILING TILES

- A. The cabling contractor shall replace all ceiling tiles that are damaged due to cable installation. Tiles shall match the existing.
- B. Prior to beginning work walk the proposed cable routes and document any existing damage with the construction manager.

3.8 ATTACHMENT CABLES:

- A. Attachment cable assemblies, for use between workstation and room data connector, attenuation requirements ANSI/TIA/ EIA-568A, ISO9001, ISO/IEC 11081. Cables shall be Category 6, 24 AWG stranded conductors, #RJ45 connectors at each end.
- B. Contractor shall furnish (1) attachment cable for each room data drop, cable length shall be as noted below unless noted otherwise on Drawings.

	Length
Classroom (Standard Rm.)	14'-0"
Computer Classroom	14'-0"
Library	14'-0"
Office/Administrative Areas	7'-0"

Note: Provide any additional attachment cables with strain relief boots for completion. Refer to Technology Room Layouts on Contract Drawings for quantity and length required.

3.9 CABLE IDENTIFICATION:

- A. All cables terminated in classrooms and wiring closets shall be identified with laser wire markers. Wire markers shall be factory printed on vinyl cloth or film with a self-adhesive, self-laminating wrap or permanent locking cable tie. Wrap type markers shall be minimum 1-1/2" long.
- B. Contractor shall submit to Engineer product data and samples of wire markers intended for use on this project.
- C. Cable identification shall be 6 digit numbers corresponding to wiring closet, patch panel, port number and drop number, refer to Drawing Legend.

- D. Furnish Laser Printable Labels (PLL) with lamination Panduit Co.; or equal.
- E. Identification numbers hand written by marking pen directly on cable jacket are not acceptable!!!
- F. Wrap type markers shall be completely wrapped around cable OD. Application of markers using "tabbed" or "flagged" methods are not acceptable.

END OF SECTION 271500

SECTION 271513 - COMMUNICATIONS COPPER HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Category 6 twisted pair cable.
 - 2. Twisted pair cable hardware, including plugs and jacks.
 - 3. Multiuser telecommunications outlet assembly.
 - 4. Cable management system.
 - 5. Cabling identification products.
 - 6. Grounding provisions for twisted pair cable.
 - 7. Source quality control requirements for twisted pair cable.

1.2 DEFINITIONS

- A. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
- B. EMI: Electromagnetic interference.
- C. FTP: Shielded twisted pair.
- D. F/FTP: Overall foil screened cable with foil screened twisted pair.
- E. F/UTP: Overall foil screened cable with unscreened twisted pair.
- F. IDC: Insulation displacement connector.
- G. LAN: Local area network.
- H. Jack: Also commonly called an "outlet," it is the fixed, female connector.
- I. Plug: Also commonly called a "connector," it is the removable, male telecommunications connector.
- J. RCDD: Registered Communications Distribution Designer.
- K. Screen: A metallic layer, either a foil or braid, placed around a pair or group of conductors.

- L. Shield: A metallic layer, either a foil or braid, placed around a pair or group of conductors.
- M. S/FTP: Overall braid screened cable with foil screened twisted pair.
- N. S/UTP: Overall braid screened cable with unscreened twisted pairs.
- O. UTP: Unscreened (unshielded) twisted pair.

1.3 COPPER HORIZONTAL CABLING DESCRIPTION

- A. Horizontal cable cabling system shall provide interconnections between Distributor A, Distributor B, or Distributor C, and the equipment outlet, otherwise known as "Cabling Subsystem 1," in the telecommunications cabling system structure. Cabling system consists of horizontal cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for horizontal-to-horizontal cross-connection.
 - 1. TIA-568-C.1 requires that a minimum of two equipment outlets be installed for each work area.
 - 2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications equipment outlet.
 - 3. Bridged taps and splices shall not be installed in the horizontal cabling.
- B. A work area is approximately 100 sq. ft. (9.3 sq. m) and includes the components that extend from the equipment outlets to the station equipment.
- C. The maximum allowable horizontal cable length is 295 feet (90 m). This maximum allowable length does not include an allowance for the length of 16 feet (4.9 m) to the workstation equipment or in the horizontal cross-connect.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Reviewed and stamped by RCDD.
 - 1. System Labeling Schedules:
 - a. Electronic copy of labeling schedules that are part of cabling and asset identification system of software.
 - 2. Cabling administration Drawings and printouts.

3. Wiring diagrams and installation details of telecommunications equipment, to show location and layout of telecommunications equipment, including the following:
 - a. Telecommunications rooms plans and elevations.
 - b. Telecommunications pathways.
 - c. Telecommunications system access points.
 - d. Telecommunications grounding system.
 - e. Telecommunications conductor drop locations.
 - f. Typical telecommunications details.
 - g. Mechanical, electrical, and plumbing systems.

C. Twisted pair cable testing plan.

D. Field Quality-Control Submittals:

1. Field quality-control reports.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For installation supervisor, and field inspector.
- B. Product Certificates: For each type of product.
- C. Source quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For splices and connectors to include in 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. Connecting Blocks: One of each type.
 2. Cover Plates: One of each type.
 3. Jacks: Ten of each type.
 4. Multiuser Telecommunications Outlet Assemblies: One of each type.
 5. Patch-Panel Units: One of each type.
 6. Plugs: Ten of each type.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 - 1. Layout Responsibility: Preparation of Shop Drawings by an RCDD.
 - 2. Installation Supervision: Installation shall be under the direct supervision of Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
- B. Testing Agency Qualifications: Testing agency must have personnel certified by BICSI on staff.
 - 1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Test cables upon receipt at Project site.
 - 1. Test each pair of twisted pair cable for open and short circuits.

1.10 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.11 COORDINATION

- A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.
- B. Telecommunications Pathways and Spaces: Comply with TIA-569-D.

- C. Grounding: Comply with TIA-607-B.

2.2 GENERAL CABLE CHARACTERISTICS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:
 - 1. Communications, Plenum Rated:
 - a. Type CMP complying with UL 1685.
 - b. Type CM, Type CMG, Type CMP, Type CMR, or Type CMX in metallic conduit installed according to NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."
 - 2. Communications, Non-Plenum Rated:
 - a. Type CMR complying with UL 1666.
 - b. Type CMP or Type CMR in listed plenum or riser communications raceway.
 - c. Type CMP or Type CMR in metallic conduit installed according to NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."
- B. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: 25 or less.
 - 2. Smoke-Developed Index: 50 or less.
- C. RoHS compliant.

2.3 CATEGORY 6 TWISTED PAIR CABLE

- A. Description: Four-pair, balanced-twisted pair cable, certified to meet transmission characteristics of Category 6 cable at frequencies up to 250 MHz.
- B. Standard: Comply with NEMA WC 66/ICEA S-116-732 and TIA-568-C.2 for Category 6 cables.
- C. Conductors: 100-ohm, 23 AWG solid copper.
- D. Shielding/Screening: Shielded twisted pairs (FTP).
- E. Cable Rating: Plenum.
- F. Jacket: Gray thermoplastic.

2.4 TWISTED PAIR CABLE HARDWARE

- A. Description: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.
- B. General Requirements for Twisted Pair Cable Hardware:
 - 1. Comply with the performance requirements of Category 6.
 - 2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.
 - 3. Cables shall be terminated with connecting hardware of same category or higher.
- C. Source Limitations: Obtain twisted pair cable hardware from single source from single manufacturer.
- D. Connecting Blocks:
 - 1. 110-style IDC for Category 6.
 - 2. Provide blocks for the number of cables terminated on the block, plus 25 percent spare, integral with connector bodies, including plugs and jacks where indicated.
- E. Patch Panel: Modular panels housing numbered jack units with IDC-type connectors at each jack location for permanent termination of pair groups of installed cables.
 - 1. Features:
 - a. Universal T568A and T568B wiring labels.
 - b. Labeling areas adjacent to conductors.
 - c. Replaceable connectors.
 - d. 24 or 48 ports.
 - 2. Construction: 16-gauge steel and mountable on 19-inch (483 mm) equipment racks.
 - 3. Number of Jacks per Field: One for each four-pair cable indicated, plus spares and blank positions adequate to suit specified expansion criteria.
- F. Patch Cords: Factory-made, four-pair cables in 36-inch (900-mm) lengths; terminated with an eight-position modular plug at each end.
 - 1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure performance. Patch cords shall have latch guards to protect against snagging.
- G. Plugs and Plug Assemblies:

1. Male; eight position; color-coded modular telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
2. Standard: Comply with TIA-568-C.2.
3. Marked to indicate transmission performance.

H. Jacks and Jack Assemblies:

1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
2. Designed to snap-in to a patch panel or cover plate.
3. Standard: Comply with TIA-568-C.2.
4. Marked to indicate transmission performance.

I. Cover Plate:

1. Two port, vertical single gang cover plates designed to mount to single gang wall boxes.
2. Plastic Cover Plate: High-impact plastic. Coordinate color with Section 260533 "Raceway and Boxes for Electrical Systems."
3. Metal Cover Plate: Stainless steel, complying with requirements in Section 260533 "Raceway and Boxes for Electrical Systems."
4. For use with snap-in jacks accommodating any combination of twisted pair, optical fiber, and coaxial work area cords.
 - a. Flush mounting jacks, positioning the cord at a 45-degree angle.

J. Legend:

1. Machine printed, in the field, using adhesive-tape label.
2. Snap-in, clear-label covers and machine-printed paper inserts.

2.5 CABLE MANAGEMENT SYSTEM

- A. Description: Computer-based cable management system, with integrated database capabilities.
- B. Document physical characteristics by recording the network, TIA details, and connections between equipment and cable.
- C. System shall interface with the following testing and recording devices:
 1. Direct upload tests from circuit testing instrument into the personal computer.

2. Direct download circuit labeling into labeling printer.

2.6 IDENTIFICATION PRODUCTS

- A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.7 SOURCE QUALITY CONTROL

- A. Factory test cables on reels according to TIA-568-C.1.
- B. Factory test twisted pair cables according to TIA-568-C.2.
- C. Cable will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 WIRING METHODS

- A. Routing:
 1. Install cables in raceways and cable trays, except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces, attics, and gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables, except in unfinished spaces.
 - a. Install plenum cable in environmental air spaces, including plenum ceilings.
 2. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- B. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools. Install conductors parallel with or at right angles to sides and back of enclosure.

3.2 INSTALLATION OF TWISTED-PAIR HORIZONTAL CABLES

- A. Comply with NECA 1 and NECA/BICSI 568.

B. General Requirements for Cabling:

1. Comply with TIA-568-C.0, TIA-568-C.1, and TIA-568-C.2.
2. Comply with BICSI's "Information Transport Systems Installation Methods Manual (ITSIMM), Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section.
3. Install 110-style IDC termination hardware unless otherwise indicated.
4. Do not untwist twisted pair cables more than 1/2 inch (12 mm) from the point of termination to maintain cable geometry.
5. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
6. Consolidation points may be used only for making a direct connection to equipment outlets:
 - a. Do not use consolidation point as a cross-connect point, as a patch connection, or for direct connection to workstation equipment.
 - b. Locate consolidation points for twisted-pair cables at least 49 feet (15 m) from communications equipment room.
7. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
8. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.
9. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section. Use lacing bars and distribution spools.
10. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
11. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
12. In the communications equipment room, install a 10-foot- (3-m-) long service loop on each end of cable.
13. Pulling Cable: Comply with BICSI Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Pulling and Installing Cable" Section. Monitor cable pull tensions.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
 2. Suspend twisted pair cabling, not in a wireway or pathway, a minimum of 8 inches (200 mm) above ceilings by cable supports not more than 60 inches (1524 mm) apart.
 3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
- D. Group connecting hardware for cables into separate logical fields.
- E. Separation from EMI Sources:
1. Comply with recommendations from BICSI's "Telecommunications Distribution Methods Manual" and TIA-569-D for separating unshielded copper communication cable from potential EMI sources, including electrical power lines and equipment.
 2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (600 mm).
 3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).
 4. Separation between communications cables in grounded metallic raceways, power lines, and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (76 mm).

- c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).
- 5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).
- 6. Separation between Communications Cables and LED Lighting Fixtures: A minimum of 5 inches (127 mm).

3.3 FIRESTOPPING

- A. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Comply with TIA-569-D, Annex A, "Firestopping."
- C. Comply with "Firestopping Systems" Article in BICSI's "Telecommunications Distribution Methods Manual."

3.4 GROUNDING

- A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.
- B. Install grounding according to the "Grounding, Bonding, and Electrical Protection" chapter in BICSI's "Telecommunications Distribution Methods Manual."
- C. Comply with TIA-607-B and NECA/BICSI-607.
- D. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall, allowing at least a 2-inch (50-mm) clearance behind the grounding bus bar. Connect grounding bus bar to suitable electrical building ground, using a minimum No. 4 AWG grounding electrode conductor.
- E. Bond metallic equipment to the grounding bus bar, using not smaller than a No. 6 AWG equipment grounding conductor.

3.5 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 270553 "Identification for Communications Systems."
 - 1. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.

- B. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.
- C. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.
- D. Cable and Wire Identification:
 - 1. Label each cable within 4 inches (100 mm) of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
 - 2. Each wire connected to building-mounted devices is not required to be numbered at the device if wire color is consistent with associated wire connected and numbered within panel or cabinet.
 - 3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet (4.5 m).
 - 4. Label each terminal strip, and screw terminal in each cabinet, rack, or panel.
 - a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group, extended from a panel or cabinet to a building-mounted device, with the name and number of a particular device.
 - b. Label each unit and field within distribution racks and frames.
 - 5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and -connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
- E. Labels shall be preprinted or computer-printed type, with a printing area and font color that contrast with cable jacket color but still comply with TIA-606-B requirements for the following:
 - 1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.6 FIELD QUALITY CONTROL

- A. Tests and Inspections:

1. Visually inspect jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments and inspect cabling connections for compliance with TIA-568-C.1.
 2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
 3. Test twisted pair cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.
 - a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
- B. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similarly to Table 10.1 in BICSI's "Telecommunications Distribution Methods Manual," or shall be transferred from the instrument to the computer, saved as text files, printed, and submitted.
- C. Nonconforming Work:
1. End-to-end cabling will be considered defective if it does not pass tests and inspections.
 2. Remove and replace cabling where test results indicate that they do not comply with specified requirements.
- D. Collect, assemble, and submit test and inspection reports.

END OF SECTION 271513

SECTION 272750 – VOIP TELEPHONE AND EMERGENCY NOTIFICATION SYSTEM

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Provide all engineering, labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents.
- B. Provide Voice over IP telephone system.
- C. Provide Voice Gateway Router with SRST.
- D. Provide Emergency Notification Boards and Zone Paging modules on the existing PA amplifier and Speakers. Notifications Boards will be installed by the owner.
- E. Program Informacast to Control Zone Paging Modules and Emergency Notification Boards in all Building in the District.
- F. Provide required interface to the District wide Door Access System. Provide required communication and full coordination with the District's Security System Service organization to complete this work.

1.2 SCOPE

- A. This section includes minimum requirements for the following:
 - 1. IP Gateways & Gatekeepers.
 - 2. IP Telephones.
 - 3. Survivable Remote Hardware and software.
 - 4. Analog cards and interfaces.
 - 5. 911 Notification.
 - 6. Survivable fail-over software/hardware.
 - 7. Cabling & Accessories.
 - 8. System administration station.
 - 9. Provide Emergency Notification Boards.

1.3 SYSTEM DESCRIPTION

- A. The new telephone system will be VoIP that utilizing dedicated VLAN running over 1GB connections between communication closets, and 10/100/1000 station links from POE switches.

- B. Desk mounted IP telephones will provide for all administrative users and classrooms. Wall mounted VoIP telephones will be provided in miscellaneous utility spaces.
- C. A voice mail with unified messaging will be provided.
- D. The system will include all call processing software and hardware, power supplies, interconnection wiring and all other equipment and software to provide performance as outlined in these specifications. The call processing software application must provide call processing, signaling and connection services to configure devices, including IP telephones, Voice over IP gateways, Centralized Voicemail and other IP devices.
- E. The system will have on site 911 notification services.
- F. The VOIP Telephone System will be connected to the public address systems in each building to provide the following functions:
 - 1. All call, zone page and direct dialing two-way intercom between handsets and public address speakers.
 - 2. Provision for restricting paging access via programmable authorization codes.
- G. The system will provide the following functions from connected telephone sets:
 - 1. Direct 7-digit dialing between all connected telephone sets
 - 2. Direct inward dialing (DID) access to selected sets.
 - 3. Restriction and authorization of functions via software programming.
- F. The system shall be interfaced to the current S2 door access system in each building to allow for locking down the building from any phone.

1.4 TELEPHONE SERVICE

- A. Prior to releasing the telephone system hardware. Schedule a meeting with the district, and the engineer to determine the final service configuration and cut over schedule.

PART 2 – PRODUCTS

2.1 HARDWARE OVERVIEW

- A. All District phones will be connected to a VOIP Hosted Solution. The District shall contract with ComSource, Inc. for Voice over IP Phone Services for the entire District.

- B. This contractor shall coordinate with NERIC for configuration of the VOIP phone system
- C. IP Gateways:
 - 1. Provide IP Gateway hardware & software.
- D. Survivable Remote Hardware and Software
 - 1. Provide software and hardware in the remote-location to automatically detect a failure in the network and initiate process to auto-configure hardware, providing call-processing backup redundancy for the IP phones in that location and ensure that the telephony capabilities stay operational.
 - 2. Upon restoration of WAN connectivity, the system shall intelligently and automatically shift call processing back to the primary Communications Server
- E. Power Equipment:
 - 1. Power equipment must have a modular design with power supplies for individual server equipment.
 - 2. Provide system monitoring indicating status and location of power faults.

2.2 SOFTWARE OVERVIEW

- A. Provide Call Processing Software. Provide the most current available software release for every application detailed in this specification. Provide redundancy software through automatic fail-over of gateways and phones to a secondary Call Processing server.
- B. Provide System Administration Software.
- C. Provide System Monitor Software that provides proactive monitoring of voice elements in the Voice over IP network and alerts maintenance personnel of potential problems.
- D. Provide Unified Voice Messaging System Software based on the number of users, coordinate exact quantity with owner.
- E. Provide IP Telephone user licensing for all telephone set quantities detailed in the Voice Configuration Table, plus licensing to accommodate for an additional 10% future growth.

- F. Provide any additional software required for a complete operational distributed telephone system.
- G. Provide Emergency Notification/Paging software for the system Singlewire Informacast for all handsets provided in system.

2.3 SYSTEM HARDWARE REQUIREMENTS

- A. The IP-based Telephone System must support the station port quantities shown on drawing.
- B. Provide latest version of software and software updates for the duration of the maintenance contract.
- C. For initial & future programming and maintenance, provide the capability for remote programming.

2.4 TELEPHONES

A. General

- 1. IP telephones will be powered with in-line power, utilizing the IEEE 802.3af compliant power over Ethernet standard
- 2. SIP compatible
- 3. G.711 and G.729a compliant
- 4. DHCP or statically configured
- 5. Hearing-aid-compatible handset with ADA-compliant volume.
- 6. Quantities are detailed in the Voice Configuration Table.

B. Type 1 – Classroom IP Set

- 1. The IP set shall be suitable for wall or desk mounting. The set shall include the following features:
 - a) Adjustable ringer
 - b) Message waiting lamp
 - c) Lighted Hold Key
 - d) Timed hooked flash
 - e) DTMF dial
 - f) Redial Key
 - g) 10/100/1000BASE-T Ethernet connection through two RJ-45 ports, one for the LAN connection, the other for connecting a downstream Ethernet device such as a PC.
 - h) 8 fixed feature keys
 - i) 4 programmable soft keys
 - j) Full Duplex speaker phone .
 - k) Monochrome 396 x 162 white backlite display

2. Design Make: Cisco 7841

C. Type 2 – Office Telephone

1. Provide the following minimum features:

- a) 5" High-resolution (320 x 240), graphical TFT color display 16-BIT color.
- b) Support for wideband (G.722 codec, adherence to TIA 920), including handset, headset, and speakerphone
- c) Ability to access any feature through the use of software keys
- d) Internal 2-port Ethernet switch for a direct connection to a 10/100/1000BASE-T Ethernet network through an RJ-45 interface with single LAN connectivity for both the phone and a colocated PC. System separate VLANs (802.1Q) for the PC and phone.
- e) Two-way hands free capability Full-duplex speakerphone with acoustic echo cancellation.
- f) Message waiting light
- g) Multi line, Multi-character display that indicates the callers information and extension if the call comes from network and the callers number if available through external caller ID.
- h) Design Make: Cisco 8841 or approved equal.

D. Type 3 - Administrative IP Telephone with Sidecar

1. Provide the following minimum features:

- a) High-resolution (320 x 240), graphical TFT color touch screen display 16-BIT color depth with backlight.
- b) Support for wideband (G.722 codec, adherence to TIA 920), including handset, headset, and speakerphone
- c) Ability to access any feature through the use of software keys
- d) Internal 2-port Ethernet switch for a direct connection to a 10/100/1000BASE-T Ethernet network through an RJ-45 interface with single LAN connectivity for both the phone and a colocated PC. System separate VLANs (802.1Q) for the PC and phone.
- e) Two-way hands free capability Full-duplex speakerphone with acoustic echo cancellation.
- f) Message waiting light
- g) Multi line, Multi-character display that indicates the callers information and extension if the call comes from network and the callers number if available through external caller ID
- h) Provide (2) Cisco CP-CKEM-C IP phone expansion modules.
- i) Design Make: Cisco 8851 with (2) CP-CKEM-C or approved equal.

E. Type 4 – Wall Phone

1. Design make: Cisco unified IP phone 7811 or approved equal.

- F. Type 5 – Conference Room Phone
 - 1. Design make: Cisco 8832 or approved equal.
- G. Type 6 - Wireless Telephone (provide 12 units)
 - 1. IEEE 802.11 a/b/g radio
 - 2. Two-inch color display
 - 3. Bluetooth 2.0 support with Enhanced Data Rate (EDR)
 - 4. IP54 rated for protection against dust and splashing water
 - 5. MIL-STD-810F standard for shock resistance
 - 6. Long battery life (up to 240 hours of standby time or 13 hours of talk time)
 - 7. Built-in speakerphone for hands-free operation
 - 8. Support for wideband audio
 - 9. Design Make: Cisco Unified Wireless IP Phone 8821
- H. Analog Voice Gateway
 - 1. Provide (8) Cisco Analog Voice Gateway devices for connection of District Fax Machines and other analog lines as required Locations to be as directed by owner. Cisco Part Number VG202.
- I. Emergency Classroom Notification Board (ENB-1)
 - 1. Provide IP base Power over ethernet Emergency Notification board. Board shall include PA Speaker, Clock and a LED Digital display. During Normal operation the Display shall display the digital time of Day. During an emergency notification shall scroll the Emergency across the screen.
 - 2. Design Make: Wahsega Labs Model number: WL-IPD-SPKR-520-INF-F
- J. Door Access Control Interface Device
 - 1. Provide IP based, fully programmable I/O device server.
 - 2. Design Make: Barix Model number: Barionet 400
- K. VOIP Paging interface to Existing Amplifiers
 - 1. Provide interface for each required zone in each building to pick up the remaining speakers in all Hallways, Gyms and external locations. Contractor shall visit the site to confirm speaker locations and requirement of the zones with owner.

2.5 SYSTEM SOFTWARE REQUIREMENTS

- A. Provide the following software features. All the listed features must be available on all systems. System acceptance will require proof that all the features are available on all systems:

1. Access restrictions.
2. Attendant administration.
3. Attendant barge-in
4. Attendant busy verify
5. Attendant call selection
6. Attendant calls waiting indication
7. Attendant camp-on
8. Attendant incoming call indicator
9. Attendant lock out
10. Attendant position busy
11. Attendant recall
12. Attendant trunk group busy identification
13. Audible reminder of held calls
14. Auto (speed) dial
15. Authorization codes
16. Automatic answer back
17. Automatic line selection
18. Bridging 500/2500 sets
19. Busy lamp field array
20. Call Announce
21. Call detail recording (internal charge accounting)
22. Call forwarding
23. Call hold
24. Call park
25. Call party name display (internal and external)
26. Call pickup/directed
27. Call transfer
28. Call waiting
29. CCSA access
30. Centrex Switch hook flash
31. Charge account and calling party number
32. Charge account/forced
33. Conference call (add on)
34. Controlled class of service
35. Coordinated dialing plan
36. Dial intercom including distinctive intercom ring and auto answer capability
37. Direct inward system access
38. Distinctive ringing for intercom and outside lines
39. Do-Not-Disturb (group or individual)
40. Don not disturb override
41. Flexible ring assignment
42. Hotlines
43. Hunting
44. Incoming DID digit conversion

45. Last number redial
46. Malicious call trace
47. Message center
48. Multiple attendant console operation
49. Network alternated route selection
50. Night service
51. Night ring transfer (programmable)
52. Off premise extension
53. On-hook dialing
54. Paging
55. Programmable Audible Signals
56. Recorded announcements
57. Station-to-station calling
58. Stored number redial
59. Attendant alternate answer
60. Automatic call distribution (ACD)
61. Automatic number identification
62. Basic ISDN features
63. Unused number announcement
64. System must support multiple message waiting indicators on a single telephone set.
65. Automatic day/night/ holiday scheduling for console functions.
66. Direct Station Select (DSS).
67. Auto attendant overflow capability.

B. Enhanced Software Features

1. Provide all feature packages as required for E911-On Site Notification and station administration module operation.
2. Provide software options to provide Centralized Voice mail integration including
 - a) Message waiting signaling from the centralized voice mail.
 - b) Auto attendant functionality through centralized voice mail.
 - c) Forward no answer or busy to centralized voice mail.
 - d) Dial "0" destination operation with centralized voice mail.
 - e) Distribution lists.
 - f) Network call re-direction.
 - g) Network Automatic Route Selection
 - h) Network Traveling Class of Service
 - i) Network coordinated dialing.
 - j) Trunk optimization.
 - k) Anti-Tromboning.
 - l) Call name display.
3. The system shall have the capability to have a user at a remote site select an outside line and be connected to the next available trunk at the main site. If all the main site trunks at the main site that the station has access

to are busy, the system will connect them to the next available trunk in the local switch.

4. The system shall have the capability to have a user at a remote site elect an outside line and be connected to the next available trunk at the local site. If all the trunks at local site that the station has access to are busy, the system will connect them to the next available trunk in the main switch.

- B. Provide programming and training for all other features that are available with the software provided by the manufacturer in their base bid at no additional cost even though they are not specifically listed in this specification.

- C. Acceptable Manufacturers
 1. Cisco

2.6 SECURITY RELATED FEATURES

- A. OSN (on site notification)

1. Program the system to signal a minimum of (2) selected telephone set in each building when "911" is dialed from any telephone in the building. Dialing 9 prior to "911" must not be required but will be supported.
2. When a user dials a "911", the call will go through to the local 911 service and give indication to a selected telephone in the building. Calls will be acknowledged by pressing a dedicated button at which time the 911 callers extension will be displayed
3. The District may choose to route 911 calls through a dedicated trunk (with overflow capabilities should it be busy), in each school.

- B. EXTERNAL CALLER ID

1. All incoming calls for the District may be delivered via PRI circuits.
2. All digital display sets must display the caller's telephone number. (And name where available) Include all required programming and software to obtain this functionality.

- C. SYSTEM ADMINISTRATION SOFTWARE

1. A GUI-based system management tool that gives consolidated access to system and network-wide functions such as unified voice and data directories, QoS, policy management, performance management, configuration, billing, fault and security. The system administration software and workstation must allow point-and-click programming and maintenance capability for each IP-based PBX and the voice messaging system.
2. Traffic Analysis Module. Provide trunk usage, peak periods, processor loads and loop traffic. Convert raw traffic statistics into a usable and simplified format.

3. System Maintenance
4. Alarm Package, including alarm logging and notification. Alarms collected in the log must be configured to notify the network manager based on escalation parameters using SNMP.
5. Lightweight Directory Access Protocol (LDAP) interface to other Enterprise directories.
6. Software licensing to support ALL District sites/ voice systems.
7. Communication to sites will be accomplished via IP to all remote locations.
8. The alarm and alarm management functions of the system must be configured so the contractor is notified immediately (in real time) if any IP-based PBX component fails or service is lost.

2.7 MUSIC AND ANNOUCEMENTS ON HOLD DEVICE

- A. Provide the ability to configure Custom Music on hold Messages. Coordinate with owner.
- B. Configure Custom messages for District as Directed
- C. Include interface into system.

2.8 VOICEMAIL / AUTOMATED ATTENDANT SYSTEM

- A. Provide a multi-application voice mail system for all teachers, administrators and staff. The centralized voicemail system will service the entire district. Include all features called for in Part 2 of this section.
- B. The system must include the following features:
 1. Voice Mail.
 2. Automated Attendant.
 3. Unified messaging
- C. Base RFP Configuration must be configured as follows:
- D. Provide 750 system voicemail boxes.
- E. The Message Processing System must include the following applications:
 1. Call answering of busy and no answer calls. The system must allow the caller to leave a message in a voice mailbox or transfer to another directory number.
 2. Busy notification and custom internal and external greetings.
 3. Program an automated holiday scheduler.
 4. Voice mail dials pager capability.

5. Private and public distribution
6. Voice messaging allowing system users to compose messages and distribute them to multiple users on the system.
7. Voice menus that provide caller directed routing and caller selected information.
8. System must have outbound dialing capability for message or pager notification.
9. The telephone number of the calling party must be stored with each voice mail message for callers inside and outside of the system.
10. Voice mail boxes must include the following options:
 - a) Review before sending
 - b) Editing
 - c) Broadcasting
 - d) Listen to all or select
 - e) Scanning
 - f) Delete messages
 - g) Re-listen to messages
 - h) Save/store messages
 - i) Reply to messages
 - j) Message forward
 - k) Skip messages
 - l) Determine time/date sent and extension number or outside number.
11. Management package must include the following reporting options:
 - a) Messages sent and received.
 - b) Messages waiting
 - c) Time on system
 - d) Frequency of use
12. Auto Attendant Functionality
 - a) Call supervision
 - b) Supervisory transfer
 - c) Alternate routing
 - d) Digital announce recording
 - e) Sub-menus
 - f) Spell by name directory assistance
 - g) Multi level custom programmable menu capability.
 - h) Ability to manually override the normal greeting with a pre recorded announcement.
 - i) Automatic day/night and holiday modes with separate greetings and menus.
13. The system must have security/password capabilities.
14. The system must be available on a 24-hour basis.

F. Provide backup software for a complete operational backup.

2.9 UNIFIED MESSAGING

- A. Provide a computer-telephony integration package that integrates with the voice/mail auto attendant package to deliver integrated voice, and E-mail to users connected to a local area network using Microsoft exchange server.
- B. The package must include the following features:
 - 1. Interface must allow access to messages via a graphical user interface (GUI) on any web browser-enabled personal computer.
 - 2. Voice mail integration providing the following point and click options:
 - a) List of all new and saved messages with ability to listen to them in any order.
 - b) Add text headers to voice messages.
 - c) Store voice messages as a data file
 - d) Call the Sender of a message.
 - e) Compile and EDIT personal distribution lists of directory numbers.
 - f) Password updating.
 - g) Import/export of distribution lists.
 - h) Selection of multiple users for distribution.
 - i) Transfer a message to a phone for "private listening"
- C. Software:
 - 1. Provide support for the following protocols:
 - a) TCP/IP
 - b) SMTP
 - c) IMAP4
 - d) VPIM
 - e) SNMP
 - f) LDAP

2.10 ROUTER

- A. RMP-1: Provide Cisco Voice Gateway Router with SRST. This router shall support T-1 lines and POTS lines. This router shall support connection to the school P.A. system. SRST shall support up to 250 phones. Cisco Model: 4351.
- B. RMP-2: Provide Cisco Voice Gateway Router with SRST. This router shall support POTS Lines and connection to the school P.A. system. SRST shall support up to 50 phones. Cisco Model: 4321.

PART 3 – EXECUTION

3.1 COORDINATION

A. Utility Company

1. Provide and be responsible for the coordination and correspondence required with service provider(s), the coordination minimally includes verifying existing C.O. trunks and directory numbers and arranging for additional trunks and/or digital services as an agent for the District. In addition, coordinate any loop to ground start trunk conversions if required.

B. Customer/District

1. Meetings must be scheduled with the District prior to beginning work. The purpose of the meetings is to obtain all needed programming information, confirm extension numbers and set types, educate the school staff on capabilities of the system they are getting, discuss and verify items including (but not limited to) the following:
 - a) Main answering positions
 - b) Identify private lines and determine their ring in and set appearance. Private lines must be set up to call forward to voice mail on busy or no answer.
 - c) Identify shared call-answering areas
 - d) Existing direct lines and associated directory numbers and stations.
 - e) Establish trunk groups (i.e., attendants for small groups of stations within the system).
 - f) Establish the numbering plan consistent with DID numbering
 - g) Exact location of analog sets for power failure transfer.
 - h) Determine the night service policy, including the time night service will be in effect and PBX lines that night calls will be routed to. In the case where the system is connected to a public address system, the night "ring" must be annunciated over the speakers in the PA system.
 - i) Verify user requirements for answering incoming calls at alternate locations if the main answering position or absent. Configure the system as directed by the District for this application.
 - j) Determine a message detail recording policy. Review a typical printout with District designated personnel. Provide instructions accessing information and formatting output.
 - k) Standards for trunk group routing, and a global District wide extension list.
 - l) Obtain a list of numbers that the District would like programmed as speed calls for digital users. Program these numbers for the District.

- m) Discuss features available on the system and develop maps for digital set programmable feature / line keys. Help develop a new District standard for line key assignments key maps will be based on a standard layout and customized for individual use as needed.
 - n) Make all requested software changes up to 60 days after cut over of each switch at no additional cost to the District.
 - o) Porting of existing phone numbers selected by the District
 - p) Provide Station Administration Telephone Templates allowing specific features and key assignments to be applied to similar stations. Provide Templates of each type of digital telephone user.
 - q) Verify, locate and label all existing District alarm circuits. Provide an RJ31X or Line Seizure Relay in each location to prioritize the appropriate alarm device "line seizure" if these lines are interfaced and shared with the PBX. Coordinate specific cabling requirements with the District's alarm company vendor.
 - r) Verify, locate and label all existing elevator telephone circuits. Coordinate specific cabling requirements with the District's elevator service provider.
- 2. It is the Integrator's responsibility to collect programming information by attending meetings, interviewing District personnel and reviewing floor plans with District personnel. A database sign off is required as a means to ensure a smooth cut over but it does not override the requirement to make any requested programming changes up to 60 days after cut over at no cost to the District.
 - 3. Meetings will be scheduled with the District as required. The first meeting will be with the contractor's Engineers and the District to discuss global programming standards and set up guidelines for the remaining meetings.
 - 4. Meet with the District and engineer to design a customized analog telephone template as required by the District.

3.2 INSTALLATION

- A. Provide all patch cables required to connect VoIP headsets to POE switches. See project definition for patch cable colors. Provide a typed and laminated schedule in each IDF and the MDF that indicates room number patch panel port and Ethernet switch and port for all connected telephones.
- B. Provide all cross-connection of the telephone service entrance. Utilize the existing 50 pair cable that was installed in Capital Project, to the new router as required.

- C. Provide DID service to all fax machines.
- D. Mark all MDF & IDF locations on the as built drawing and provide a cable record spreadsheet disk in Excel format. The patch cable system from the MDF must be neatly organized and bundled after the system has been accepted.
- E. Internal cable must be bundled and arranged in a manner to permit easy access to internal equipment and connections. Where a pullout feature is present there must be a sufficient loop to allow full access without cable binding.
- F. Label all telephones with the correct extension number, feature/line keys as programmed. Use typed machine labels.
- G. Make all requested programming changes up to 60 days after system acceptance at no additional cost to the District.
- H. Provide all cables and accessories required to connect the VoiP system and the public address system for night ring, 911 emergency alert and paging features required by this specification.
- I. As a mandatory requirement, all bids must include a customized user guide describing station feature operations for all digital, analog and IP sets.
- J. Dispose of all packaging material.

3.3 PROGRAMMING OF SINGLEWIRE INFORMACAST

- A. Schedule meeting with district and engineer to configure Informacast for the following feature and determine which handsets and other devices get the features.
- B. Configure 911 notification to selected IP phone and district cell phones as directed by owner.
- C. Configure "building lockdown" notification to all building IP phones to play a tone and Flash the screen with LOCKDOWN message, connect to door access system to lock all access doors, connect to building fire alarm panel to play pre-recorded lock down message. Program for ALL CLEAR when lockdown is cleared by playing tone and display ALL Clear Message and then return to normal Screen
- D. Configure "building lockout" notification to all building IP phones to play a tone and Flash the screen with LOCKOUT message, connect to door access system to lock all access doors, connect to building fire alarm to play pre-recorded "building lockout" message. Program for ALL CLEAR when lockout is cleared by playing tone and display ALL Clear Message and then return to normal Screen.

- E. Configure severe weather alerting to all district IP phones. System shall automatically alert all IP phone of severe weather within 10 miles of district buildings.

3.3 DOOR ACCESS INTERFACE FOR ALL BUILDINGS

- A. This contractor shall hire the Districts S2 Security vendor and pay for all required upgrade to the S2 system.
- B. Provide a IP device in the local wiring closet where the S2 Door access controller resides, this Controller with require a contract closure triggered by the VOIP phone system from any phone in the building to activate a Lockdown of the S2 controlled doors. This may require an addition of an S2 input board or other hardware which can be provided by the S2 Vendor and cost covered by this VOIP contractor.
- C. S2 Vendor information
 - 1. eCLIPSE Network Solutions, LLC
518-218-0130
888-851-0644 fax
Contact: Steve Pitsas spitsas@eclipsens.com

3.4 CUT OVER

- A. The contractor must provide category 6 patch cables as called for in project definition in the equipment racks for all new voice ports. Cables shall be sized so there is minimum excess in wire managers. Cables must be completely dressed out at conclusion of cutover.
- B. The Contractor must provide enough personnel to complete 100% of the cut over within 8 hours.
- C. One week prior to cut over, a meeting will be held to review the cut over schedule, Integrator staffing and overall readiness for cut over.
- D. The new system cut over will need to be scheduled outside of normal working hours and must be scheduled 2 weeks in advance with the District.
- E. The cutover may take place in phases, depending on Telco coordination & the progress of the cabling contractor responsible for the new District-wide cable infrastructure. There may be a requirement for the existing system to remain intact at some buildings and temporarily have VOIP in some buildings and PBX in others. The contractor must accommodate this as part of base bid work. Additional funds will not be authorized to accomplish this work.

3.5 TESTING

- A. The Contractor must test all functions on each set and provide a test report to the Engineer certifying the systems compliance. The Contractor must demonstrate all functions to the Engineer on a phone set chosen by the Engineer prior to system acceptance.

3.6 TELEPHONE TRAINING AND SUPPORT

- A. Provide a minimum of fifteen VoIP telephone sets connected to the system temporarily, for training. Provide a qualified trainer to provide initial 1-hour training sessions for all users on the telephone and message processing system. Each user must have a telephone set during the training.
- B. Provide a document including site-specific instructions describing all basic features of phones with each hand set. Submit a copy of this documentation for approval to Engineer prior to the training. Distribute the document to all users at time of training.
- C. On the first day the system is in full use, provide two on-site trainers to answer all questions the users have. Locate one trainer in each side of building. There must also be a tech on site to correct any problems and make any requested changes or additions.
- D. On the second day the system is in full use, the System Integrator must provide a minimum of one on-site trainer to answer all end user questions. There must also be a tech on site to correct any problems and make any requested changes or additions.

END OF SECTION 272750

SECTION 275113 - PUBLIC ADDRESS (PA) SYSTEM

PART 1 GENERAL

1.1 WORK INCLUDED

- A. Provide labor, materials, equipment and services to perform operations required for the complete installation and related work in Contract Documents.

1.2 GENERAL DESCRIPTION

- A. The system covered by this section of the specifications will be provided by the Owner to include all equipment, devices, hardware, software, firmware and programming to install a completed operating system as described herein and shown in the drawings.
- B. The Contractor shall provide all labor, materials and accessories for a complete Public Address System installation including cabling, cable support, raceways, backboxes and grounding/bonding.
- C. Overall system engineering, layout, equipment installation and testing shall be provided by an authorized representative of the equipment manufacturer.
- D. Equipment and accessories furnished under this contract shall be the standard products of a single manufacturer.

1.3 SUMMARY

- A. The system shall utilize the school's shared data network, and not require the use of any proprietary switches, routers, network cabling, or other network components. The physical network components shall be provided by the Owner. Beyond the shared data network hardware, the rest of the system shall be complete with all necessary materials, labor, hardware, software, firmware and programming specifically tailored for the installation. It shall be possible to permanently modify the software on site by using a system administrator software network interface.
 - 1. The system shall integrate seamlessly as a complete system for local sound reinforcement supporting intercom, classroom audio, paging, and bells functionality. An analog solution using speakers and volume controls in the offices, corridors, exterior locations, restrooms, gymnasium and cafeteria. The platform shall provide complete internal communications and employing state of the art IP Technology including the minimum functions listed.

- a. Each classroom / education space to have a dedicated network connection to the intercom paging system head-end to provide 2-way communications from the integrated paging system console as well as the district IP based phone system.
- b. Each office / administrative space to have 1-way communications from the paging system and is capable to being addressed from the building telephone system handset.
- c. Each corridor / common space / exterior space including library, cafeteria and gymnasium to have 1-way communications from the paging system and be capable of being addressed from the building telephone system handset.
- d. The system shall have the ability to call 911 or any other programmed number/extension from the classroom as a part of the intercom communication system giving opportunity of messages to identified individuals or groups.
- e. Emergency announcement that will override any pre-programmed zones assuring that all Emergency/Lockdown etc., are heard at each and every speaker location.
- f. Class change tones through integration with master clock.
- g. Capability of prerecording emergency announcements that can simply be activated by a simple Soft Key or via a dedicated push button.
- h. Atomic Time Synchronization with Class Change Tones utilizing multiple, programmable schedules for each zone.
- i. District wide, Emergency, group, all school and zone live voice paging.
- j. District wide, emergency, group, all school and zone paging for pre-recorded audio – tones, music and voice.
- k. Web-based user interface.
- l. System shall support strobes or Visual Messaging Displays to alert of notifications as an integrated component of the system.

2. The system shall support a minimum of 1000 level priorities which shall be user definable, allowing each end point to place a minimum of 5 different priority calls at the same time.
3. Any authorized administrator shall be able to call from outside the school into any classroom, zone or entire school directly via the School District supplied SIP enabled Telephone Network. This shall allow remote monitoring, call-in annunciation and two-way conversation from outside the facility as well as paging into the system. (Compliance with NEMA Standard SB-40 for emergency communications in K-12 Schools).
4. Authorized system users shall be able to create a minimum of twenty (20) automated sequences with emergency instructions, tones, emails and relay activations, and the ability to replay them.
5. Automated message strings shall be manually initiated from a single-button access on the console, on a SIP connected telephone, a panic button, from the web interface or via interface with third party systems.
6. Paging and two-way intercom features shall be accessible from any system console or SIP connected telephone for each campus.
7. The platform shall synchronize its system time to the network timeserver or a web-based time server.
8. Each single campus installation shall be locally survivable for intercom, paging, bells, and emergencies such as lockdown, even when the district connection is unavailable.
9. This specification establishes a minimum level of quality, features, and performance for individual components as well as the integrated system.
10. Automatically sound a tone or play a pre-page WAV file over any loudspeaker connected for two-way communication to alert the classroom teacher that this 2-way call has been established. This is intended to prevent unauthorized monitoring.
11. System shall support management of IP based PoE visual message displays and automate the programming of devices through the interface including automatically applying visual messages for bells and notifications without the use of a secondary application or software.
12. The system shall support CAP and allow for API interoperability such as gunshot detection, weapon detection, vape detection, and other 3rd party hardware.

13. The system shall provide an administrative console for the front office, consisting of a touch screen interface no less than 22" diagonal interface.
14. The User Interface shall be map based and support full touch operation. The manufacturer shall provide the ability to take a map in any format, including paper copy, PDF, Visio, etc. and create from that the map used for the primary user interface. Non map-based User Interfaces will not be considered.
15. The system must allow 3rd party IP Cameras integrations into the system map to display during emergency events.
16. The WAV or MP3 files shall be programmable as to what level of priority they can be broadcast. They shall be programmable to override any class change tones, normal all call, music, and intercom in the event of an emergency. Files shall also have the ability to be broadcast into any one or all of the zones with the system. Simultaneous playback of different audio to different zones must be possible.
17. The system shall support the use of a BLE-enabled Badges with dual activation buttons. Activation of Badge buttons shall be customizable within the EPIC platform. The Badge shall have a battery life of up to five years to ensure long-term reliability.
18. The system shall support an automated commissioning function that allows the system to be placed into a test mode and monitors and reports the commissioning status of the devices.
19. The platform shall directly connect to the WAN/LAN without the need for a separate server at each school location. Configuration, including bell schedules, calendars, and emergency sequences can remotely be created, changed, stored and downloaded to the system by an authorized user from a browser-based interface.
20. The platform shall provide the ability to initiate school safety paging announcements, evacuation tones and take cover tones from any telephone or connected web-browser within the facility or outside the facility to any other location within the facility or district.
21. The platform shall provide the ability to selectively communicate or monitor individual classrooms in emergency situations from any telephone within the facility or outside the facility to any other location within the facility; all communication within the classroom shall be hands free and will not require any interaction by the classroom user.

22. The platform shall provide classroom users the ability to confirm that they have safely secured their classrooms during lockdown with a single button press.
23. System shall incorporate full Fire Alarm Mute Integration. Provide a relay closure to silence system device operation while the Fire Alarm System is active. This will mute system devices during the Fire Alarm activation causing no bell or pages to operate. Once the event is complete and cleared, system will automatically reset to a normal state.

1.4 DEFINITION OF TERMS

- A. Installer(s): Shall refer to the person, persons, or company who or which actually contracts to perform the work specified herein.

1.5 SUBMITTALS

- A. Product data for each component.
- B. Shop Drawings: Prior to proceeding with the work, provide detailed equipment assemblies and indicate dimensions, weights, required clearances, method of field assembly, components, and location of each field connection, and a complete schedule of all equipment and materials with associated manufacturers cuts sheets which are to be used. A complete point to point wiring diagram of any and all panels and how they interconnect with all the components and or devices that are part of the system as well as any ancillary devices that are being provided by other trades. The shop drawing submittals shall include scaled drawings of all racks, panels, consoles and special assemblies. The show drawing shall include all circuit numbers of all cables and terminal connections as well as how they are labeled.
 1. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring. Identify terminals to facilitate installation, operation, and maintenance. Include a single-line diagram showing cabling interconnection of components and levels throughout system and impedances.
 2. Artwork drawings and lists indicating proposed nameplate nomenclature and arrangements for control panels and plug panels prior to fabrication reflecting equipment used.
 3. Each drawing shall have a descriptive title and all sub-parts of each drawing shall be labeled. All drawings shall have the name and locations of the project, Systems Contractor's name in the title block.

4. Details and descriptions of any other aspect of the system, which must differ from the contract documents due to field conditions or equipment, furnished.
- C. FCC Approval: The system shall be approved for direct interconnection to the telephone utility under Part 68 of FCC rules and regulations. Systems, which are not FCC approved or utilize an intermediary device for connection, will not be considered. Provide the FCC registration number of the system being proposed as part of the submittal process.
- D. Product Certificates: Signed by manufacturers of equipment certifying that products furnished comply with specified requirements.
- E. Installer Certificates: Signed by manufacturer certifying that installers comply with requirements.
- F. Manufacturer Certificates: Signed by manufacturers certifying that they comply with requirements.
- G. Field Test Reports: Indicate and interpret test results for compliance with performance requirements. Include record of final matching transformer-tap settings, and signal ground-resistance measurement certified by Installer.
- H. Maintenance Data: For equipment to be included in maintenance manuals specified in Division 1.
 1. Record of Owners equipment-programming option decisions.
 2. All instructions necessary for proper operation and manufacturer's instructions.
 3. "Proof of Performance" information.
 4. Manufacturer's maintenance information.
 5. Copies of non-proprietary computer programs and system set up disks documenting all programmable features of the installed system.
- I. Record Drawings: Prior to final acceptance, provide three (3) complete sets of drawings indicating all cable numbers and construction details in accordance with the actual system installation. Revise all shop drawings to represent actual installation conditions. These Record Drawings will be used during "Final Acceptance Testing". The route of all cables run shall be shown on the record drawing submittals. Cable tags shown on the shop drawing submittals shall

correspond with cable tags that are located inside equipment enclosures as well as documented on the as-built drawing.

- J. System Training: Submit the following information describing the training programs and system trainers as outlined in paragraph 1.6 of this specification and in accordance with Division 1 specifications.
1. Include with the submittal a preliminary staff development training program in outline form for review and approval by the owner's representative.
 2. Include with the submittal a current copy of the trainer's certification from the manufacturer that certifies and identifies the trainer(s) who are eligible to provide training and support for the project.
 3. Include with the submittal a current copy of trainer's need's assessment form which will be reviewed with the owner's designated representative for the system's preliminary system programming and configuration.
 4. Include with the submittal copies of all documentation used to identify for the owner those participants attending and completing the training programs.
- K. A copy of the manufacturer's standard statement of warranty proving all equipment provided for the school communications network is covered with the required five-year warranty shall be included with the project submittal. This statement of warranty shall be provided on the manufacturer's stationary. See paragraph 1.7.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who is an authorized representative of equipment manufacturer for both installation and maintenance of equipment required for this Section. Provide the following within thirty (30) days after notification to proceed:
1. Provide a list of installations that the Installer has specifically installed for verification by the Owner. Random installations from other vendors and/or Installers shall not be accepted. The Installer, not its employees, must meet these qualifications.
 2. The Installer shall be bondable.
 3. The Installer shall demonstrate to the satisfaction of the Owner or his representative that he has:

- a. Adequate plant and equipment to pursue the work properly and expeditiously.
 - b. Adequate staff and technical experience to implement the work.
 - c. Suitable financial status to meet the obligations of the work.
 - d. Technically capable and factory trained service personnel at a local service facility to provide routine and emergency service for all products used in this project.
- B. Any Contractor, who intends to bid on this work and does not meet the requirements of the "Quality Assurance" paragraph(s), shall employ the services of a "Installer" who does meet the requirements and who shall provide the equipment, make all connections and continuously supervise the installation. A subcontractor so employed as the "Installer" must be acceptable to the Architect/Engineer. The "Installer" shall be identified within thirty (30) days of notification to proceed for acceptance by the Architect/Engineer
- C. Because the life expectancy of this type of communications structure normally exceeds 10 years, the owner expects continuity from the service provider. If the installing/servicing company has not been an authorized provider of the manufacturers product for it least ten years, the following is required:
 1. A list of (2) systems manufacturers of which they currently are authorized service providers where the relationship exceeds ten years.
 2. A letter from the manufacturer outlining the details of changes in service providers over the last ten years and what actions they will take to ensure continuity of service to the customer.
- D. Each major component of equipment shall have the manufacturers name, address and model number on a plate securely affixed in a conspicuous place. NEMA code ratings, UL Label, or other data that is die-stamped into the surface of the equipment shall be easily visible.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.
- F. Comply with NFPA 70
- G. Comply with NEMA Standard SB-40 for Emergency Communications in K-12 schools.

- H. Comply with UL 60950.

1.7 IN-SERVICE TRAINING

- A. The contractor shall provide and implement a complete and comprehensive staff training program for all administrators, facility staff members, and teachers. This mandatory training program will provide school staff a complete understanding of how to utilize and properly operate all functions.
- B. The training program shall be implemented by a staff member/trainer employed by the contractor. The trainer must be factory certified to provide training on their product.
- C. All staff development training is to be coordinated through the owner's designated representative. As training sessions are completed, the trainer will provide the school's administrative staff and school district's staff a document listing all of the staff and faculty members who attended, received, and completed the training program.

1.8 WARRANTY

- A. Provide a manufacturer's five-year warranty of the school communications network equipment against defects in material and workmanship. This warranty will cover all electronic equipment, as well as analog clocks, speakers, and call-in switches. If any defects are found within the warranty period, the defective equipment shall be replaced at no cost (equipment only); a one-year warranty shall be provided for labor.
- B. A copy of the manufacturer's standard statement of warranty proving all equipment provided for the school communications network is covered with the required five-year warranty shall be included with the project submittal. This statement of warranty shall be provided on the manufacturer's stationary. The standard five-year warranty is an important element in establishing a standard in quality. Manufacturers who circumvent the five-year warranty by offering special "extended warranties" that are not part of their normal published warranty will not be accepted.
- C. Contractor shall respond, excluding weekends and holidays, within 24 hours to any warranty service calls. If equipment cannot be repaired within 24 hours of service visit, the contractor shall provide "loaner" equipment to the facility at no charge.

1.9 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide the following system:
 - 1. Audio Enhancement – EPIC (Education Paging & Intercom Communications) System™ with SAFE System (Signal Alert For Education).

PART 2 PRODUCTS

2.1 SYSTEM REQUIREMENTS

- A. Intercom Paging System.
 - 1. The system shall be a software-controlled system, whose primary interface is a web-based portal, accessible from any authorized computer. The system shall support being deployed on physical server hardware or through virtualization on the customer's hardware. For the physical server, the system shall utilize a 1U rack server, operating as an appliance, dedicated to the operation of the IPB (Intercom Paging and Bells) & SAFE (Signal Alert For Education) System™ only. The rack server shall have industry standard redundancy, including RAID1, Dual Power Supplies, and hot swappable hard drives. The entire system shall be Linux based. If virtualized the system shall support VMWare ESXI version 6.5 or later
 - 2. The system shall be based on standards compliant SIP and RTP communications across the network and shall allow direct Trunk Integration to the VoIP telephone system.
 - 3. The system shall provide a simple calendar-based scheduling system for bells. It shall provide the ability to have an unlimited number of bell schedules.
 - 4. The system shall provide a map-based User Interface. All major functions, including Intercom, Paging, Notifications and Alerts shall be done using the map as the foundation for those actions. Paging shall clearly show on the map where the page audio will be transmitted to.
 - 5. Bell Schedules shall be easily assigned to days and changed simply with authenticated access to the system through any browser-based device. Bell schedules shall be able to be changed even if a current schedule is active in the system same day and apply immediately.

6. The system shall support utilizing a shared data network and support (VLAN [Virtual Local Area Network] enabled) or dedicated network as means of distribution for all voice overhead paging, emergency paging, emergency tones, intercom, and class change tones. System shall support routing of traffic across multiple subnets and network segments.
7. The system shall be capable of accessing remote classrooms (trailers, temporary classrooms etc.) via IP interface or room audio system with room microphone. This shall provide intercom, class change tones, emergency tones, and normal / emergency paging via a wired network to these remote locations.
8. Exterior speakers shall be capable of being on separate zones and programmed separately.
9. The system shall have the ability to synchronize to the same NTP server utilized for the Master Clock system.
10. The system shall have the ability to produce user defined tone signals for time tones or emergency tones.
11. The system shall have SIP Integration to connect all talk-paths to the VoIP phone system of choice. The system shall provide the ability to support a SIP trunk from the building's VoIP phone system to provide two-way communication from all administrative telephones to any location equipped with a talkback speaker or audio system with room microphone. The system shall provide its own SIP environment, and in the case of a failure of the schools VoIP telephone system, be capable of operating completely independently for all functions, save access from the handsets connected to the schools VoIP system.
12. The system shall not be reliant on WAN or internet connectivity for operation.
13. The system shall interface with any VoIP telephone system using SIP type integration thus allowing the school (s) to upgrade or replace their telephone system without suffering a requirement to replace, or lose any feature of, their internal communications (intercom) system. Any system that limits system features based upon any selected telephone system and is not SIP based shall not be acceptable.
14. The system shall provide web-based off-site programming and diagnostics of the system. It shall also be capable of determining basic circuit faults.

15. The system shall have a Web based administration programming tool which allows the administrative personnel to easily manage Audio Sources, Class Change schedules, paging groups, time updates, holiday schedules and day/night mode operation from an internet browser. System shall support HTML5.
16. The system shall be capable of being fully integrated with the school's LDAP (Lightweight Directory Access Protocol) or Active Directory system. Systems that do not provide LDAP or Active Directory integration shall not be considered.
17. The system shall provide web browser access to the system specifically for a teacher. Teacher access shall be assigned through LDAP or Active Directory. The Teacher screen shall provide information specific to the room that the teacher is assigned to. That information shall consist of, but not limited to, the next scheduled event for the room (Bell, Announcement, etc.), Audio/Visual Controls for their classroom technology, Teacher Name, Room Number, an Intercom Call button, and an Emergency call button.
18. The system shall provide 2-way handsfree communication in each classroom.
19. System Classroom and Common Zone network interfaces shall be capable of utilizing standard Cat 6/6a infrastructure for installation from the Telecommunications Closets only to the classroom and/or zone, thus allowing for only one type of wiring infrastructure within the school. Distribution of all voice signaling shall utilize a shared or dedicated network.
20. The system shall automatically broadcast page emergency instructions throughout an entire school when an alarm (e.g. lockdown, lockout, security, fire) is tripped or manually activated. The emergency instructions shall be preprogrammed and require no user intervention. The system shall provide redundant alarm annunciation over intercom/paging speakers and is not meant to replace primary fire alarm or security systems.
21. The system shall have the ability to control signage displays for display of clocks, messages, digital signage, countdown timers as well as allow for automated messages to be displayed automatically for notifications.

22. System shall support connection to District View Server for centralized management and licensing and services must be included as part of the system to support that connection, integration and programming.
 23. The system must include perpetual licensing and include all in version software upgrades at no additional cost.
- B. Intercom Paging System Network Interface
1. Shall allow users to install intercom paging systems spanning multiple building or facilities connected through a VLAN.
 2. 100/1000 Ethernet switch port configured on a dedicated VLAN.
- C. Intercom Paging System Power
1. All Network interfaces used in the classroom and for the common zones shall be powered via PoE from the district provided network switches.
 2. All network switches shall include an uninterruptible power source to provide adequate runtime.
- D. System Head End Uninterruptible Power Supply
1. Head End Kiosk UPS - APC Back-UPS
 - a. Output power capacity: 255 watts/425 VA. 120 volt, 50/60 Hz +/- 3Hz frequency.
 - b. Output power connections: (4) NEMA 5-15R, (2) Surge NEMA 5-15R.
 - c. Transfer Time: 6ms average, 10ms maximum.
 - d. Input Power: 120 volt, 5 amp Input current, 50/60 Hz frequency.
 - e. Input Power Cord: NEMA 5-15P.
 - f. Lead Acid Battery - 8-hour Recharge.
 2. Head End Appliance UPS – Eaton 5P1000RC.
 - a. Line-interactive, 5P rackmount.
 - b. 770 watt/1,000 VA rating.

- c. (10) – 5-15R Receptacles.
- d. True Sine Wave Output.
- e. Communication - RS-232 (RJ45) ports; USB port as standard (HID).
6-foot RS-232 and USB cables.

2.2 EQUIPMENT AND MATERIAL

A. Server Software:

- 1. Provides district wide paging, bell event scheduling, emergency notification and configuration for entire district.
- 2. Ability to configure system and initiate system features, per school and district wide via web based interface.
- 3. The software has the ability to sync system time to the Atomic Clock Signal or to the school's or districts network time server.
- 4. The software will provide a web-browser to deliver district wide emergency paging, pre-recorded messages and tones from any authorized computer in the facility or the district. The software must be capable of automatically notifying district personnel via the WAN of an alarm condition.
- 5. The software can automatically broadcast page emergency instructions via associated system hardware throughout an entire district when an alarm (e.g. lockdown, lockout, security, fire) is initiated via the web-based interface. The emergency instructions are preprogrammed and require no user intervention. The system provides redundant alarm annunciation over intercom/paging speakers and is not meant to replace primary fire alarm or security systems.
- 6. The software can be installed in cloud, virtual or physical server environments.
- 7. The web-based user interface supports secure HTTP browsing.
- 8. The server software supports encryption to ensure secure access.

B. Equipment Rack:

1. Equipment racks shall provide 44 spaces (77") minimum for mounted system equipment.
2. All head-end, distribution, and source equipment, including data and power, shall be located in racks configured as approved by the Engineer.
3. Rack mounted equipment shall be accessible from front and rear.
4. All unused rack spaces will be covered with appropriate blank/vent panels.

C. Administrative Kiosks:

1. 24" full HD multi-touch display for front-end system interaction to be located within Main Office and Security Vestibule areas. The display incorporates a paging microphone and audio speakers. Functionality to provide full access to all features such as all call, paging groups, emergency tones, control music, WAV file distribution, test rooms, crisis mode, and schedules.

D. Ceiling Speakers:

1. Cut-in ceiling speaker shall consist of a white 13.5" grill, a speaker and integral back box or equivalent ceiling speaker with appropriate backbox, grille and tile bridge.
2. Integrated 25/70/100V Transformer with tap settings accessible without disassembling speaker from 1.25W to 15W or 8 Ohm bypass. The speaker shall be capable of handling minimum 50 watts continuous power.
3. Sound pressure level at 1 meter on axis with a 1 Watt input shall be 96 dB. The frequency response shall be 86 Hz to 16 kHz.
4. Speaker back can meets UL2043 criteria for plenum installation.

E. Classroom Speaker Performance:

1. 7" Tile Cut in speaker. Vented enclosure with spring loaded mounting tabs. Depth not to exceed 5.8".
2. 8 Ohm Nominal, 50W Continuous Pink Noise. Sensitivity - 88 dB (1W/1M). Frequency Response 70 Hz - 15 kHz (-10 dB) 100 Hz - 14 kHz +/-2 dB).

F. Surface/Wall Speakers:

1. Wall speaker shall consist of a speaker and matched surface mount enclosure. Maximum dimensions of the housing shall be 11 5/8" square and 4 1/8" deep. The speaker shall be 8" (20.32 cm) in diameter. and have a ceramic magnet weighing 4.8 ounces. The baffle shall be constructed of 22 gauge steel with white baked hybrid epoxy.
2. The speaker, housing and hardware shall be electrically and acoustically matched for a frequency response of 65 Hz to 17 kHz. Average sensitivity 92dB SPL, 1W/1M. Maximum output shall be 99dB.

G. Paging Horn:

1. Loudspeaker assembly with a double re-entrant horn, compression type loudspeaker, 16W- 25/70V integrated transformer, and a BS8VPS baffle (stainless steel, vandal resistant, powder-coated white).
2. Average Sensitivity: 110dB SPL, 1W/1M. Loudspeaker Power Rating: 16W RMS, EIA 426A Standard. Nominal Coverage Angle: 90° Included Angle, -6 dB / 2 kHz, Half space.

H. Indoor/Outdoor 70-V Loud Speaker:

1. 6.5" 70v Outdoor Rated speaker. Woofer: Metallic Anodized Injection Molded Cone with Rubber Surround. Tweeter: 1" liquid cooled aluminum dome. Finish Dimensions: 12.86" (310mm) x 8" (217) x 7.25" (195).
2. Power: 5-125 Watts. Frequency: 55Hz – 20kHz. Sensitivity: 90dB. Impedance: 6 Ohms.

I. IP Call Station:

1. Sip compliant, flush mount with brushed stainless steel finish.
2. 2 Amp relay contact. Poe powered (Class 1, <4 watts).
3. Maximum Sound Pressure: 90dB SPL @ 1m.

J. Intercom Paging System Volume Control:

1. The volume control must support a rotary selector switch with 11 positions. Volume control shall be white in color and be sized to fit a decora style plate.

2. Inputs on control shall support incoming 25/70V signal on both the + and – with outgoing signal on + and -. Support for up to 12 AWG Wire. 25W RMS.

K. Classroom Sound Amplification:

1. Provide a fully PoE Powered Receiver/Amplifier. Integrated 3 channel DECT RF receiver. The primary control of the system shall be done through the teacher microphone.
2. Audio Power: 30 watts RMS mains powered - 92% Efficient Class D amplifier. 1% percent THD across full frequency range of amplifier. Frequency Response: 20 Hz to 20kHz. Power Requirements: PoE 802.3af/at 25.5W maximum. Signal-to-Noise: >89dB.
3. Thermal and short circuited protected.
4. Provide 4 RS-232 ports which provide pass-through control of a downstream device like a projector, etc. RS-232 processor shall be capable of differentiating between commands destined for the amplifier, and responding to those commands, and commands intended for the downstream and passing those commands through to the alternative RS-232 ports.
5. Integrated DECT Technology RF Receiver The Receiver shall utilize DECT technology. DECT is a radio technology for voice applications. DECT is ideal for the classroom because the use of both frequency and time domain is ideally suited to smaller areas with a large number of users. In each classroom, it will be an independent system, with all necessary electronics to support the receiving & pairing functionality mounted on the wall near the amplifier or in the ceiling. The receiver will be connected to the amplifier through a universal twisted pair cable, using balanced audio connections. Power for the receiver shall be provided through the same cable as the balanced audio connections.

L. Classroom Intercom Wall Plates:

1. For all locations where a Classroom Amplifier/Network Interface is specified. Provides a simple, standardized control interface for projectors, monitors, display devices, or other AV devices in a compact double-gang form factor. A CUSTOMIZABLE INTERFACE which will allow for a variety of configurations including full color graphical representations of equipment and buttons as well as multi-page capability.

2. Dimensions: 4.5" (L) x 4.5" (W) x 1.25" (D).

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine conditions, with the Installer present, for compliance with requirements and other conditions affecting the performance of the School Communications and School Safety Network.
- B. Do not proceed until unsatisfactory conditions have been corrected.

3.2 WIRING

- A. Where allowed, exposed wiring shall be installed in surface metal raceway, Wiremold 700, 2100, G4000 or G6000 Series or approved equivalent, as required due to conductor fill. Provide finish coat of paint to match existing wall surfaces.
- B. Concealed wiring in walls and under stage may be installed without raceway. Provide supports for all wiring on maximum 18 in. centers where wiring is not finished.
- C. PA system wiring indicated on floor plans is diagrammatic. Provide all required wiring and connections to provide specified functions, per manufacturer's recommendations.
- D. All wiring shall be color coded and installed per manufacturer's wiring diagrams.
- E. Wiring may be opened wired in cable tray or "J" hooks above accessible suspended lay-in ceilings. Wiring in walls or exposed on walls shall be enclosed in EMT conduit. Cable shall be supported at a minimum of every 5'.

3.3 INSTALLATION

- A. General: Install system in accordance with NFPA 70 and other applicable codes. Install equipment in accordance with manufacturer's written instructions. The entire system shall be installed in accordance with approved manufacturers wiring diagrams and these specifications. The contractor shall furnish all conduits, cable tray, surface raceway, wiring, outlet boxes, junction boxes, cabinets etc... as well as all required miscellaneous materials and labor necessary for the complete installation of the cable support / pathway system.

- B. Furnish and install all material, devices, components and equipment for a complete operational system.
- C. Impedance and Level Matching: Carefully match input and output impedance's and signal levels at signal interfaces. Provide matching networks where required.
- D. Wiring splices shall be made only in designated junction boxes and tagged on both sides of the junction. The junction shall be made on clearly labeled, insulated terminal strip. Transposing or changing the color-coding of the cable is not permitted. Wire nut connectors are not acceptable. System cable and the 120vac power cable shall be in separate conduits.
- E. Control Circuit Wiring: Install control circuits in accordance with NFPA 70 and as indicated. Provide number of conductors as recommended by system manufacturer to provide control functions indicated or specified.
- F. All cabling and devices shall be labeled with type written labels. Device labels and cable labels shall match the labeling information that is documented on the as-built drawings.
- G. All housings are to be located as indicated.
- H. The contractor shall provide necessary transient protection on the AC power feed, all copper station lines leaving or entering the building, and all central office trunks. All protection shall be as recommended by the equipment supplier and referenced to earth ground.
- I. Wiring within Enclosures: Provide adequate length of conductors. Bundle, lace, and train the conductors to terminal points with no excess. Provide and use lacing bars.
- J. Provide physical isolation from speaker-microphone, telephone, line-level wiring, and power wiring. Run in separate raceways, or where exposed or in same enclosure, provide 12 inch minimum separation between conductors to speaker-microphones, telephone wiring and adjacent parallel power. Provide physical separation as recommended by equipment manufacturer for other system conductors.
- K. Identification of Conductors and Cables: Use color coding of conductors and apply wire and cable marking tape to designate wires and cables so all media are identified in coordination with system wiring diagrams.
- L. Weatherproofing: Provide weatherproof enclosures for items to be mounted outdoors or exposed to weather.

3.4 GROUNDING

- A. Provide equipment grounding connections for Integrated Electronic Communications Network systems as indicated. Tighten connections to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounds.
- B. Ground equipment, conductor, and cable shields to eliminate shock hazard and to minimize to the greatest extent possible, ground loops, common mode returns, noise pickup, cross talk, and other impairments. Provide 5-ohm ground at main equipment location. Measure, record, and report ground resistance.
- C. Provide all necessary transient protection on the AC power feed and on all copper station lines leaving or entering the building. Note in system drawings, the type and location of these protection devices as well as all wiring information.

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Services: Provide services of a duly factory authorized service representative for this project location to supervise the field assembly and connection of components and the pre-testing, testing, and adjustment of the system.
- B. Inspection: Make observations to verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Provide a list of final tap settings of paging speaker line matching transformers.
- C. Testing: Rectify deficiencies indicated by tests and completely re-test work affected by such deficiencies at Contractor's expense. Verify by the system test that the total system meets the Specifications and complies with applicable standards.

3.6 FINAL ACCEPTANCE TESTING

- A. The Final Acceptance Testing shall be provided to the Owner or the Owners designated representative only. Final acceptance testing to any other trade or service provider for the project will not comply with the requirements of this section.
- B. The contractor will provide a Final Acceptance Test record document signed by both the contractor and the Owner or designated Owner's Representative establishing the "In Warranty" date. The warranty period will not commence until the Final Acceptance Test is completed.

- C. Be prepared to verify the performance of any portion of the installation by demonstration, listening and viewing test, and instrumented measurements. Make additional adjustments within the scope of work and which are deemed necessary by the Owner because of the acceptance test.
- D. Each individual system operation on a circuit-by-circuit basis shall be tested for its complete operation. Any devices that are to be connected to the system shall be tested as specified. Device locations and address / circuit numbers shall be documented on the as-built drawings as well as the wiring configuration of the device circuits. Device locations shall be field verified by the contractor and shall include any costs in the bid that is relating to all devices being connected to the system. The procedure for testing the entire system shall be set forth in these specifications and with the consent and approval of the Architect / Engineer, Owner and equipment manufacturer.

3.7 COMMISSIONING

- A. The contractor shall train the Owner's maintenance personnel in the procedures and schedules involved in operating, troubleshooting, servicing, and preventative maintenance of the system. This training will be in accordance with the training as outlined in Section 1.6, paragraphs 3, 5 & 6 of these specifications. In addition to the Training Materials provided, the contractor will also furnish Operators Manuals and Users Guides at the time of this training. Schedule training with at least 7-day notice.

3.8 OCCUPANCY ADJUSTMENTS

- A. The contractor shall provide Occupancy Adjustments in accordance with Section 1.6, paragraph 9 of these specifications. A response scenario amenable to both the owner and the contractor will be established and followed for the first year of service.

3.9 DOCUMENTATION AND TRAINING

- A. After the final system test and the Owner and Architect / Engineer has accepted the system to be in the proper operating condition, the contractor shall compile and provide to the Owner three (3) complete operation and maintenance manuals and three (3) sets of as-built drawings on the completed system. These drawings shall include any devices that are connected to the system with their address / circuit number documented as well as the wiring configuration of all device circuits. The as-built drawings shall be an updated and revised copy of the submittal drawings showing all modifications made during the installation of the system. A copy of the as-built drawings in electronic format in AutoCAD Release

2024 or higher will be forwarded on to the Owner and Architect / Engineer for archiving in the operation and maintenance manuals.

3.10 CLEANING AND PROTECTION

- A. Prior to final acceptance, the contractor shall vacuum and clean all system components and protect them from damage and deterioration. All blank spaces in equipment cabinets will be covered with blank panels. Top and side panels, and all cabinet doors will be installed. All general areas within and around all equipment rack/cabinets in the facility will be swept, vacuumed, and cleaned up. No cabinets will be left unlocked and all cabinet keys will be turned over to the owner or designated owner's representative.

END OF SECTION 275113

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SECTION 275313 - CLOCK SYSTEMS

PART 1 – GENERAL

1.1 WORK INCLUDED

- A. The contractor shall provide the complete installation of a master clock system. All system devices and equipment with all required system acceptance testing and associated training will be furnished by the School District. The system will replace the existing clock system in the renovated building areas and provided in the new construction areas.
- B. Provide labor and materials required to perform operations required for the complete installation and related Work as required in Contract Documents.

1.2 SUBMITTALS

- A. Complete equipment list including quantities.
- B. Catalog descriptive literature for all equipment.
- C. Riser Wiring Diagram showing all devices, wire quantities and sizes.
- D. Typical terminal Wiring diagram for each type of device.
- E. Terminal Wiring diagram for the master clock and program panel.
- F. Provide wiring diagram showing connection to paging, intercom and class bell systems.

1.3 RELATED SECTIONS

- A. Basic Electric Requirements.
- B. Basic Materials and Methods.

1.4 SYSTEM DESCRIPTION

- A. General:
 - 1. The clock and program system is an integrated, microprocessor-based system for originating and distributing time and time correction signals. It displays the time at remote locations and provides programmed, audible signals and operation of remote switching. The system transmits times and program signals to indicate clocks and audible signal

- equipment over paging and intercom system wiring. The system shall be capable of 48 hour backup in the event of a power outage.
2. Systems shall provide synchronized GPS time throughout the building(s) via wired (network).
 3. All components shall be listed UL836 (if applicable) and meet FCC Part 15.
 4. All batteries shall be capable of a 5 year operational lifespan.
 5. Wireless correction signal.
- B. Provide all components and installation required for system features and functions that include, but are not limited to, the following:
1. Precision time reference independent of line frequency of power source.
 2. Automatically corrects all secondary synchronous clocks.
 3. Automatic daylight savings time correction.
 4. Function and Performance of Program Control System: Provide all components and installation required for system features and functions that include, but are not limited, to the following:
 - a. Continuously run a minimum of three independent schedules of events simultaneously. Minimum of 125 events per schedule. Schedules shall correspond to the school schedule.
 - b. All event schedules can be programmed to run continuously, controlling any output circuit.
 - c. Minimum of four output circuits for automatic remote function switching.
 - d. All output circuits have automatic daylight savings time correction and automatic shift to a separately programmable holiday and weekend schedule.
 - e. Events scheduled using keypad and LED or liquid crystal display. System shall be user programmable and user friendly.
 - f. Nonvolatile memory for event schedules.

- g. Circuit duration for events adjustable from one of twenty-nine seconds minimum.
- h. Manual controls for all output circuits on integral control panel.
- i. The clock and program system shall interface with paging and intercom system to provide a program tone over the paging and intercom system speakers.
- j. The clock system head end equipment shall mount in surface mounted enclosure or computer rack mount.

1.5 SITE SURVEY

- A. Layout: Perform system site survey prior to installation to verify wireless coverage. Submit results to Engineer. Provide additional transmitters, or larger wattage transmitters at no charge to Owner for complete coverage throughout the area of coverage.

1.6 DESIGN MAKE

- A. Sapling

1.7 ACCEPTABLE MANUFACTURER

- A. Sapling,

PART 2 – PRODUCTS

2.1 MASTER CLOCK AND PROGRAM CONTROLLER

- A. The master clock and program controller shall be micro-processor based and of solid state, modular design. Each individual function shall be provided by solid state plug-in panels or modules.
- B. Each program circuit shall be programmed for time of day, day of week and holiday routines. Programs shall be user changeable via display mounted on controller.
- C. From The Programmer/Display, The System User Shall As Minimum Be Able To Program The Functions Listed Below:
 - 1. Set the date, day and time.
 - 2. Clear previous programs.
 - 3. Enable new time programs.

4. Enable or disable discrete outputs on command.
 5. Program 10 discrete outputs based on day (including holiday), and time.
- D. Provide a program channel selector switch with a minimum of four selectable positions, to allow up to four separate programs per circuit. Each program selector channel shall be user-programmable for such functions as half-day, regular day and Auditorium schedules.
- E. In the event of 120 VAC power loss, the master clock and controller shall not lose memory and retain all programming. When 120 VAC power is restored, all system clocks and program circuits shall be automatically updated to the current day and time. Provide minimum 48 hours of battery reserve and calculations. Battery life shall be 5 years minimum.
- F. Provide correction each quarter hour and upon restoration of power.
- G. Provide a key-operated lockout to prevent unauthorized programming of the controller.
- H. The master clock and program controller shall operate on 120 VAC 60 Hz power. Operating temperature range shall be 32°F to 122°F. Operating humidity range shall be 0% to 95% RH non-condensing.
- I. Enclosure shall be code gauge steel with baked-on enamel finish. Panel face shall be smooth with no projections. All components shall be located behind a lockable outer door made of plexiglass and metal. Enclosure shall be surface mounted.
- J. Synchronized time received from GPS antenna. Correction of clocks shall be via transmission from signal from transmitters.

2.2 REPEATERS

- A. Input:
1. RS485
 2. Owner LAN
 3. GPS
- B. Operating Frequency: 915-928 MHZ with frequency hopping.
- C. RF power 1 watt minimum.

2.3 WIRING

- A. Any power wiring for Master Clock System shall be of the same approved type as used for electric light and power wiring, and shall meet all the requirements of the National, State and Local Electric Codes.
- B. The size of the different wires shall be those specified by the manufacturer.
- C. All wires shall be color coded and tagged at all junction and termination points and shall be tested free from grounds or short circuits between conductors.

2.4 SECONDARY CLOCKS

- A. Provide a direct wire synchronous motor driven clock. Provide correction each quarter hour, and upon restoration of power. Clock shall operate from a battery with 5 year life.
- B. All clock components shall be heavy-duty and completely sealed.
- C. Provide shatterproof lens.
- D. Provide hour, minute hands. Hand color shall be black. Dial shall be 12 in. round for classrooms and 16 in. round for gymnasium, Pool and cafeteria and auditorium.
- E. Provide wire clock guard for Gymnasiums, Pools and where noted on the drawings.

2.5 BACK BOXES

- A. General: Provide recessed back boxes for all clocks and signal devices. Equip with knockouts and hanger straps. Provide box cover plate and grounded receptacle to suit mounting and connection of devices. Reuse existing backboxes where possible.

2.6 SIGNAL DEVICES

- A. Class tone changes shall be broadcast over the paging and intercom speakers called for in Telecommunication System Specification Section.

2.7 ADDITIONAL WORK TO BE INCLUDED

- A. Provide secondary clocks.
 - 1. Twenty (20) spares with batteries.

- B. Provide all power branch circuits and installation work required.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. All installations shall be accomplished in a professional manner by qualified personnel regularly engaged in and experienced in this type of work.
- B. Install all equipment in accordance with manufacturer's recommendations.
- C. All 120 volt wiring shall be copper and installed in steel conduit in a separate and segregated systems. Refer to Section 16100 for raceway systems requirements.
- D. Clock system conduit may be reused where possible.
- E. Provide on 20 ampere, 120 volt power circuit to the master clock and program controller; provide 20A – 1P circuit breaker at panelboard and identify on panel directory.
- F. All surface mounted devices shall be mounted on a special box furnished by clock equipment manufacturer. Total assembly shall be secure, smooth contour and have no protrusions.
- G. Locate GPS antenna for 24/7/365 operation in all weather conditions. Maintain integrity of roofing.

3.2 TESTING AND INSTRUCTION

- A. The complete clock system shall be fully tested and guaranteed for a period of one year after Owner's Representative written acceptance. (This guarantee shall also include any defects in wiring that may have been reused). Coordinate off shift instruction with Owner.
- B. Provide four (4) - 4 hour sessions of instruction to the operating personnel designated by the Owner with regard to use and operation of the system during the duration of the warranty period.
- C. Provide five (5) sets of keys to all panels.
- D. Prior to request for final payment submit bound Operator manuals that shall include as a minimum:

1. Bill of Material.
2. Manufacturer's equipment description for each type of device and control module type used.
3. Record drawings for wiring diagrams showing typical connection diagrams for each type of device and a complete riser diagram showing all devices, and wiring requirements. Record drawings for wiring diagrams shall show all terminal connections at the Master Clock and Program Controller.
4. Instruction report stating when instruction was given and who was in attendance, signed by Owner's representative.
5. A written test report from an authorized representative of the equipment manufacturer certifying that each device and overall system operation has been 100% tested and approved.
6. Ten-year FCC licenses. Obtain signatures and required data from Owner.
7. Site Survey documentation.
8. Five year Warranty Statement in accordance with the General Provisions Section of these Specifications.

END OF SECTION 275313

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SECTION 282300 – VIDEO SURVEILLANCE SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DESCRIPTION OF WORK

- A. Section includes the complete installation of surveillance system consisting of cameras, digital video recorder, data transmission wiring, and a control station with its associated equipment.
- B. The system covered by this section of the specifications will be provided by the Owner to include all equipment, devices, hardware, software, firmware and programming to install a completed operating system as described herein and shown in the drawings.
- C. Related Requirements:
 - 1. Section 260519 "Low-Voltage Electrical Power Conductors and Cables". or.
 - 2. Section 271500 "Horizontal Cabling CAT 6 and 6A.
- D. The owner will furnish IP CCTV cameras.
- E. Provide category 6 cable from the closest IDF closet to each camera.
- F. Provide surge arrestor for all exterior cameras.
- G. Mount and aim all cameras as directed by the owner's security contractor.

1.3 SUMMARY

- A. Provide installation of Owner furnished video surveillance system cameras as indicated on the Drawings.

1.4 DEFINITIONS

- A. Voltage Class: For specified circuits and equipment, voltage classes are defined as follows:

1. Control Voltage: Listed and labeled for use in remote-control, signaling, and power-limited circuits supplied by a Class 2 or Class 3 power supply having rated output not greater than 150 V and 5 A, allowing use of alternate wiring methods complying with NFPA 70, Article 725.
2. Low Voltage: Listed and labeled for use in circuits supplied by a Class 1 or other power supply having rated output not greater than 1000 V, requiring use of wiring methods complying with NFPA 70, Article 300, Part I.

1.5 SEQUENCING AND SCHEDULING

- A. Video Surveillance Equipment: Maintain existing equipment fully operational until system modifications have been tested and accepted.
- B. Equipment Removal: After acceptance of new system, remove existing disconnected equipment and associated wiring.

1.6 ACTION SUBMITTALS

- A. Approved Permit Submittal: Submittals must be approved by authorities having jurisdiction prior to submitting them to Architect.
- B. Product Data: For each type of product, including furnished options and accessories.
 1. Include construction details, material descriptions, dimensions, profiles, and finishes.
 2. Include rated capacities, operating characteristics, and electrical characteristics.
- C. Shop Drawings:
 1. Include plans, elevations, sections, and details, including details of attachments to other Work.
 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.
 3. Functional Block Diagram: Show single-line interconnections between components for signal transmission and control. Show cable types and sizes.
 4. Dimensioned plan and elevations of equipment racks, control panels, and consoles. Show access and workspace requirements.
 5. Wiring Diagrams: For power, signal, and control wiring.
 6. Design Data: Include an equipment list consisting of every piece of equipment by model number, manufacturer, serial number, location, and date of original installation. Add pretesting record of each piece of equipment, listing name of

person testing, date of test, set points of adjustments, name and description of the view of preset positions, description of alarms, and description of unit output responses to an alarm.

1.7 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Qualification Statements: For Installer.

1.8 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For cameras, power supplies, infrared illuminators, monitors, videotape recorders, digital video recorders, video switches, and control-station components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1.9 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace video surveillance system equipment and components that fail because of defects in materials or workmanship within specified warranty period.

- 1. Warranty Period: 3 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 VIDEO SURVEILLANCE SYSTEM

- A. Source Limitations for Fire-Alarm System and Components: Components must be compatible with, and operate as extension of, existing system. Provide system manufacturer's certification that components provided have been tested as, and will operate as, a system. Video-signal format shall comply with NTSC standard, composite interlaced video. Composite video-signal termination shall be 75 ohms.
- B. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor's entry connection to components. Minimum Protection for Communication, Signal, Control,

and Low-Voltage Power Connections as recommended by manufacturer for type of line being protected.

- C. Tamper Protection: Tamper switches on enclosures, control units, pull boxes, junction boxes, cabinets, and other system components shall initiate a tamper-alarm signal when unit is opened or partially disassembled. Control-station, control-unit alarm display shall identify tamper alarms and indicate locations.

2.2 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Video surveillance system shall withstand the effects of earthquake motions determined according to ASCE/SEI 7. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NECA 1.
- D. Comply with NFPA 70.
- E. Electronic data exchange between video surveillance system with an access-control system shall comply with SIA TVAC.

2.3 POWER SUPPLIES

- A. Low-voltage power supplies matched for voltage and current requirements of cameras and accessories, and of type as recommended by manufacturer of camera.
 - 1. Enclosure: NEMA 250, Type 1.

2.4 CAMERA-SUPPORTING EQUIPMENT

- A. Mounting Brackets for Fixed Cameras: Type matched to items supported and mounting conditions. Include manual pan-and-tilt adjustment.
- B. Protective Housings for Fixed and Movable Cameras: Steel enclosures with internal camera mounting and connecting provisions that are matched to camera/lens combination and mounting and installing arrangement of camera to be housed.

1. Camera Viewing Window: Polycarbonate window, aligned with camera lens.
2. Duplex Receptacle: Internally mounted.
3. Alignment Provisions: Camera mounting shall provide for field aiming of camera and permit removal and reinstallation of camera lens without disturbing camera alignment.
4. Built-in, thermostat-activated heater units. Units shall be automatically controlled so the environmental limits of the camera equipment are not exceeded.
5. Sun shield shall not interfere with normal airflow around the housing.
6. Mounting bracket and hardware for wall or ceiling mounting of the housing. Bracket shall be of same material as the housing; mounting hardware shall be stainless steel.
7. Finish: Housing and mounting bracket shall be factory finished using manufacturer's standard finishing process suitable for the environment.
8. Enclosure Rating: NEMA Type 4X, IP67 protection.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.
 1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed before installation begins.
- B. Prior to modifying the system, perform tests to ascertain the operating condition of the existing system. Test shall be witnessed by the Company Field Advisor. Prepare a written report for the Director's Representative indicating the repairs required, if any, to make the existing sub-systems function properly.
- C. Examine roughing-in for electrical connections to verify actual locations of connections before installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.
- E. Review fixed camera viewing angle and field of view with Owner and adjust as required by Owner prior to installation of camera.

3.2 PREPARATION

- A. Preinstallation Testing: Perform verification of functionality of installed components of existing system prior to starting work. Document equipment or components not functioning as designed.
- B. Interruption of Existing Video Surveillance System Service: Do not interrupt service to facilities occupied by Owner unless permitted under the following conditions:
 - 1. Notify Construction Manager no fewer than 7 days in advance of proposed interruption of service.
 - 2. Do not proceed with interruption of service without Construction Manager's written permission.
- C. Protection of In-Place Conditions: Protect devices during construction unless devices are placed in service to protect facility during construction.

3.3 INSTALLATION OF EQUIPMENT

- A. Comply with NECA 305, NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."
 - 1. Devices placed in service before other trades have completed cleanup must be replaced.
 - 2. Devices installed, but not yet placed, in service must be protected from construction dust, debris, dirt, moisture, and damage in accordance with manufacturer's written storage instructions.
- B. Install cameras and infrared illuminators level and plumb.
- C. Install cameras with 84-inch- (2134-mm-) minimum clear space below cameras and their mountings. Change type of mounting to achieve required clearance.
- D. Set pan unit and pan-and-tilt unit stops to suit final camera position and to obtain the field of view required for camera. Connect/adjust all controls and alarms.
- E. Install power supplies and other auxiliary components at control stations unless otherwise indicated.
- F. Transient Voltage Surge Suppressors (TVSS): The Contractor shall mount TVSS within 3 m (118 in) of equipment to be protected inside terminal cabinets or suitable NEMA 1

enclosures. Terminate off-premise conductors on input side of device. Connect the output side of the device to the equipment to be protected. Connect ground lug to a low impedance earth ground (less than 10 ohms) via Number 12 AWG insulated, stranded copper conductor

- G. Install tamper switches on components indicated to receive tamper switches, arranged to detect unauthorized entry into system-component enclosures and mounted in self-protected, inconspicuous positions.
- H. Avoid ground loops by making ground connections only at the control station.
 - 1. For 12- and 24-V dc cameras, connect the coaxial cable shields only at the monitor end.
- I. Connecting to Existing Equipment: Verify that existing video surveillance system is operational before making changes or connections.
 - 1. Expand, modify, and supplement existing control and monitoring equipment as necessary to extend existing control and monitoring functions to new points. New components must be capable of merging with existing configuration without degrading performance of either system.

3.4 ELECTRICAL CONNECTIONS

- A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."
- C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.
- D. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.
- E. Splices, Taps, and Terminations: For power and control wiring, use numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

- F. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
 - 1. Nameplate must be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."

3.5 PATHWAYS

- A. Pathways above recessed ceilings and in inaccessible locations may be routed exposed.
 - 1. Exposed pathways located less than 96 inch (2440 mm) above floor must be installed in EMT.
- B. Pathways must be installed in EMT.

3.6 GROUNDING

- A. Provide independent-signal circuit grounding recommended in writing by manufacturer.
- B. Ground equipment and associated circuits in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."
- C. Ground shielded cables at control panel location only. Insulate shield at device location.

3.7 FIELD QUALITY CONTROL

- A. Field tests must be witnessed by authorities having jurisdiction.
- B. Adminstrant for Tests and Inspections:
 - 1. Administer and perform tests and inspections with assistance of factory-authorized service representative.
- C. Tests and Inspections:
 - 1. Inspection: Verify that units and controls are properly installed, connected, and labeled, and that interconnecting wires and terminals are identified.
 - 2. Pretesting: Align and adjust system and pretest components, wiring, and functions to verify that they comply with specified requirements. Conduct tests at varying lighting levels, including day and night scenes as applicable. Prepare video-surveillance equipment for acceptance and operational testing as follows:
 - a. Verify operation of auto-iris lenses.

- b. Set back-focus of fixed focal length lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Adjust until image is in focus with and without the filter.
 - c. Set back-focus of zoom lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Additionally, set zoom to full wide angle and aim camera at an object 50 to 75 feet (17 to 23 m) away. Adjust until image is in focus from full wide angle to full telephoto, with the filter in place.
 - d. Set and name all preset positions; consult Owner's personnel.
 - e. Set sensitivity of motion detection.
 - f. Connect and verify responses to alarms.
 - g. Verify operation of control-station equipment.
 3. Test Schedule: Schedule tests after pretesting has been successfully completed and system has been in normal functional operation for at least 14 days. Provide a minimum of 10 days' notice of test schedule.
 4. Operational Tests: Perform operational system tests to verify that system complies with Specifications. Include all modes of system operation. Test equipment for proper operation in all functional modes.
- D. Video surveillance system will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.1 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 Project during other-than-normal occupancy hours for this purpose. Tasks shall include, but are not limited to, the following:
 1. Check cable connections.
 2. Check proper operation of cameras and lenses. Verify operation of auto-iris lenses and adjust back-focus as needed.
 3. Adjust all preset positions; consult Owner's personnel.
 4. Recommend changes to cameras, lenses, and associated equipment to improve Owner's use of video surveillance system.
 5. Provide a written report of adjustments and recommendations.

3.2 CLEANING

- A. Clean installed items using methods and materials recommended in writing by manufacturer.
- B. Clean video-surveillance-system components, including camera-housing windows, lenses, and monitor screens.

END OF SECTION 282305

SECTION 283112 – FIRE ALARM AND EMERGENCY COMMUNICATIONS SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract including the General and Supplementary Conditions of Division 1 of the Specification Sections, apply to the work of this section.

1.2 DESCRIPTION

- A. The contractor shall provide the complete installation of a networked fire alarm and emergency communications system. All system devices and equipment with all required system acceptance testing and associated training will be furnished by the School District. Fire alarm control panels and other network devices will be equipped with network interface modules able to function with the type of wiring specified for the network communication bus signaling line circuit. The system will replace the existing fire alarm in the building. The system will provide the following features.
 - 1. Fire Alarm, detection, monitoring and control
 - 2. All call and Zone paging with telephone interface and paging stations.
 - 3. Emergency Notification.
 - 4. Interface to Public Address systems for muting on alarm or take over for public address or emergency announcement.
 - 5. All system equipment, devices and materials shall be of the following manufacturer unless otherwise indicated:

Gamewell-FCI, Honeywell Building Technologies
12 Clintonville Road
Northford, Connecticut 06472
Phone: (203)-484-7161
Fax: (203)-484-7118
<https://gamewell-fci.com>

Gamewell-FCI Local Engineered System Distributor:
Syracuse Time & Alarm Company, Inc.
2201 Burnet Ave
Syracuse, New York 13206
Phone: (800)-792-2667
Contact: Steve Stallman – ssallman@syrtime.com
<https://www.syrtime.com>

- B. The contractor shall provide temporary connections to the existing fire alarm systems that initiates a building wide alarm during the construction to accommodate construction phasing.
- C. The contractor shall remove and dispose of the existing fire alarm and public-address systems in their entirety after the new system is completely tested and certified.
- D. The Fire Alarm System shall be provided under a direct contract to the Owner. The Contractor shall provide a turnkey fire alarm system including the installation electrical subcontractor work in their bid and is responsible for providing all proprietary fire alarm system components under the pricing terms referenced in that contract. The Contractor is responsible for providing non-proprietary components of the Fire Alarm System, such as conduit, cabling, raceways, and junction boxes in accordance with provisions of this project's specification manual.
- E. The Contractor shall be responsible for installing, testing, and start- up of a complete functioning fire alarm system, and each element thereof, as specified or indicated on the Drawings or reasonably inferred, including every article, device or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's function as indicated by the design and the equipment specified. Elements of the work include materials, labor, supervision, supplies, equipment, transportation and utilities. Installation of devices shall be performed or supervised by a National Institute for Certification of Engineering Technologies (NICET) Level 3 or higher Fire Alarm Technician. Submit copies of the certification for employees through shop drawing submittals.

1.3 WORK INCLUDED

- A. This section includes the installation, connection and testing of an Owner furnished microprocessor controlled, intelligent reporting fire alarm system with voice evacuation, public address and mass notification. The system shall be networkable and be able to connect campuses and remote buildings over various types of broadband connections.
- B. This section includes the minimum requirements for the following equipment:
 - 1. Fire Alarm Control Panel
 - 2. Remote Annunciator
 - 3. Remote Paging Station
 - 4. Telephone System Interface
 - 5. Initiating Devices
 - 6. Notification Appliances
 - 7. Speakers and Amplifiers
 - 8. Control relays
 - 9. Monitor Modules
 - 10. Wireless control relays and initiation devices
 - 11. Fault isolation relays
 - 12. Magnetic Door Holders
 - 13. Digital Communicator
 - 14. Master Clock system Interface
 - 15. Mass Notification, Speakers, Appliances and Displays
 - 16. Emergency Lockdown Buttons
 - 17. Power/Supervisory connections to Fire Protection Tamper and Flow Switches
 - 18. Exterior Notification Bell – Automatic Sprinkler System
 - 19. Wiring
 - 20. Wire Guards
 - 21. Cable including speaker and fire alarm

1.4 REFERENCES

- A. The following NFPA Standards
 - 1. NFPA 13 - Sprinkler Systems.
 - 2. NFPA 72 - National Fire Alarm Code.
 - 3. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
 - 4. NFPA 101 - Life Safety Code.
 - 5. NFPA 12 - Extinguishing Systems (low and high)
 - 6. NFPA 12A - Halon 1301 Extinguishing Systems
 - 7. NFPA 70 Article 760 - Fire Alarm Systems.

- B. The following U.L. Standards:
 - 1. UL 38 -Manually Actuated Signaling Boxes
 - 2. UL 864/UOJZ, APOU - Control Units for Fire Protective Signaling Systems.
 - 3. UL 217 Smoke Detectors, Single and Multiple Station
 - 4. UL 228 Door Closers - Holders for Fire Protective Signaling System
 - 5. UL 268 - Smoke Detectors for Fire Protective Signaling Systems.
 - 6. UL 268A - Smoke Detectors for Duct Applications.
 - 7. UL 521 - Heat Detectors for Fire Protective Signaling Systems.
 - 8. UL 228 - Door Holders for Fire Protective Signaling Systems.
 - 9. UL 464 - Audible Signaling Appliances.
 - 10. UL 1638 - Visual Signaling Appliances.
 - 11. UL 38 - Manually Activated Signaling Boxes.
 - 12. UL 346 - Water flow Indicators for Fire Protective Signaling Systems
 - 13. UL 1480 - Speakers for Fire Alarm and Signaling Systems, Including Accessories
 - 14. UL 1481 - Power Supplies for Fire Protective Signaling Systems.
 - 15. UL 864 - Control Units for Fire Protective Signaling Systems.
 - 16. UL 217 - Smoke Detectors, Single and Multiple Station.
 - 17. UL 1076 - Control Units for Burglar Alarm Proprietary Protective Signaling Systems.
 - 18. UL 1971 - Visual Notification Appliances.
 - 19. UL 2017 - Standard for General-Purpose Signaling Devices and Systems.
 - 20. UL 60950 - Safety of Information Technology Equipment.
 - 21. UL 2572 – Mass Notification Systems
 - 22. UL S4048 – Speaker & Speaker Strobes
 - 23. UL S5512 - Strobes
 - 24. UL3594 – Alert Strobes
- C. The following FM Standards
 - 1. FM6320 – Gas Detection
 - 2. FM 3030863 – Horn Strobes
- D. New York State Building Code
- E. International Building Code
- F. International Fire Code
- G. New York State Education Department Manual of Planning Standards – Latest Edition
- H. The system shall be listed by the national agencies as suitable for extinguishing release applications. The system shall support release of high and low-pressure CO₂.
- I. All requirements of the Authority Having Jurisdiction (AHJ).

1.5 QUALITY ASSURANCE

- A. The fire alarm system shall comply with requirements of NFPA Standard 72 for Protected Premises Signaling Systems except as modified and supplemented by this specification. The system shall be electrically supervised and monitor the integrity of all conductors.
- B. The fire alarm system shall be manufactured by an ISO 9001 certified company and meet the requirements of BS EN9001: ANSI/ASQC Q9001-1994.
- C. The system and its components shall be Underwriters Laboratories, Inc. listed under the appropriate UL testing standard as listed herein for fire alarm applications and the installation shall be in compliance with the UL listing.
- D. The installing company shall employ NICET (minimum Level II Fire Alarm Technology) technicians on site to guide the final checkout and to ensure the systems integrity.
- E. Provide all hardware, software, programming tools and documentation necessary to modify the fire alarm system on site. Modification includes addition and deletion of devices, circuits, zones and changes to system operation and custom label changes for devices or zones. The system structure and software shall place no limit on the type or extent of software modifications on-site.

1.6 SYSTEM DESCRIPTION

- A. Point addressable fire alarm system with manual and automatic initiation devices.
- B. System shall be supervised to continuously monitor the integrity of the circuit conductors and power supplies.
- C. Initiation Device Circuits (IDC) shall be wired Class B (NFPA Style D) as part of an addressable device connected by the SLC Circuit.
- D. Notification Appliance Circuits (NAC) shall be wired Class A , Survivability Level 1 Circuit return pathways shall be separated by 1/3 the diagonal of the specific signaling zone.
- E. Alarm signals arriving at the FACP shall not be lost following a primary power failure (or outage) until the alarm signal is processed and recorded.
- F. Performance of the fire alarm system circuits shall be in accordance with Class B, operation and wiring for Initiating Device Circuits (IDC) and Class A operation and wiring for Notification Appliance Circuits (NAC's).

- G. The fire alarm control panel shall permit on-site programming to accommodate facility expansions, renovations, or fire alarm system modifications. All memory shall be non-volatile.
- H. The control panel shall have 24 VDC output power supplies for notification appliance circuits. System shall be capable of adding additional power supplies as required to power all notification appliances.
- I. Shutdown of Building HVAC system equipment shall occur with a supervisory alarm until the system is reset. All fans over 1,000 cfm shall be shut down.
- J. Summary Reports: The Fire Alarm Control Panel shall be capable of displaying and printing summary reports. The summary reports shall include:
 - 1. A list of all alarm points not in their normal state.
 - 2. A list of all points in the system, including their current status.
 - 3. A list of data for all control by event programs.
 - 4. A list of data for all time initiated programs.
 - 5. Alarms shall be processed at three levels of priority.
 - 6. Fire alarms shall have the highest priority.
 - 7. Other alarms that require interaction by the attendant shall have the second level of priority.
 - 8. Monitored points which do not require interaction by the attendant shall be the lowest level of priority.
- K. System Access: Access to the system shall be controlled by at least three levels of security to prevent programming modifications by unauthorized personnel.
 - 1. The lowest level of access, shall permit the attendant to view the system display, print alarms and perform life safety control by event functions. The Attendant has minimal access to the system functions.
 - 2. The mid-level access shall permit the attendant to change user programmable parameters.
 - 3. The highest level of access shall permit the modification of system software. This level shall be accessed only by a qualified representative of the equipment manufacturer.
- L. Remote annunciator(s) located at the main entrance to each building shall provide information available at the FACP for use by responders.
- M. The system shall provide zone paging functionality from the remote annunciator locations the fire alarm panels and dedicated remote paging stations at locations shown on the construction drawings. There shall be a minimum of the following zones. Refer to the construction drawings for additional zone requirements.

1. Classrooms
 2. Corridors
 3. Main Offices
 4. Kitchen/Serving
 5. Exterior
 6. All Page
- N. The system shall play back prerecorded messages or provide tones from various types of alarm inputs. Each type of input shall provide a separate prerecorded message or distinct tone. Prerecorded messages will be manually overridden by first responders or other authorized users from the system paging stations.
- O. The system shall be interfaced to the owners VoIP telephone system to allow access to zone paging utilizing an access code from any handset connected to the telephone system. The Telephone system is a Cisco VoIP type with an onsite call manager.
- P. The system shall be interfaced to the building Master Clock system for class change tones. Refer to the riser diagram to determine the number of interfaces required. Provide relays and wiring as required to connect to the wireless clock system included in the electric contract.
- Q. The system shall provide mass notification using all page, zone page and emergency strobes. Mass notification can be activated from emergency lockdown stations that trigger a prerecorded all page message or manually from any of the remote annunciators, paging stations or connected telephone sets.
- R. Emergency lockdown will be triggered by any of the emergency stations connected to the system. In an emergency lock down the speaker portion of notification devices shall emit three-pulse temporal pattern in accordance with ANSI S3.41, Audible Emergency Evacuation Signal. The Fire Alarm Mass Notification appliance (combination speaker/amber "ALERT" strobe) circuits will be activated by the Digital Voice Command (DVC) microphone assembly and Emergency Warning Pushbutton stations. Activation of a pushbutton will initiate a pre-recorded announcement, release all magnetic door holds, notify Rapid Response of a lockdown and activate all mass notification strobes. Provide pushbuttons stations as located

1.7 SUBMITTALS

- A. General:
1. Complete schedule of all equipment supplied including quantities, model numbers, etc.
 2. Product data sheets for all equipment.
 3. System operation description covering this specific Project including

method of operation and supervision of each type of circuit and sequence of operations for all manually and automatically initiated system inputs and outputs. Manufacturer's standard descriptions for generic systems are not acceptable.

4. Name, address, phone number and contact person of nearest fully equipped service organization.
5. For equipment other than that specified, the contractor shall supply proof that such substitute equipment equals or exceeds the features, functions, performance, and quality of the specified equipment.

B. Shop Drawings:

1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
2. Include manufacturer's name(s), model numbers, ratings, power requirements, equipment layout, device arrangement, complete wiring point-to-point diagrams, and conduit layouts.
3. Complete riser diagram indicating all devices, all connections, cable types and wire identification numbers.
4. Wiring diagrams from manufacturer differentiating between factory and field installed wiring. Include diagrams for equipment and for system with all terminals and interconnections identified. Indicate components for both field and factory wiring.
5. Shop drawings showing details of graphic annunciator.
6. Standby battery calculations report.

C. Certifications:

1. Together with the shop drawing submittal, submit a certification from the major equipment manufacturer indicating that the proposed supervisor of the installation and the proposed performer of contract maintenance is an authorized representative of the major equipment manufacturer. Include names and addresses in the certification.

D. Submittals with O&M Manuals at End of Project:

1. Complete as-built drawings of the Fire Alarm System indicating signal initiating and signal circuits including as-built riser diagram indicating all address identification numbers and floor plans showing the devices.
2. In addition, provide as-built floor plan drawing(s) indicating all cable routing pathways (include all "T" tap locations and branches).
3. Operating and maintenance manuals listing the manufacturer's name(s), including technical data sheets.
4. As-built point to point interconnecting diagrams for the main console connections.
5. Certificate of completion indicating all devices field tested and system is complete and operational. Include written statement of completed Owner training.

1.8 WARRANTY

- A. All work performed and all material and equipment furnished under this contract shall be free from defects and shall remain so for a period of at least (1) year from the date of acceptance. The full cost of maintenance, labor and materials required to correct any defect during this one-year period shall be included in the submittal bid.
- B. Provide software and firmware updates during the warranty period.
- C. Provide the services of a factory trained and authorized technician to perform all system software modifications, upgrades or changes that occur during the warranty period. Response time of the technician to the site shall not exceed 4 hours.

1.9 TRAINING

- A. Provide an initial 4 hours of instruction to the operating personnel designated by the Owner's Representative about use and operation of the system. Content of the training shall include:
 - 1. Overview of system operations.
 - 2. Overview of system equipment and device locations.
 - 3. Detailed operation guidelines.
 - 4. Periodic maintenance procedures.
 - 5. Periodic testing procedures.
- B. Provide two additional 2-hour training sessions during the first full year of warranty. Training sessions will be scheduled with the owner prior to final payment and a voucher will be given to the owner for the training. Review system operation and questions that the owners designated personnel have about the system operation.

1.10 EXTRA PRODUCTS

- A. Provide the following quantity of spare devices to the owner:

	Description	Qty. Required
1.	Manual Pull Station with Factory Back Box	2
2.	Photoelectric Smoke Detector and base	8
3.	Thermal Detector (rate of rise) and base	2
4.	Wall mounted Carbon Monoxide Detector	2
6.	Strobe Unit with Factory Back Box	6
7.	Wall Mounted Speaker/Strobe Unit with Factory Back Box	6
8.	8" Ceiling speaker with backbox	4

9.	8" Wall mounted speaker with backbox	4
10.	Addressable Control Relay	4
11.	Addressable Monitor Module	4

- B. Include the cost to install the spare devices with the bid. Install the devices if required. Turn all uninstalled equipment over to the owner.

1.11 DATA LOOP REQUIREMENTS

- A. The system shall be configured to the minimum quantity of multiple data loops as required to connect all of the initiating devices indicated on plans.
- B. Maximum quantity of initiating devices shall not exceed 80% of the maximum allowed device count per data loop.

1.12 FIRE ALARM SEQUENCE OF OPERATION

- A. Upon an abnormal condition on the fire alarm system, the appropriate LED (alarm, supervisory, or trouble) shall flash. The panel audible alarm shall pulse for alarm conditions and sound steadily for trouble or supervisory conditions. All abnormal events shall be logged into the database, along with the date and time.
- B. Operation of any fire alarm initiating device shall cause the following to happen:
1. Sound all alarm signals throughout the building in a temporal Code.
 2. Activate all visual strobe lights throughout the building.
 3. Display the points in alarm on the display at the fire alarm control panel and at all remote alarm annunciator panels and print at all system printers. The visual indication shall remain until the alarm condition is reset.
 4. Transmission to Remote Station: Automatically route alarm, supervisory and trouble signals to a remote central station service transmitter provided under contract, using listed and approved equipment. Provide all equipment necessary to transmit signals to meet local authority requirements.
 5. Operate alarm relay contacts to shut down all supply fans in the system. All smoke dampers shall close 30 seconds after their respective fan systems have shut down.
 6. Operate alarm relay contacts to initiate the elevator capture sequence.
 7. Operate alarm relay contacts to release all magnetically held doors throughout the building.
 8. Subsequent initiating alarms shall repeat the respective sequence of operations.

- C. The Fire Alarm System wiring and power supplies shall be electrically supervised and report trouble conditions to the fire alarm control panel. Any opens, shorts or grounds on the system wiring shall cause the following:
 - 1. Sound a distinct pulsed audible alarm at the fire alarm control panel.
 - 2. Flash the yellow common trouble LED.
 - 3. Display the points in alarm on the LCD display at the fire alarm control panel and at all remote alarm annunciator panels and point at all system printers. The visual indication shall remain until the alarm condition is reset.
 - 4. Notify the UL listed Central Station via the digital communicator.
 - 5. Subsequent trouble alarms shall repeat the respective Sequence of Operation.

- D. Alarm Silencing: Pressing the "Alarm Silence" button shall cause all notification appliances to be deactivated. A yellow LED located in the fire alarm control panel shall illuminate to indicate the alarm has been silenced.

- E. Elevator Recall:
 - 1. Elevator recall will direct passenger car to primary or alternate floor level in accordance with the description below. Elevator contractor will determine actual floor levels to be used as primary and alternate.
 - 2. When FACP is in alarm and smoke is detected on the primary floor, system will send a signal to the elevator controls to send passenger car to the alternate floor.
 - 3. When FACP is in alarm and smoke is detected on any other floor (other than primary floor), system will send a signal to elevator controls to send passenger car to alternate floor level.
 - 4. When smoke is detected in the elevator machine room, send passenger car to primary floor level.

PART 2 - PRODUCTS

2.1 DESIGN MAKE ACCEPTABLE MANUFACTURERS

- A. Gamewell-FCI, Honeywell Building Technologies E3 Series System with the DVC Series Voice Communication System.

2.2 GENERAL

- A. All equipment and components shall be new, and the manufacturer's current model. The materials, appliances, equipment and devices shall be tested and listed by a nationally recognized approvals agency for use as part of a protective signaling system, meeting the National Fire Alarm Code.

- B. All equipment and components shall be installed in strict compliance with manufacturers' recommendations. Consult the manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc., before beginning system installation.
- C. All equipment shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place (e.g., detectors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load.
- D. All interfaces and associated equipment are to be protected so that they will not be affected by voltage surges or line transients consistent with UL standard 864.

2.3 RACEWAY AND WIRE

- A. Conduit:
 - 1. Install all wiring in equipment rooms, mechanical rooms and utility rooms in conduit.
 - 2. Conduit shall be in accordance with The National Electrical Code (NEC), local and state requirements.
 - 3. Conduit fill shall not exceed 40 percent of interior cross-sectional area where three or more cables are contained within a single conduit.
 - 4. Cable must be separated from any open conductors of power, or Class 1 circuits, and shall not be placed in any conduit, junction box or raceway containing these conductors, per NEC Article 760.
 - 5. Wiring for 24-volt DC control, alarm notification, emergency communication and similar power-limited auxiliary functions may be run in the same conduit as initiating and signaling line circuits. All circuits shall be provided with transient suppression devices and the system shall be designed to permit simultaneous operation of all circuits without interference or loss of signals.
 - 6. Conduit shall not enter the fire alarm control panel, or any other remotely mounted control panel equipment or back boxes, except where conduit entry is specified by the FACP manufacturer.
 - 7. Conduit shall be 3/4-inch (19.1 mm) minimum.
- B. Surface raceway
 - 1. Where wiring is required to be run exposed on existing finished surfaces utilize surface raceway.
- C. Wire:
 - 1. Wiring shall be in accordance with local, state and national codes (e.g., NEC Article 760) and as recommended by the manufacturer of the fire alarm system. Number and size of conductors shall be as recommended by the fire alarm system manufacturer, but not less than 18 AWG (1.02 mm) for Initiating Device Circuits, Signaling Line Circuits, and Notification Appliance

Circuits.

2. All wire and cable shall be listed and/or approved by a recognized testing agency for use with a protective signaling system.
3. Wiring may be installed in cable hangers above accessible ceilings. Wire and cable not installed in conduit shall have a fire resistance rating suitable for the installation as indicated in NFPA 70 (e.g., FPLR).
4. Wiring used for the multiplex communication circuit (SLC) shall be twisted and unshielded and support a minimum wiring distance of 12,500 feet. The design of the system shall permit use of IDC and NAC wiring in the same conduit with the SLC communication circuit.
5. All field wiring shall be electrically supervised for open circuit and ground fault.
6. The fire alarm control panel shall be capable of t-tapping Class B (NFPA Style 4) Signaling Line Circuits (SLCs). Systems that do not allow or have restrictions in, for example, the number of t-taps, length of t-taps etc., are not acceptable.
7. Speaker circuit cable shall be 18/2 shielded twisted pair.
8. Fiber optic cable for network connections shall be multimode or single mode as required by the manufacturer and application. Install fiber optic network cable in plenum rated red inner duct.
9. Provide cable certified and approved by the system manufacturer.
10. All cable shall be plenum rated.

D. Terminal Boxes, Junction Boxes and Cabinets:

1. All boxes and cabinets shall be UL listed for their use and purpose.

E. Initiating circuits shall be arranged to serve like categories (manual, smoke, water flow). Mixed category circuitry shall not be permitted except on signaling line circuits connected to intelligent reporting devices.

F. The fire alarm control panel shall be connected to a separate dedicated branch circuit(s), maximum 20 amperes. Provide red breaker lock-on device for branch circuit. This circuit shall be labeled as FIRE ALARM. Fire alarm control panel primary power wiring shall be 12 AWG. The control panel cabinet shall be grounded securely to either a cold-water pipe or grounding rod.

2.4 MAIN FIRE ALARM CONTROL PANEL - FACP

- A. Shall contain a microprocessor based Central Processing Unit (CPU) and power supply. The CPU shall communicate with and control the following types of equipment used to make up the system: intelligent addressable smoke and thermal (heat) detectors, addressable modules, printer, annunciators, and other system controlled devices.

- B. In conjunction with intelligent Loop Control Modules and Loop Expander Modules, the main FACP shall perform the following functions:
 - 1. Supervise and monitor all intelligent addressable detectors and monitor modules connected to the system for normal, trouble and alarm conditions.
 - 2. Supervise all initiating signaling and notification circuits throughout the facility by way of connection to addressable monitor and control modules.
 - 3. Detect the activation of any initiating device and the location of the alarm condition. Operate all notification appliances and auxiliary devices as programmed. In the event of CPU failure, all SLC loop modules shall fallback to degrade mode. Such degrade mode shall treat the corresponding SLC loop control modules and associated detection devices as conventional two-wire operation. Any activation of a detector in this mode shall automatically activate associated Notification Appliance Circuits.

- C. System Capacity and General Operation:
 - 1. The FACP shall communicate over a Local Area Network (LAN) or Wide Area Network (WAN) utilizing a peer-to-peer, inherently regenerative communication format and protocol. The network shall support communication speed up to 100 Mb and support up to 200 panels / nodes per network.
 - 2. The control panel shall be capable of expansion of up to 10 SLC loops. Each module shall support up to 318 analog/addressable devices for a maximum system capacity of 3180 points.
 - 3. The Fire Alarm Control Panel shall include a full featured operator interface control and annunciation panel that shall include a backlit 640-character liquid crystal display, individual, color coded system status LEDs, and a QWERTY style alphanumeric keypad for the field programming and control of the fire alarm system. Said LCD shall also support graphic bit maps capable of displaying the company name and logo of either the owner or installing company.
 - 4. All programming or editing of the existing program in the system shall be achieved without special equipment and without interrupting the alarm monitoring functions of the fire alarm control panel.
 - 5. The FACP shall be able to provide the following features:
 - a. Pre-signal and Positive Alarm Sequence: The system shall provide means to cause alarm signals to only sound in specific areas with a delay of the alarm from 60 to up to 180 seconds after start of alarm processing. In addition, a Positive Alarm Sequence selection shall be available that allows a 15- second time period for acknowledging an alarm signal from a fire detection/initiating device. If the alarm is not acknowledged within 15 seconds, all local and remote outputs shall automatically activate immediately.
 - b. Smoke Detector Pre-alarm Indication at Control Panel: To obtain early warning of incipient or potential fire conditions, the system

- shall provide a programmable option to determine system response to real-time detector sensing values above the programmed setting. Two levels of Pre-alarm indication shall be available at the control panel: alert and action.
- c. Alert: It shall be possible to set individual smoke detectors for pre-programmed pre-alarm thresholds. If the individual threshold is reached, the pre-alarm condition shall be activated.
 - d. Action: If programmed for Action and the detector reaches a level exceeding the pre-programmed level, the control panel shall indicate an action condition. Sounder bases installed with either heat or smoke detectors shall automatically activate on action Pre-Alarm level, with general evacuation on Alarm level.
 - e. The system shall support a detector response time to meet world annunciation requirements of less than 3 seconds.
 - f. Device Blink Control: Means shall be provided to turn off detector/module LED strobes for special areas.
 - g. NFPA 72 Smoke Detector Sensitivity Test: The system shall provide an automatic smoke detector test function that meets the sensitivity testing requirements of NFPA 72.
 - h. Programmable Trouble Reminder: The system shall provide means to automatically initiate a reminder that troubles exist in the system. The reminder will appear on the system display and (if enabled) will sound a piezo alarm.
 - i. On-line or Off-line programming: The system shall provide means to allow panel programming either through an off-line software utility program away from the panel or while connected and on-line. The system shall also support upload and download of programmed database and panel executive system program to a Personal Computer/laptop. A single change to one CPU database shall not require a database download to other CPUs.
 - j. History Events: The panel shall maintain a history file of the last 4000 events, each with a time and date stamp. History events shall include all alarms, troubles, operator actions, and programming entries. The control panels shall also maintain a 1000 event Alarm History buffer, which consists of the 1000 most recent alarm events from the 4000 event history file.
 - k. Smoke Control Modes: The system shall provide means to perform FSCS mode Smoke Control to meet NFPA-92A and 90B and HVAC mode to meet NFPA 90A.
 - l. The system shall provide means for all SLC devices on any SLC loop to be auto programmed into the system by specific address. The system shall recognize specific device type ID's and associate that ID with the corresponding address of the device.
 - m. Passwords and Users: The system shall support two password levels,

master and user. Up to 9 user passwords shall be available, each of which may be assigned access to the programming change menus, the alter status menus, or both. Only the master password shall allow access to password change screens.

- n. Block Acknowledge: The system shall support a block Acknowledge for Trouble Conditions
- o. Sensitivity Adjust: The system shall provide Automatic Detector Sensitivity Adjust based on Occupancy schedules including a Holiday list of up to 15 days.
- p. Environmental Drift Control: The system shall provide means for setting Environmental Drift Compensation by device. When a detector accumulates dust in the chamber and reaches an unacceptable level but yet still below the allowed limit, the control panel shall indicate a maintenance alert warning. When the detector accumulates dust in the chamber above the allowed limit, the control panel shall indicate a maintenance urgent warning
- q. Custom Action Messages: The system shall provide means to enter up to 100 custom action messages of up to 160 characters each. It shall be possible to assign any of the 100 messages to any point.
- r. Local Mode: If communication is lost to the central processor the system shall provide added survivability through the intelligent loop control modules. Inputs from devices connected to the SLC and loop control modules shall activate outputs on the same loop when the inputs and outputs have been set with point programming to participate in local mode or when the type codes are of the same type: that is, an input with a fire alarm type code shall activate an output with a fire alarm type code.
- s. Read status preview - enabled and disabled points: Prior to re-enabling points, the system shall inform the user that a disabled device is in the alarm state. This shall provide notice that the device must be reset before the device is enabled thereby avoiding activation of the notification circuits.
- t. Multi-Detector and Cooperating Detectors: The system shall provide means to link one detector with up to two detectors at other addresses on the same loop in cooperative multi-detector sensing. There shall be no requirement for sequential addresses on the detectors and the alarm event shall be a result of all cooperating detectors chamber readings.
- u. ACTIVE EVENT: The system shall provide a Type ID called FIRE CONTROL for purposes of air-handling shutdown, which shall be intended to override normal operating automatic functions. Activation of a FIRE CONTROL point shall cause the control panel to (1) initiate the monitor module Control-by-Event, (2) send a message to the panel display, history buffer, installed printer and annunciators, (3) shall not light an indicator at the control panel, (4)

- Shall display ACTIVE on the LCD as well a display a FIRE CONTROL Type Code and other information specific to the device.
- v. NON-FIRE Alarm Module Reporting: A point with a type ID of NON-FIRE shall be available for use for energy management or other non-fire situations. NON-FIRE point operation shall not affect control panel operation nor shall it display a message at the panel LDC. Activation of a NON-FIRE point shall activate control by event logic but shall not cause any indication on the control panel.
 - w. Mass Notification Override: The system shall be UL 2572 listed for Mass Notification and shall be capable, based on the Risk Analysis, of being programmed so that Mass Notification/Emergency Communications events take precedence over fire alarm events.
 - x. One-Man Walk Test: The system shall provide both a basic and advanced walk test for testing the entire fire alarm system. The basic walk test shall allow a single operator to run audible tests on the panel. All logic equation automation shall be suspended during the test and while annunciators can be enabled for the test, all shall default to the disabled state. During an advanced walk test, field-supplied output point programming will react to input stimuli such as CBE and logic equations. When points are activated in advanced test mode, each initiating event shall latch the input. The advanced test shall be audible and shall be used for pull station verification, magnet activated tests on input devices, input and output device and wiring operation/verification.
 - y. Control by Event Functions: CBE software functions shall provide means to program a variety of output responses based on various initiating events. The control panel shall operate CBE through lists of zones. A zone shall become listed when it is added to a point's zone map through point programming. Each input point such as detector, monitor module or panel circuit module shall support listing of up to 10 zones into its programmed zone map.
 - z. Permitted zone types shall be general zone, releasing zone and special zone. Each output point (control module, panel circuit module) can support a list of up to 10 zones including general zone, logic zone, releasing zone and trouble zone. It shall be possible for output points to be assigned to list general alarm. Non-Alarm or Supervisory points shall not activate the general alarm zone.
 - aa. 1000 General Zones: The system shall support up to 1000 general purpose software zones for linking inputs to outputs. When an input device activates, any general zone programmed into that device's zone map will be active and any output device that has an active general zone in its map will be active. It shall also be possible to use general zone as arguments in logic equations.
 - bb. 1000 Logic Equations: The system shall support up to 1000 logic equations for AND, OR, NOT, ONLY1, ANYX, XZONE or RANGE

operators that allow conditional I/O linking. When any logic equation becomes true, all output points mapped to the logic zone shall activate.

- cc. 100 trouble equations per device: The system shall provide support for up to 100 trouble equations for each device, which shall permit programming parameters to be altered, based on specific fault conditions. If the trouble equation becomes true, all output points mapped to the trouble zone shall activate.
- dd. Control-By-Time: A time based logic function shall be available to delay an action for a specific period of time based upon a logic input with tracking feature. A latched version shall also be available. Another version of this shall permit activation on specific days of the week or year with ability to set and restore based on a 24-hour time schedule on any day of the week or year.
- ee. Multiple agent releasing zones: The system shall support up to 10 releasing zones to protect against 10 independent hazards. Releasing zones shall provide up to three cross-zone and four abort options to satisfy any local jurisdiction requirements.
- ff. Alarm Verification, by device, with timer and tally: The system shall provide a user-defined global software timer function that can be set for a specific detector. The timer function shall delay an alarm signal for a user- specified time period and the control panel shall ignore the alarm verification timer if another alarm is detected during the verification period. It shall also be possible to set a maximum verification count between 0 and 20 with the "0" setting producing no alarm verification. When the counter exceeds the threshold value entered, a trouble shall be generated to the panel.
- gg. Secure/Access Operation: The system shall have the capability of configuring input modules to monitor status of door contact or other security type sensors. These input modules shall be able to be commanded from the normally "Secure" state to an "Access" state. While in the secure state, the module will transmit alarm conditions to the controller, which shall be annunciated on the LCD and LED displays. The modules shall be placed into the Access state either through the LCD display or through predefined operator keys. While in the Access state, all alarms from the module will be shunted. Placing the module into the access state shall cause a discrete LED associated with input point to flash, but no other trouble or disable condition will be annunciated. Change from Secure to Access and reverse shall be transmitted to the central monitoring station on a per zone basis. Systems that cause or indicate a trouble or disable condition are unacceptable.

F. Central Processing Unit

- 1. The Central Processing Unit shall contain and execute all control-by-event (including Boolean functions including but not limited to AND, OR, NOT,

ANYx, and CROSSZONE) programs for specific action to be taken if an alarm condition is detected by the system. Such control-by-event programs shall be held in non-volatile programmable memory and shall not be lost with system primary and secondary power failure.

2. The Central Processing Unit shall also provide a real-time clock for time annotation, to the second, of all system events. The time-of-day and date shall not be lost if system primary and secondary power supplies fail.
3. The CPU shall be capable of being programmed on site without requiring the use of any external programming equipment. Systems that require the use of external programmers or change of EPROMs are not acceptable.
4. The CPU shall provide an EIA-232 interface between the fire alarm control panel and the UL Listed Electronic Data Processing (EDP) peripherals.
5. The CPU shall provide two EIA-485 ports for the serial connection to annunciation and control subsystem components.
6. The EIA-232 serial output circuit shall be optically isolated to assure protection from earth ground.

G. Display

1. The system display shall provide a 640-character backlit alphanumeric Liquid Crystal Display (LCD). It shall also provide eleven Light-Emitting-Diodes (LEDs) that indicate the status of the following system parameters: AC POWER, FIRE ALARM, PREALARM, SECURITY, SUPERVISORY, SYSTEM TROUBLE, OTHER EVENT, SIGNALS SILENCED, POINT DISABLED, CONTROLS ACTIVE, and CPU FAILURE.
2. The system display shall provide a QWERTY style keypad with control capability to command all system functions, entry of any alphabetic or numeric information, and field programming. Two different password levels with up to ten (one Master and nine User) passwords shall be accessible through the display interface assembly to prevent unauthorized system control or programming.

H. Loop (Signaling Line Circuit) Control Module:

1. The Loop Control Module shall monitor and control a minimum of 318 intelligent addressable devices. This includes 159 intelligent detectors (Ionization, Photoelectric, or Thermal) and 159 monitor or control modules.
2. The Loop Control Module shall contain its own microprocessor and shall be capable of operating in a local/degrade mode (any addressable device input shall be capable of activating any or all addressable device outputs) in the unlikely event of a failure in the main CPU.
3. Each SLC shall be capable of NFPA 72 Style 4, Style 6, or Style 7 (Class A or B) wiring.
5. The SLC interface board shall receive analog or digital information from all intelligent detectors and shall process this information to determine

whether normal, alarm, or trouble conditions exist for that particular device. Each SLC Loop shall be isolated and equipped to annunciate an Earth Fault condition. The SLC interface board software shall include software to automatically maintain the detector's desired sensitivity level by adjusting for the effects of environmental factors, including the accumulation of dust in each detector. The analog information may also be used for automatic detector testing and the automatic determination of detector maintenance requirements.

I. Charger Power Supply

1. The auxiliary addressable power supply is a remote 24 VDC power supply used to power Notification Devices and field devices that require regulated 24 VDC power.
2. The addressable power supply for the fire detection system shall provide up to a minimum of 6.0 amps of 24-volt DC regulated power for Notification Appliance Circuit (NAC) power or 10.0 amps of 24-volt DC general power. The power supply shall have an additional 0.5 amp of 24 VDC auxiliary power for use within the same cabinet as the power supply. It shall include an integral charger designed to charge 12 - 200-amp hour batteries.
3. The addressable power supply shall provide four individually addressable Notification Appliance Circuits that may be configured as Class "A" or Class "B" circuits. All circuits shall be power-limited per UL 864 requirements.
4. The addressable power supply shall provide built-in synchronization for certain Notification Appliances on each circuit without the need for additional synchronization modules. The power supply's output circuits shall be individually selected for synchronization. A single addressable power supply shall be capable of supporting both synchronized and non-synchronized Notification Devices at the same time.
5. The addressable power supply shall operate on 120 or 240 VAC, 50/60 Hz.
6. The interface to the power supply from the Fire Alarm Control Panel (FACP) shall be via the Signaling Line Circuit (SLC) or other multiplexed means. Power supplies that do not use an intelligent interface are not suitable substitutes. The required wiring from the FACP to the addressable power supply shall be a single unshielded twisted pair wire.
7. The addressable power supply shall monitor for battery charging failure, AC power loss, power brownout, battery failure, NAC loss, and optional ground fault detection. In the event of a trouble condition, the addressable power supply shall report the incident and the applicable address to the FACP via the SLC.
8. The addressable power supply shall have an AC Power Loss Delay option. If this option is utilized and the addressable power supply experiences an AC power loss, reporting of the incident to the FACP will be delayed. A delay time of zero, two, eight or sixteen hours shall be programmable.
9. The addressable power supply mounts in either the FACP backbox or

it's own dedicated surface mounted backbox with cover.

10. Each of the power supply's four output circuits shall be programmed- for Notification Appliance Circuit or General Purpose 24 VDC power. Any output circuit shall be able to provide up to 2.5 amps of 24 VDC power.
11. The addressable power supply's output circuits shall be individually supervised when they are selected to be either a Notification Appliance Circuit when wired Class "A" or by the use of an end-of-line resistor. When the power supply's output circuit is selected as General 24 VDC power, the circuit shall be individually supervised when an end-of-line relay is used.
12. When selected for Notification Appliance Circuits, the output circuits shall be individually programmable for Steady, March Time, Dual Stage or Temporal.
13. When selected as a Notification Appliance Circuit, the output circuits of the addressable power supply shall have the option to be coded by the use of a universal zone coder.
14. The addressable power supply shall interface and synchronize with other power supplies of the same type. The required wiring to interface multiple addressable power supplies shall be a single unshielded, twisted pair wire.
15. An individual or multiple interfaced addressable power supplies shall have the option to use an external charger for battery charging. Interfaced power supplies shall have the option to share backup battery power.

J. Remote Transmissions:

1. Provide local energy or polarity reversal or trip circuits as required.
2. The system shall be capable of operating a polarity reversal or local energy or fire alarm transmitter for automatically transmitting fire information to the local fire department and law enforcement agencies.
3. Provide capability and equipment for transmission of zone alarm and trouble signals to remote operator's terminals, system printers and annunciators.
4. Transmitters shall be compatible with the systems and equipment they are connected to such as timing, operation and other required features.

K. Field Programming

1. The system shall be programmable, configurable and expandable in the field without the need for special tools, laptop computers, or other electronic interface equipment. There shall be no firmware changes required to field modify the system time, point information, equations, or annunciator programming/information.
2. It shall be possible to program through the standard FACP keyboard all system functions.
3. All field defined programs shall be stored in non-volatile memory.

4. Two levels of password protection shall be provided in addition to a key-lock cabinet. One level shall be used for status level changes such as point/zone disable or manual on/off commands (Building Manager). A second (higher-level) shall be used for actual change of the life safety program (installer). These passwords shall be five (5) digits at a minimum. Upon entry of an invalid password for the third time within a one-minute time period an encrypted number shall be displayed. This number can be used as a reference for determining a forgotten password.
 5. The system programming shall be "backed" up via an upload/download program and stored on compatible removable media. A system back-up disk shall be completed and given in duplicate to the building owner and/or operator upon completion of the final inspection. The program that performs this function shall be "non-proprietary", in that, it shall be possible to forward it to the building owner/operator upon his or her request.
 6. The installer's field programming and hardware shall be functionally tested on a computer against known parameters/norms which are established by the FACP manufacturer. A software program shall test Input-to-Output correlations, device Type ID associations, point associations, time equations, etc. This test shall be performed on an IBM-compatible PC with a verification software package. A report shall be generated of the test results and two copies turned into the engineer(s) on record.
- L. Specific System Operations
1. Smoke Detector Sensitivity Adjust: A means shall be provided for adjusting the sensitivity of any or all addressable intelligent detectors in the system from the system keypad. Sensitivity range shall be within the allowed UL window and have a minimum of 9 levels.
 2. Alarm Verification: Each of the intelligent addressable smoke detectors in the system may be independently selected and enabled to be an alarm verified detector. The alarm verification delay shall be programmable from 0 to 60 seconds and each detector shall be able to be selected for verification. The FACP shall keep a count of the number of times that each detector has entered the verification cycle. These counters may be displayed and reset by the proper operator commands.
- M. System Point Operations:
1. Any addressable device in the system shall have the capability to be enabled or disabled through the system keypad or video terminal.
 2. System output points shall be capable of being turned on or off from the system keypad or the video terminal.
 3. Point Read: The system shall be able to display the following point status diagnostic functions without the need for peripheral equipment. Each point shall be annunciated for the parameters listed:
 - a. Device Status.
 - b. Device Type.

- c. Custom Device Label.
 - d. Software Zone Label.
 - e. Device Zone Assignments.
 - f. Analog Detector Sensitivity.
 - g. All Program Parameters.
 - 4. System History Recording and Reporting: The fire alarm control panel shall contain a history buffer that will be capable of storing up to 4000 system events. Each of these events will be stored, with time and date stamp, until an operator requests that the contents be either displayed or printed. The contents of the history buffer may be manually reviewed; one event at a time, and the actual number of activations may also be displayed and or printed. History events shall include all alarms, troubles, operator actions, and programming entries.
 - 5. The history buffer shall use non-volatile memory. Systems which use volatile memory for history storage are not acceptable.
 - 6. Automatic Detector Maintenance Alert: The fire alarm control panel shall automatically interrogate each intelligent system detector and shall analyze the detector responses over a period of time.
 - 7. If any intelligent detector in the system responds with a reading that is below or above normal limits, then the system will enter the trouble mode, and the particular Intelligent Detector will be annunciated on the system display, and printed on the optional system printer. This feature shall in no way inhibit the receipt of alarm conditions in the system, nor shall it require any special hardware, special tools or computer expertise to perform.
 - 8. The system shall include the ability (programmable) to indicate a "pre-alarm" condition. This will be used to alert maintenance personal when a detector is at 80% of its alarm threshold in a 60 second period.
- O. Power Supply:
- 1. Off-line switching power supply(s) shall be provided for the fire alarm control panel or network node and provide 6.0 amps of available power for the control panel and peripheral devices.
 - 2. Provisions will be made to allow the audio-visual power to be increased as required by adding modular expansion audio-visual power supplies.
 - 3. Positive-Temperature-Coefficient (PTC) thermistors, circuit breakers, or other over- current protection shall be provided on all power outputs. The power supply shall provide an integral battery charger for use with batteries up to 55 AH or may be used with an external battery and charger system. Battery arrangement may be configured in the field.
 - 4. The power supply shall continuously monitor all field wires for earth ground conditions, and shall have the following LED indicators:
 - a. Ground Fault LED.
 - b. AC Power Fail LED.
 - c. NAC on LED (4).

5. The main power supply(s) shall operate on 120 VAC, 60 Hz, and shall provide all necessary power for the FACP.
 6. The main power supply shall provide a battery charger using dual-rate charging techniques for fast battery recharge and be capable of charging batteries up to 200 AH.
 7. All circuits shall be power-limited, per UL864 requirements.
- P. Auxiliary Field Power Supply
1. The auxiliary addressable power supply is a remote 24 VDC power supply used to power Notification Devices and field devices that require regulated 24VDC power. The power supply shall also include and charge backup batteries.
 2. The addressable power supply for the fire alarm system shall provide a minimum of
6.0 amps of 24-volt DC regulated power for Notification Appliance Circuit (NAC) power or 5 amps of 24-volt DC general power. The power supply shall have an additional .5 amp of 24 VDC auxiliary power for use within the same cabinet as the power supply. It shall include an integral charger designed to charge 7.0 - 25.0-amp hour batteries.
 3. The addressable power supply shall provide four individually addressable Notification Appliance Circuits that may be configured as two Class "A" and two Class "B" or four Class "B" only circuits. All circuits shall be power-limited per UL 864 requirements.
 4. The addressable power supply shall provide built-in synchronization for certain Notification Appliances on each circuit without the need for additional synchronization modules. The power supply's output circuits shall be individually selected for synchronization. A single addressable power supply shall be capable of supporting both synchronized and non-synchronized Notification Devices at the same time.
 5. The addressable power supply shall operate on 120 or 240 VAC, 50/60 Hz.
 6. The interface to the power supply from the Fire Alarm Control Panel (FACP) shall be via the Signaling Line Circuit (SLC) or other multiplexed means.
 7. Power supplies that do not use an intelligent interface are not suitable substitutes. The required wiring from the FACP to the addressable power supply shall be a single unshielded twisted pair wire. Data on the SLC shall be transmitted between 24 VDC, 5 VDC and 0 VDC at approximately 3.33k baud.
 8. The addressable power supply shall supervise for battery charging failure, AC power loss, power brownout, battery failure, NAC loss, and optional ground fault detection. In the event of a trouble condition, the addressable power supply shall report the incident and the applicable address to the FACP via the SLC.
 9. The addressable power supply shall have an AC Power Loss Delay option. If this option is utilized and the addressable power supply experiences an AC power loss, reporting of the incident to the FACP will be delayed. A delay time of eight or sixteen hours shall be Dip-switch selected.

10. The addressable power supply shall mount in either the FACP back box or its own dedicated surface mounted back box with cover.
11. Each of the power supply's four output circuits shall be DIP-switch selected for Notification Appliance Circuit or General Purpose 24 VDC power. Any output circuit shall be able to provide up to 2.5 amps of 24 VDC power.
12. The addressable power supply's output circuits shall be individually supervised when they are selected to be either a Notification Appliance Circuit when wired Class "A" or by the use of an end-of-line resistor. When the power supply's output circuit is selected as General 24VDC power, the circuit shall be individually supervised when an end-of-line relay is used.
13. When selected for Notification Appliance Circuits, the output circuits shall be individually DIP-switch selectable for Steady, March Time, Dual Stage or Temporal.
14. When selected as a Notification Appliance Circuit, the output circuits of the addressable power supply shall have the option to be coded by the use of a universal zone coder.
15. The addressable power supply shall interface and synchronize with other power supplies of the same type. The required wiring to interface multiple addressable power supplies shall be a single unshielded, twisted pair wire.

Q. Specific System Operations:

1. Smoke Detector Sensitivity Adjust: A means shall be provided for adjusting the sensitivity of any or all addressable intelligent detectors in the system from the system keypad. Sensitivity range shall be within the allowed UL window and have a minimum of 9 levels.
2. Alarm Verification: Each of the intelligent addressable smoke detectors in the system may be independently selected and enabled to be an alarm verified detector. The alarm verification delay shall be programmable from 5 to 30 seconds and each detector shall be able to be selected for verification. The FACP shall keep a count of the number of times that each detector has entered the verification cycle. These counters may be displayed and reset by the proper operator commands.
3. Point Disable: Any addressable device or conventional circuit in the system may be enabled or disabled through the system keypad.
4. Point Read: The system shall be able to display or print the following point status diagnostic functions:
 - a. Device status.
 - b. Device type.
 - c. Custom device label.
 - d. View analog detector values.
 - e. Device zone assignments.
 - f. All program parameters.
5. System Status Reports: Upon command from an operator of the system,

- a status report will be generated and printed, listing all system status.
6. System History Recording and Reporting: The fire alarm control panel shall contain a history buffer that will be capable of storing up to 800 events. Up to 200 events shall be dedicated to alarm and the remaining events are general purpose. Systems that do not have dedicated alarm storage, where events are overridden by non-alarm type events, are not suitable substitutes. Each of these activations will be stored and time and date stamped with the actual time of the activation. The contents of the history buffer may be manually reviewed, one event at a time, or printed in its entirety. The history buffer shall use non-volatile memory. Systems that use volatile memory for history storage are not acceptable substitutes.
 7. Automatic Detector Maintenance Alert: The fire alarm control panel shall automatically interrogate each intelligent detector and shall analyze the detector responses over a period of time. If any intelligent detector in the system responds with a reading that is above or below normal limits, then the system will enter the trouble mode, and the particular detector will be annunciated on the system display, and printed on the optional printer. This feature shall in no way inhibit the receipt of alarm conditions in the system, nor shall it require any special hardware, special tools or computer expertise to perform.
 8. Pre-Alarm Function: The system shall provide two levels of pre-alarm warning to give advance notice of a possible fire situation. Both pre-alarm levels shall be fully field adjustable. The first level shall give an audible indication at the panel. The second level shall give an audible indication and may also activate control relays. The system shall also have the ability to activate local detector sounder bases at the pre-alarm level, to assist in avoiding nuisance alarms.
 9. Software Zones: The FACP shall provide 100 software zones, 10 additional special function zones, 10 releasing zones, and 20 logic zones.
 10. The fire alarm control panel shall include a walk test feature. It shall include the ability to test initiating device circuits and notification appliance circuits from the field without returning to the panel to reset the system. Operation shall be as follows:
 - a. Alarming an initiating device shall activate programmed outputs, which are selected to participate in walk test, for 3 seconds.
 - b. Introducing a trouble into the initiating device shall activate the programmed outputs for 8 seconds.
 - c. All devices tested in walk test shall be recorded in the history buffer.
 11. Supervisory Operation: An alarm from a supervisory device shall cause the appropriate indication on the system display, light a common supervisory LED, but will not cause the system to enter the trouble mode.
 12. Non-Alarm Input Operation: Any addressable initiating device in the system may be used as a non-alarm input to monitor normally open contact type devices. Non-alarm functions are a lower priority than fire alarm initiating devices.

13. Combo Zone: A special type code shall be available to allow waterflow and supervisory devices to share a common addressable module. Waterflow devices shall be wired in parallel, supervisory devices in series.

2.5 EMERGENCY VOICE COMMUNICATIONS PANEL - EVCP

- A. The digital voice system shall meet the following requirements.
 1. The Digital Voice Command Center shall be located with the FACP, shall contain all equipment required for all audio control, emergency telephone system control, signaling and supervisory functions. This shall include speaker zone indication and control, telephone circuit indication and control, digital voice units, microphone and main telephone handset. The DVCP shall support up to 8 channels of voice when configured with Digital Audio Amplifiers and 4 channels of voice when employing the optional analog output card. Each DVCP shall support up to 32 digital audio amplifiers.
 2. Function: The Digital Voice Command Center equipment shall perform the following function
 - a. Operate as a supervised multi-channel emergency voice communication system.
 - b. Operate as a two-way emergency telephone system control center.
 - c. Audibly and visually annunciate the active or trouble condition of every speaker circuit and emergency telephone circuit.
 - d. Audibly and visually annunciate any trouble condition for digital tone and voice units required for normal operation of the system.
 - e. Provide all-call Emergency Paging activities through activation of a single control switch or zone paging using selector switch.
 - f. As required, provide vectored paging control to specific audio zones via dedicated control switches.
 - g. Provide a factory recorded "library" of voice messages and tones in standard WAV file format, which may be edited and saved on a PC running a current Windows® operating system.
 - h. Provide a software utility capable of off-line programming for the VCC operation and the audio message files. This utility shall support the creation of new programs as well as editing and saving existing program files. Uploading or downloading the software content shall not inhibit the emergency operation of other nodes on the fire alarm network.
 - i. Support an optional mode of operation with four analog audio outputs capable of being used with UL 864 fire-listed analog audio amplifiers and SCL controlled switching.
 - j. The Digital Voice Command shall be modular in construction and shall be capable of being field programmable without requiring the return of any components to the manufacturer and without

requiring use of any external computers or other programming equipment.

- k. The Digital Voice Command and associated equipment shall be protected against unusually high voltage surges or line transients.
- 3. The emergency voice alarm communication system shall incorporate a two-way emergency telephone communication system.
 - a. Two-way emergency telephone communication circuits shall be supervised for open and short circuit conditions.
 - b. Two-way emergency telephone (Fire Fighter Telephone) communication shall be supported between the Digital Voice Command Center and up to (7) remote Fire Fighter's Telephone locations simultaneously on a telephone riser.
 - c. Means shall be provided to connect FFT voice communications to the speaker circuits in order to allow voice paging over the speaker circuit from a telephone handset.

B. Audio Amplifiers:

- 1. The Audio Amplifiers shall provide Audio Power (25 Volt RMS or 70 RMS) for distribution to speaker circuits.
- 2. Amplifiers for the proposed system shall be mounted at the fire alarm control panel location or remotely in network closets.
- 3. Multiple audio amplifiers may be mounted in a single enclosure, either to supply incremental audio power, or to function as an automatically switched backup amplifier(s).
- 4. Enclosure(s) shall be wall mounted or rack mounted as required.
- 5. Amplifiers shall be furnished as required to meet the zone requirements called for on the riser diagram. The riser diagram is schematic. Where required provide multiple amplifiers in a single zone.
- 6. The audio amplifier shall include an integral power supply, and shall provide built-in LED indicators for the following conditions:
 - a. Earth Fault
 - b. Audio Amplifier Failure Detected Trouble.
 - c. Active Alarm Bus input.
 - d. Audio Detected
 - e. Audio detected on Firefighter's Telephone Riser.
 - f. Receiving Audio from digital audio riser.
 - g. Short circuit on speaker circuit
 - h. Data Transmitted
 - i. Data Received
 - j. Board failure.
 - k. Active fiber optic media connection
 - l. Power supply Earth Fault.
 - m. Power supply 5V present.
 - n. Power supply conditions - Brownout, High Battery, Low Battery, Charger Trouble.
- 7. The audio amplifier shall provide the following built-in controls:

- a. Amplifier Address Selection Switches.
 - b. Signal Silence of communication loss annunciation Reset.
 - c. Level adjustment for background music.
 - d. Enable/Disable for Earth Fault detection
 - e. Switch for 2-wire/4-wire FFT riser.
 8. Adjustment of the correct audio level for the amplifier shall not require any special tools or test equipment.
 9. Audio input and amplified output supervision, back up input, and automatic switch over function, (if primary amplifier should fail).
 10. One-tone back up shall be provided by either a plug-in-amplifier card or a designated backup amplifier of identical model as the primary amplifier.
 11. One designated backup amplifier shall be capable of backing up multiple primary amplifiers mounted in the same or adjacent cabinets.
 12. Multi-channel operation from a single amplifier shall be supported by the addition of an optional plug-in amplifier card.
- C. Audio Message Generator (Prerecorded Voice) / Speaker Control:
1. Each initiating zone or intelligent device shall interface with an emergency voice communication system capable of transmitting a prerecorded voice message to all speakers in the building.
 2. Actuation of any alarm initiating device shall cause a prerecorded message to sound over the speakers. The message shall be repeated (4) times. Pre-message and post-message tones shall be supported.
 3. A built-in microphone shall be provided to allow paging through speaker circuits.
 4. System paging from emergency telephone circuits shall be supported.
 5. The audio message generator shall have the following indicators and controls to allow for proper operator understanding and control.
 - a. LED Indicators.
 - b. Lamp Test.
 - c. Trouble.
 - d. Off-Line Trouble.
 - e. Microphone Trouble.
 - f. Phone Trouble.
 - g. Busy/Wait.
 - h. Page Inhibited.
 - i. Pre/Post Announcement Tone.

2.6 NETWORK INTERFACE

- A. Provide fiber optic network interface as required for installation. The interface shall be point to point between control panels using dedicated fiber optic cable run in a plenum rated red Inner duct above accessible ceilings and in EMT conduit where run exposed in utility and mechanical rooms without ceilings.

- B. Fiber Optic Interface Features:
 - 1. NFPA Style 4 (Class B) or Style 7 (Class A) operation.
 - 2. Data is immune to all environmental noise.
 - 3. Optical isolation to prevent ground loops.
 - 4. Fiber type: 62.5/125 micrometers (multi-mode); 50/125micrometers (multimode), or 9/125 micrometers (singlemode).
 - 5. Maximum attenuation is 10 dB with 62.5/125 μ m cable, and 6.5 dB with 50/125 μ m cable, and 30 dB with 9/125 μ m cable.
 - 6. Wavelength (1): 1310 nanometers.
 - 7. Connectors: LC style.
 - 8. 100 Mb baud transmission rate.
 - 9. Data is regenerated at each node.
 - 10. (2) network ports for simultaneous connection to fire alarm control panel and to programming computer.

2.7 REMOTE PAGING STATION

- A. The remote paging station shall be configured as a wall mounted paging station and have the following features:
 - 1. Up to three programmable message priority levels determined by site programming used to allow high-priority emergency pages to override lower priority general pages.
 - 2. 24 programmable buttons may be used for a range of functions, including:
 - a. Control for vectored pages.
 - b. Control for HVAC shutdown, door release, or other emergency functions.
 - c. Initiation of recorded messages and other event annunciation.
 - d. Annunciation of activation or trouble for audio zones or other points.
 - 3. Electrically isolated digital audio ports for direct connection with up to 32 Digital Audio Loop (DAL) devices.
 - 4. Where required fiber modules maybe used to convert one or both Digital Audio Ports for operation with single-mode or multi-mode fiber.
- B. Shall be listed for use with mass notification systems.

2.8 NOTIFICATION APPLIANCES AND MASS NOTIFICATION ALARMS

- A. Strobe Units
 - 1. Strobe lights shall meet the requirements of the ADA, UL Standard 1971, be fully synchronized, and shall meet the following criteria:
 - 2. The maximum pulse duration shall be 2/10 of one second.
 - 3. Strobe intensity shall meet the requirements of UL 1971.
 - 4. The flash rate shall meet the requirements of UL 1971.

5. White housing with FIRE marking in red per 2013 NFPA 72 Handbook section A.18.3.3.2
- B. Strobe/Speaker:
 1. Design Make: Notifier System Sensor SPS and SPSC L series
 2. Provide ceiling or wall mounted as indicated on plans
 3. The speaker/strobe shall have the following features
 - a. Plug-in design and protective cover for reduced ground faults
 - b. Universal mounting plate with an onboard shorting spring to test wiring continuity before installation
 - c. Field selectable candela settings on wall units: 15, 30, 75, 95, 110, 135, 185
 - d. Automatic selection of 12- or 24-volt operation at 15 and 30 candela
 - e. Rotary switch for field selection of speaker voltage (25 and 70.7 Vrms) and power settings (1/4, 1/2, 1 and 2 watts)
 - f. High fidelity and high-volume sound output
 - g. Tamper-resistant construction
 - h. White housing with no marking.
 4. The speaker shall be a dual-voltage transformer speaker capable of operating at 25.0 or 70.7 nominal Vrms. It shall be listed to UL 1480 and shall be approved for fire protective service. The speaker shall have a frequency range of 400 to 4,000 Hz and shall have an operating temperature between 32°F and 120°F. Speakers shall have power taps and voltage that are selected by rotary switches. Speakers shall have 1/4 W, 1/2 W, 1 W, and 2 W taps. (dBA @10 ft) 77, 80, 83, and 86 respectively.
 5. Standard Operating Temperature: 32°F to 120°F (0°C to 49°C)
 6. Shall mount to a 4" x 4" x 2-1/8" back box.
 7. Provide weatherproof type where required for exterior applications.
- C. 8" Ceiling or wall mounted Fire Alarm/Public Address speaker.
 1. Design Make: Notifier SPCW8
 2. 8-Inch Dual Voltage
 3. Tap-setting range between 1/8 Watt and 8 Watts.
 4. High efficiency sound output with low total harmonic distortion and high fidelity sound output.
 5. Wide frequency range for general signaling such as paging and background music.
 6. Listed to ANSI/UL 1480, CAN/ULC S541 and CSA C22.2. No. 205 requirements for public mode and general signaling applications as well as ANSI/UL 2043 plenum rated.
 7. Suitable for indoor and damp installations.
 8. Voltage and speaker tap settings via jumper connection. Field selection of speaker voltage (25 and 70.7 Vrms) and power settings (1/8, 1/4, 1/2, 1, 2, 4, and 8 watts).
 9. Temperature range 32°F to 120°F (0°C to 49°C).
 10. Accepts wire up to 12 AWG.

11. Provide with surface or recessed ceiling or wall mounted box as shown on electrical plans. Refer to architectural plans to verify ceiling and wall types.
12. Surface mounted boxes shall be of a color selected by the architect and have rounded corners.

D. Mass Notification Audio Visual Devices

1. Provide mass notification in compliance with ANSI/UL 1638 Standard for General Signaling Visible Appliances.
2. Weatherproof
3. Provide clear lenses for use with color lens strobe attachments (blue) strobe devices without a candela derating.
4. Mass Notification Features
 - a. Plain or printed white housings
 - b. Blue lens strobe
 - c. Meets DOD specification requirements
5. Advance Features
 - a. Plug-in design for simplified installation and troubleshooting
 - b. Mounting plate with shorting spring to test wiring continuity
 - c. Automatic selection of 12- or 24-volt operation at 15 and 15/75 candela
 - d. Field-selectable candela settings of 15, 15/75, 30, 75, 95, 110, 115, 135, 150, 177, 185
6. Rated from 32°F to 120°F (0°C to 49°C) (indoor devices);
7. -40°F to 151°F (-40°C to 66°C) (NEMA 4X, IP56 weatherproof devices)
8. Tamper-resistant Torx head screw
9. Shall mount to a standard 4" x 4" x 1.5" back box, 4-inch octagon back box or double-gang back box. Two-wire products shall also mount to a single-gang 2" x 4" x 1 7/8" (5.08 x 10.16 x 4.76 cm) back box.
10. The notification appliance circuit wiring and amplifier wiring shall terminate at the universal mounting plate.
11. The strobe shall be wired as a primary signaling notification appliance and comply with the Americans with Disabilities Act requirements for visible signaling appliances, flashing at 1 Hz over the strobe's entire operating voltage range.
12. The strobe light shall consist of a xenon flash tube and associated lens/reflector system.
13. The speaker strobe shall be listed to UL 1480 and UL 1971 and be approved for fire protective signaling systems.
14. Speaker shall be capable of operating at 25.0 or 70.7 nominal Vrms selected via rotary switch and shall have a frequency range of 400 to 4000 Hz.
15. Speakers shall have power taps that are selected by rotary switch.
16. Synch module shall be listed to UL 464 and shall be approved for fire protective service.
17. Daisy chaining two or more synchronization modules together shall synchronize all the zones they control. The module shall not operate on a

- coded power supply.
18. White housing with ALERT marking in red per 2013 NFPA 72 section 24.4.3.17.7.

2.9 ANNUNCIATOR

- A. Alphanumeric LCD Type Annunciator
1. Enhanced-format 640-character LCD display with backlighting.
 2. The LCD annunciator shall display all alarm and trouble conditions in the system.
 3. An audible indication of alarm shall be integral to the alphanumeric display.
 4. The display shall be UL listed for fire alarm application.
 5. It shall be possible to connect up to (32) LCD displays and be capable of wiring distances up to 6,000 feet from the control panel.
 6. History Buffer (1000 Alarm events; 4000 System events).
 7. The LED annunciator shall offer an interface to a graphic style annunciator and provide each of the features listed above.
- B. The annunciator shall provide complete zone control of all zones available on the system using clearly marked initiation buttons.
- C. Remote Microphone and Cabinet
1. Unit shall be housed in a common cabinet with the remote annunciator
 2. Unit shall have the following features:
 - a. Automatic gain control
 - b. Supervised microphone
 - c. Form C trouble contacts
 - d. Form-C contacts activated when microphone in use
 - e. Power on LED
 - f. Trouble LED
 - g. Low Level Audio IN and THRU screws

2.10 DIGITAL COMMUNICATOR

- A. Provide a digital communicator for each fire alarm control panel in the system.
- B. Features:
1. The UDACT is an interface for communicating digital information between a fire alarm control panel and an UL-Listed central station.
 2. The UDACT shall be compact in size, mounting in a standard module position of the fire alarm control cabinet. Optionally, the UDACT shall have the ability for remote mounting, up to 6,000 feet from the fire alarm control panel. The wire connections between the UDACT and the control panel shall be supervised with one pair for power and one pair for multiplexed

communication of overall system status. Systems that utilize relay contact closures are not acceptable.

3. The UDACT shall include connections for dual telephone lines (with voltage detect), per UL/NFPA/FCC requirements. It shall include the ability for split reporting of panel events up to three different telephone numbers.
4. The UDACT shall be completely field programmable from a built-in keypad and 4 character red, seven segment display.
5. The UDACT shall be capable of transmitting events in at least (15) different formats. This ensures compatibility with existing and future transmission formats.
6. Communication shall include vital system status such as:
 - a. Independent Zone (Alarm, Trouble, Non-Alarm, Supervisory).
 - b. Independent Addressable Device Status.
 - c. AC (Mains) Power Loss.
 - d. Low Battery and Earth Fault.
 - e. System Off Normal.
 - f. 12 and 24-Hour Test Signal.
 - g. Abnormal Test Signal (per UL Requirements).
 - h. EIA-485 Communications Failure.
 - i. Phone Line Failure.
7. The UDACT shall support independent zone/point reporting when used in the Contact ID format. In this format, the UDACT shall support transmission of up to 2,040 points. This enables the central station to have exact details concerning the origin of the fire or response emergency.
8. Provide IP Communicator to connect the panel to the VoIP Ethernet network.

2.11 INITIATION DEVICES

- A. General:
 1. Addressable devices shall use and maintain decade, decimal address switches. Devices shall be capable of being set to an address in a range of 001 to 159.
 2. Addressable devices, which use a binary-coded address setting method, such as a DIP-switch, are not an allowable substitute. Addressable devices that require the address be programmed using a special tool or programming utility are not an allowable substitute.
 3. Detectors shall be intelligent (analog) and addressable and shall connect with two wires to the fire alarm control panel Signaling Line Circuits.
 4. Addressable smoke and thermal detectors shall provide dual alarm and power/polling LEDs. Both LEDs shall flash green under normal conditions,

indicating that the detector is operational and in regular communication with the control panel, and both LEDs shall be placed into steady red illumination by the control panel, indicating that an alarm condition has been detected. If required, the LED flash shall have the ability to be removed from the system program. An output connection shall also be provided in the base to connect an external remote alarm LED.

5. The fire alarm control panel shall permit detector sensitivity adjustment through field programming of the system. The panel on a time-of-day basis shall automatically adjust sensitivity. Using software in the FACP, detectors shall automatically compensate for dust accumulation and other slow environmental changes that may affect their performance. The detectors shall be listed by UL as meeting the calibrated sensitivity test requirements of NFPA Standard 72.
6. The detectors shall be ceiling-mount and shall include a separate twist-lock base with tamper proof feature. Base options shall include a sounder base with a built-in (local) sounder rated at 85 DBA minimum, a relay base and an isolator base designed for Style 7 applications.
7. The detectors shall provide a test means they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a magnetic switch) or initiated remotely on command from the control panel.
8. Detectors shall also store an internal identifying type code that the control panel shall use to identify the type of device (ION, PHOTO, THERMAL).
9. Detectors will operate in an analog fashion, where the detector simply measures its designed environment variable and transmits an analog value to the FACP based on real-time measured values. The FACP software, not the detector, shall make the alarm/normal decision, thereby allowing the sensitivity of each detector to be set in the FACP program and allowing the system operator to view the current analog value of each detector.
10. Addressable devices shall store an internal identifying code that the control panel shall use to identify the type of device.
11. A magnetic test switch shall be provided to test detectors and modules. Detectors shall report an indication of an analog value reaching 100% of the alarm threshold.
12. Addressable modules shall mount in a 4-inch square (101.6 mm square), 2-1/8 inch (54 mm) deep electrical box. An optional surface mount Lexan enclosure shall be provided where required.

B. Addressable Manual Fire Alarm Box (Manual Station):

1. All operated stations shall have a positive, visual indication of operation and utilize a key type reset.
2. Manual fire alarm boxes shall be constructed of Lexan with clearly visible operating instructions provided on the cover. The word FIRE shall appear on the front of the stations in raised letters, 1.75 inches (44 mm) or larger

3. Built-in bicolor LED, which is visible through the handle off the station, flashes in normal operation and latches steady red when in alarm.
 4. Handle latches in down position and the word "ACTIVATED" appears to clearly indicate the station has been operated.
 5. Captive screw terminals wire-ready for easy connection to SLC loop (accepts up to 12 AWG/3.25 mm² wire).
 6. Surface mounted manufacturer box or semi flush mounted. to a standard single gang, double-gang, or 4" square electrical box.
 7. Smooth dual-action design.
 8. Must meet ADAAG controls and operating mechanisms guidelines(Section 4.1.3[13])
 9. Must meet ADA requirement for 5 lb. maximum activation force.
 10. Must Include Braille text on station handle.
 11. Provide trim ring where required for finished appearance.
 12. Must meet UL 38, Standard for Manually Actuated Signaling Boxes.
 13. Shell, door, and handle are molded of durable polycarbonate material with a textured finish.
 14. Temperature Range: 32°F to 120°F (0°C to 49°C)
 15. Relative Humidity: 10% to 93% (noncondensing)
 16. Manual stations shall connect with two wires to one of the control panel SLC loop
 17. The manual station shall, on command from the control panel, send data to the panel representing the state of the manual switch.
 18. Manual stations shall provide address setting by use of rotary decimal switches.
 19. Provide hinged Lexan cover in gymnasiums and other areas subject to damage.
- C. Photoelectric Smoke Detector:
1. The detectors shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density.
 2. Features
 - a. Sleek, low-profile design.
 - b. Addressable-analog communication.
 - c. Noise immunity.
 - d. Low standby current.
 - e. Two-wire SLC connection.
 - f. Remote Single-gang LED accessory.
 - g. Dual LED design providing 360° viewing angle.
 - h. Visible bi-color LEDs blink green every time the detector is addressed, and illuminate steady red on alarm
 - i. Remote test feature from the panel.
 3. Walk test with address display (an address on 121 will blink the detector LED: 12- [pause]-1
 4. Built-in functional test switch activated by external magnet.

5. Built-in tamper-resistant feature.
 6. Sealed against back pressure.
 7. Constructed of off-white fire-resistant plastic, designed to commercial standards, and offers an attractive appearance. 94-5V plastic flammability rating.
 8. SEMS screws for wiring of the separate base.
 9. Optional relay, isolator, and sounder bases. (Provide as required by field conditions)
 10. Specifications
 - a. Sensitivity: 0.5% to 2.35% per foot obscuration
 - b. Size: 2.1" (5.3 cm) high; base determines diameter.
 - c. 6-6.5" diameter.
 - d. Shipping Weight: 5.2oz. (147g).
 - e. Operating Temperature range: Normal (32°F to 120°F).
 - f. Low temperature (-4°F to 158°F).
 - g. UL/ULC Listed Velocity Range: 0-4000 ft/min. (1219.2 m/min.), suitable for installation in ducts.
 - h. Relative Humidity: 10%-93% noncondensing.
 - i. Thermal Ratings: Fixed-temperature setpoint 135°F (57°C).
 11. Voltage Range: 15-32 volts DC peak.
 12. Standby Current (max. avg.): 300μA @ 24VDC (one communication every five seconds with LED enabled).
 13. LED Current (max.): 6.5mA @ 24 VDC ("ON").
- D. Intelligent Thermal (Heat) Detectors:
1. State-of-the-art thermistor technology for fast response.
 2. Provide rate of rise and fixed temperature type detectors. Refer to drawings for types. Detectors are rate of rise unless noted with a fixed temperature:
 - a. Rate-of-rise model 15°F (8.3°C) per
 - b. Fixed temperature model at 135°F (57°C);
 - c. High-temperature model fixed at 190°F (88°C).
 3. Two-wire SLC connection.
 4. Visible LEDs "blink" every time the unit is addressed
 5. 360°-field viewing angle of the visual alarm indicators (twobi-color LEDs). LEDs blink green in Normal condition and turn on steady red in Alarm.
 6. Integral communications and built-in device-type identification.
 7. Remote test feature from the panel.
 8. Built-in functional test switch activated by external magnet.
 9. Walk test with address display (an address of 121 will blink the detector LED 12-(pause)-1).
 10. Designed for direct-surface or electrical-box mounting.
 11. Sealed against back pressure.
 12. Separate base that allows interchange of photoelectric, ionization and thermal sensors.
 13. Constructed of off-white fire-resistant plastic, with 94-5V plastic

flammability rating.

14. Detector spacing: UL approved for 50 ft. (15.24 m) center to center. FM approved for 25 x 25 ft. (7.62 x 7.62 m) spacing.

E. Photoelectric Duct Smoke Detector:

1. Coordinate exact location sampling tube installation with HC.
2. Where detectors are installed above ceilings or above 10 ft. in exposed locations provide a remote test station installed flush in ceiling below or in on accessible wall in mechanical space.
3. Based on Photoelectric, integrated low-flow technology.
4. Air velocity rating from 100 ft/min to 4,000 ft/min (0.5).
5. Operating temperature (-4°F to 158°F, 20°C to 70°C) and humidity (0% to 95% non-condensing).
6. Cover tamper signal.
7. Available space within housing to accommodate mounting of a relay module.

F. Addressable Dry Contact Monitor Module:

1. Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional alarm initiating devices (any N.O. dry contact device) to one of the fire alarm control panel SLCs.
2. The IDC zone shall be suitable for Style D or Style B operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.
3. For difficult to reach areas, the monitor module shall be available in a miniature package and shall be no larger than 2-3/4 inch (70 mm) x 1-1/4 inch (31.7 mm) x 1/2 inch (12.7 mm). This version need not include Style D or an LED.
4. For multiple dry contact monitoring a module shall be available that provides (10) Style B or (5) Style D input circuits.

G. Two Wire Detector Monitor Module:

1. Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional 2-wire smoke detectors or alarm initiating devices (any N.O. dry contact device).
2. The IDC zone may be wired for Class A or B (Style D or Style B) operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.
3. For multiple 2-wire smoke detector circuit monitoring a module shall be available that provides (6) Style B or (3) Style D input circuits.

H. Beam Smoke Detector

1. Single-ended reflective design with Listed to UL 268
2. Transmitter/receiver built into same unit.

3. Alignment is easily accomplished with an optical sight and a two-digit signal strength meter incorporated into the beam detector.
 4. Listed for operation from -22°F to 131°F,
 5. Six user-selectable sensitivity levels.
 6. 16' to 328' protection range.
 7. Digital display — no special tools required.
 8. Built-in automatic gain control compensates for signal deterioration from dust buildup.
 9. Provide with remote test station.
 10. Provide with I heater kits for prevention of condensation where environment requires
 11. Cover shall be Paintable.
- I. Carbon Monoxide Detection:
1. Detector shall be used to UL 2075 for gas and vapor detectors and sensors. Unit to be equipped with sounder and trouble relay. Provide dual color LED indication which blinks to indicate normal standby, alarm or end of life. Unit shall send a supervisory signal to the Central Monitoring Station. Unit operating voltage 12/24 VDC, 85 dB alarm signal. Provide fire alarm system monitor module to enable the detector to be addressable. Design make: System Sensor C01224T.
 2. Notification combination Horn/Strobe shall be used to UL 2075 for CO applications and NFPA 720 for CO (T4) alarm. Unit shall be equipped with red "CO" lettering, white housing and amber strobe lens. Unit shall be interconnected to associated CO detector within the first space served by the CO producing source. Provide trouble relay as required for interconnection. Unit operating voltage 24 VDC, 85 dB alarm signal.
- J. Natural Gas Detection:
1. Detector shall be used to UL 2075 for natural. Unit to be equipped with sounder and trouble relay. Provide dual color LED indication which blinks to indicate normal standby, alarm or end of life. Unit shall send a supervisory signal. Unit operating voltage 12/24 VDC, 85 dB alarm signal.
 2. Notification combination Horn/Strobe shall be used to UL 2075 for natural gas applications and NFPA 720 for alarm. Unit shall be equipped with red "NG" lettering, white housing and green strobe lens. Unit shall be interconnected to associated natural gas detector within the first space served by the natural gas producing source. Provide trouble relay as required for interconnection. Unit operating voltage 24 VDC, 85 dB alarm signal.
- K. VRF Refrigerant Leak Detection:
1. Detector shall be used to UL 2075 for refrigerant gas detectors and sensors. Unit to be equipped with sounder and trouble relay. Provide dual color LED

indication which blinks to indicate normal standby, alarm or end of life. Unit shall send a supervisory signal. Unit operating voltage 12/24 VDC, 85 dB alarm signal.

2. Notification combination Horn/Strobe shall be used to UL 2075 for natural gas applications and NFPA 720 for alarm. Unit shall be equipped with red "NG" lettering, white housing and red strobe lens. Unit shall be interconnected to associated natural gas detector within the first space served by the natural gas producing source. Provide trouble relay as required for interconnection. Unit operating voltage 24 VDC, 85 dB alarm signal.

L. Mass Notification Pushbutton:

1. Provide emergency warning button with red mushroom style button.
2. Button shall release magnetic door holds, play pre-recorded message on speakers and initiate alert strobes and displays MONITOR AND RELAY MODULES

M. Addressable Control Module:

1. Addressable control modules shall be provided to supervise and control the operation of one conventional NACs of compatible, 24 VDC powered, polarized audio/visual notification appliances.
2. The control module NAC may be wired for Style Z or Style Y (Class A/B) with a current rating of 2 Amps for Style Z and 3 Amps for Style Y.
3. Audio/visual power shall be provided by a separate supervised circuit from the main fire alarm control panel or from a supervised UL listed remote supply.
4. For multiple circuit control a module shall be available that provides (6) Style B or (3) Style D control circuits.

N. Addressable Releasing Control Module:

1. An addressable Flash Scan releasing module shall be available to supervise and control compatible releasing agent solenoids.
2. The module shall operate on a redundant protocol for added protection.
3. The module shall be configurable for Style Z or Style Y (Class A/B) and support (1) 24 volt or (2) 12 volt solenoids.

O. Addressable Relay Module:

1. Addressable Relay Modules shall be available for HVAC control and other network building functions. The module shall provide two form C relays rated at up to 3 Amps resistive and up to 2.0 Amps inductive. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure that 100% of all auxiliary devices energize at the same time on the same pair of wires.
2. For multiple relay control a module shall be available that provides (6) programmable Form-C relays.

P. Isolator Module:

1. Isolator modules shall be provided to automatically isolate wire-to-wire short circuits on an SLC Class A or Class B branch. The isolator module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the SLC loop segment or branch. At least one isolator module shall be provided for each floor or protected zone of the building.
2. If a wire-to-wire short occurs, the isolator module shall automatically open-circuit (disconnect) the SLC. When the short circuit condition is corrected, the isolator module shall automatically reconnect the isolated section.
3. The isolator module shall not require address-setting, and its operations shall be totally automatic. It shall not be necessary to replace or reset an isolator module after its normal operation.
4. The isolator module shall provide a single LED that shall flash to indicate that the isolator is operational and shall illuminate steadily to indicate that a short circuit condition has been detected and isolated.

2.14 MAGNETIC DOOR HOLDERS

- A. Door portion has pivotal mounted stainless-steel armature with shock-absorbing nylon bearing. 25 lbs. of holding force. Door holder to release in an alarm condition. Semi flush mounting, 24 VDC.

2.15 KNOX BOX

- A. Provide surface mount, black, stainless steel door hinged key box. Mount box 6'-0" above finished grade. Design make: Knox-Box 3200 series.

2.16 CABLE

- A. Provide cable as called for by the system manufacturer. Minimum speaker cable size 18/2 twisted shielded pair.

2.17 BATTERIES

- A. Provide battery and charger to provide 24 VDC standby power for the fire alarm system.
- B. Provide lead-calcium maintenance free batteries. Size batteries to permit (24) hours under supervisory condition and then sound all alarms for (5) minutes.
- C. Cell reversal protection.
- D. (10) year minimum life expectancy.
- E. Battery charger shall be self-regulating, solid-state type, capable of full charging a depleted battery within (5) hours.

- F. Install battery charger within the fire alarm control panel.
- G. Install batteries with fire alarm control panel or in a vented enclosure located adjacent to the fire alarm control panel.

PART 3 - EXECUTION

3.1 PRE-INSTALLATION MEETINGS

- A. Prior to beginning work and providing submittals, schedule a meeting(s) with the school district, engineer and construction manager to discuss the overall system performance and configuration. At a minimum outline the following:
 - 1. Public Address zones and wiring requirements
 - 2. Exact "Blue Light Locations"
 - 3. .WAV files to be used for specific announcement and alarm types
 - 4. Exact location of all control equipment. (fire alarm control panel, remote paging stations, annunciators, display panels, NAC and amplifier cabinets, etc.)
 - 5. Exact requirements for connection to the VoIP and security systems.
 - 6. Required Speaker taps.
- B. At the completion of the meeting provide minutes to all in attendance documenting the decisions made. Obtain a sign off from the school district acknowledging the discussion and decision documented in the minutes.

3.2 GENERAL INSTALLATION

- A. The location of the main equipment on plans is approximate verify the exact locations of all major equipment with the owner at the pre-installation meeting.
- B. Provide ceiling tile replacement within Corridors as required to accommodate Smoke Detector and speaker removals. Contractor may relocate existing tiles or utilize previous locations as long as Detectors are spaced 30'-0" on center and within 15'-0" away from ends of Corridors and within 21'-0" away from walls in large assembly spaces.
- C. Install manual station with operating handle 4'-0" above floor. Install audible and visual signal devices 6'-8" above floor.
- D. Automatic Detector/Digital Communicator Installation: Conform to NFPA 72E.

- E. Support cables to building structure. Supporting to ductwork, conduit, or lying on the ceiling tile is unacceptable.
- F. In exposed areas, fire alarm cable shall be routed in EMT conduit or surface wire way as applicable.
- G. Provide steel wire guards at all exterior notification devices as well as in gymnasiums, multipurpose rooms and locker rooms.
- H. During installation and testing, and prior to the system being put into service, all manual stations shall be appropriately marked "NOT IN SERVICE" by the Contractor.
- I. Wiring to all initiation and signal circuits shall be two wire Class B. A fault on a circuit loop shall cause a trouble alarm to initiate for its associated loop at the fire alarm control panel.
- J. All wiring shall conform to N.E.C. Articles 725 and 760, and to NFPA-72, "National Fire Alarm Code".
- K. All surface mounted devices shall be mounted on a special box furnished by fire alarm equipment manufacturer. Total assembly shall be secure, smooth contour and have no protrusions.
- L. Where detectors are installed on wood or masonry surfaces, attach brackets directly to the surface with tamperproof fasteners. Where detectors are installed on suspended ceilings, provide additional supports in the ceiling, such as channel support system, angle iron or additional runner bars. Fasten the additional supports rigidly to the ceiling runner bar system. Attach bracket to the supports with tamperproof fasteners. Install metal spacers between the bracket and supports so that the ceiling tiles will not be a part of the support system.
- M. Mount FACP and all sub panels at working height.
- N. Audible/Visible Device Installation:
 - 1. Devices shall be installed at 80" minimum above the floor, or 6" below the ceiling, whichever is lower, in accordance with ADA guidelines.
 - 2. Audible devices intended for operation in public spaces shall have a sound level of not less than 75 dBA at 10', nor more than 110 dBA at the minimum hearing distance from the device.
 - 3. All audible emergency alarm signals shall be at least 15 dbA over the existing sound level within a space or shall exceed the maximum sound level by 5 dbA for at least 60 seconds, whichever is louder. Within areas occupied by persons with hearing impairments, audible emergency alarms must have the intensity and frequency to provide notification of an alarm condition.

O. Wiring:

1. Wiring shall be in accordance with National Electric Code
2. All exposed wiring shall be installed in conduit or surface raceway. Existing conduit if acceptable may be used. Fire rated cabling may be run above accessible ceilings. Cable in mechanical rooms, crawl spaces and exterior shall be run in conduit.
3. All wiring not in conduits shall be plenum rated and fire rated and installed in a separate bridge ring raceway system, located on 4' centers.
4. Underground conduit shall be Schedule 40, PVC at 24", minimum, below grade. Risers from underground conduits to exterior devices shall be rigid steel. Underground conduits shall be 3/4 inch trade size, minimum. A separate ground wire shall be pulled and properly terminated when PVC conduit is used.
5. Conduit to PIV's and backflow preventers shall be run in sprinkler supply piping trench. Work shall be coordinated with fire sprinkler subcontractor.
6. Wire and cable shall be #14 AWG size, solid copper, THHN/TWN for horns, manual stations, smoke or heat detectors, water flow switches, valve supervisory switches and other initiating and indicating devices. Communication loop wiring shall be shielded in accordance with the Manufacturer's recommendations
7. Wiring shall be continuous from device to device. Splicing shall be accomplished by use of terminal blocks in locked cabinets keyed alike with the fire alarm control unit, or junction boxes. No connections or splices shall be made underground.
8. Control cabinets shall not be used as pull boxes or raceways. Wiring gutters and locked terminal cabinets shall be used.
9. The fire alarm system wiring shall be installed in a workmanlike manner, subject to the approval of the project manager.
10. All harnessing of wires shall be accomplished by use of approved nylon tie wraps.
11. All wiring shall be numbered and color coded in accordance with this specification.
12. Tests of all wiring shall be conducted for proper connection, continuity, and resistance to ground. The minimum allowable resistance between any two conductors or between conductors and ground is (1) megohm as checked by a "megger" after all conduit, conductors, detector bases, etc. have been installed, but before the detector devices are plugged into the base or end-of-line devices installed.

P. Routing:

1. All fire alarm system conduits shall be provided either parallel or perpendicular to building structural members.
2. All fire alarm system conduits shall be provided at a height so as not to obstruct any portion of a window, doorway, stairway, or a passageway, and

shall not interfere with the operation of any existing mechanical or electrical equipment.

3. All fire alarm system conduits and cable shall be routed to minimize the potential for physical damage, either mechanical or by fire.
4. All fire alarm system junction boxes, pull boxes, terminal cabinets, control enclosures and device back boxes shall be readily accessible for testing, service and maintenance.

Q. Wall, Floor and Ceiling Penetrations:

1. All conduit penetrations of walls shall be provided with escutcheon plates on either side of the wall.
2. All conduit penetrations of walls, floors, and ceiling shall be sealed around the conduits, restoring the walls, floors and ceilings to their original condition, fire resistance and integrity.

R. Terminations:

1. All fire alarm conductor terminations shall be on numbered terminals or terminal strips. All fire alarm conductor terminations shall be within junction boxes, device back boxes, terminal cabinets, control panels or other suitable metal enclosures. Terminals and terminal strips shall be suitable for the size and number of conductors connected to them.
2. All connections and end-of-line devices shall be accessible for inspection, testing and servicing.
3. Terminations to terminals other than barrier/pressure plate type terminals shall use crimp-on ring-type or Y-type spade connectors
4. Splices shall be permitted only when routing of existing conductors prohibits point-to-point terminations in existing junction boxes, terminal cabinets, etc. All such splices shall be provided with new terminal strips with proper labeling in junction boxes, terminal cabinets, etc.

S. Control Panel Location and Wiring:

1. Install annunciator panel in the main lobby/F.D. Point of Entry if the control panel is located in an area other than the main lobby/F.D. Point of Entry.
2. All control panel wiring shall be fully dressed and bundled with nylon tie wraps. Bundled wiring shall be routed parallel to terminal strips within control panels, with individual conductors turned out at 90 degree angles to their associated terminal connections. AC power conductors shall be bundled and routed separately from low voltage conductors. A minimum 2-inch separation shall be maintained between AC power conductors and low voltage conductors wherever possible. All control cabinets shall be sized to accommodate the requirements of this section.
3. Each conductor terminating within a control panel shall be uniquely numbered with durable plastic tags or uniquely identifiable by a combination of numbers and color codes. These conductor numbers shall be shown on the record (As-Built) drawings in a manner allowing ready

identification of any field wiring conductor in any control panel.

- T. Mounting and Labeling of Devices:
 - 1. All fire alarm devices shall be rigidly mounted, using appropriate back boxes, to building structural members, permanent walls, ceilings or fixtures designed for the purpose.
 - 2. All devices shall be labeled with device address or device count as appropriate. Label shall be sticky back type attached to base of device. Label identification shall be consistent with As-Built drawings.
- U. Color Coding and Wire Numbering:
 - 1. All conductors entering and leaving terminal cabinets and junction boxes shall be numbered in a logical and consecutive manner.
 - 2. All conductors shall be color coded. Color coding shall be by wire insulation, not taping or banding. The numbering and color coding shall be continuous for each circuit wire.
 - 3. Wires shall be numbered at each connection, termination, and junction point. Wire numbering tags shall be Brady Perma-Code, Westline, or equal.

3.3 INTERRUPTIONS TO EXISTING FIRE ALARM SYSTEM

- A. General:
 - 1. Do not remove any portion of the existing fire alarm system from operation while installing new work without written approval of the Project Manager.
 - 2. Pupil occupied spaces must have existing systems maintained during school operation.
 - 3. In order to accomplish the above requirements, temporary wiring and relocations of some existing and/or new equipment will be necessary. These temporary locations must be approved by the project manager and arranged so as to avoid safety problems.
 - 4. Provide a temporary connection between existing and new panels as required for project phasing.

3.4 PUBLIC ADDRESS AND EMERGENCY COMMUNICATIONS

- A. All information for the system wiring shall be supplied by the manufacturer.
- B. The drawings are schematic. The system manufacturer shall incorporate their wiring requirements on the system drawings. The contractor shall be responsible, in conjunction with the system manufacturer for complete wiring requirements and conduit sizes.
- C. Provide amplifier quantities as required to handle all connected speakers and

20% future capacity.

- D. Prior to beginning work meet with the Owner and discuss zone cabling and programming options. Make adjustments as required by the owner and provide daisy chained speaker zones as called for by the owner.
- E. Install all devices shown on plan. Verify the exact location of all devices on architectural ceiling plans and elevations or with existing construction. If a mounting height is not called for on the plans, verify the height prior to roughing the back box.
- F. Install PA system cabling may be installed in the following pathways:
 - 1. In open top cable hangers 4 feet on center above ceilings that do not contain ACBM.
 - 2. Existing raceway and conduit sleeves installed for the original system
 - 3. In surface raceway in exposed locations in finished classrooms, offices, conference, break rooms, and corridors.
 - 4. In conduit in mechanical areas such as the boiler room and fan rooms.
- G. Where surface raceway is required, paint to match existing walls.
- H. Connect the speakers to operate at the following wattages:
 - 1. Classrooms, Offices and Libraries: 1 watt.
 - 2. Exterior: 6- 8 watts.
 - 3. Gymnasiums and Auditoriums: 6-8 watts
 - 4. Corridors: 2 watts.
- I. After system has been completely tested, "dress out" the central equipment rack. Neatly bundle all cable with nylon cable. Provide sufficient loop in the cable bundle to allow moving the cabinet away from wall for maintenance, repairs and additions.
- J. Provide volume control dials as indicated on the drawings.
- K. Upon completion of the system installation, it shall be the responsibility of the Contractor to perform the necessary adjustments and balancing of all signals and amplifier level controls to insure proper system operation.
- L. The system shall be physically inspected by the Owner's representative and the Architect/Engineer to assure that all equipment is installed in a neat and workmanlike manner as called for in the plans and specifications.
- M. As a minimum requirement, the internal intercommunication system should be tested to prove the following:
 - 1. The complete sound system is free from grounds, opens and shorts.

2. Each device function as specified herein.
 3. Proper adjustment of all speaker taps to provide clearly audible, but unobtrusive paging in all areas.
- N. Fill out test report at the end of this section.
- O. The Contractor shall be responsible for minor system adjustments such as tap changes, signal balancing, etc., for a period of one year after system acceptance. Respond to a call from the Owner within 48 hours. These adjustments shall be performed at no additional cost to the Owner

3.5 TEST

- A. Before final acceptance of the system, the Contractor, in the presence of the Owner's representative, shall test each and every component and device in the system. Test shall be documented with signed copy submitted to the Owner and Architect/Engineer.
- B. The service of a competent, factory-trained engineer or technician authorized by the manufacturer of the fire alarm equipment shall be provided to technically supervise and participate during all of the adjustments and tests for the system. All testing shall be in accordance with NFPA 72, Chapter 7.
1. Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.
 2. Close each sprinkler system flow valve and verify proper supervisory alarm at the FACP.
 3. Verify activation of all water flow switches.
 4. Open initiating device circuits and verify that the trouble signal actuates.
 5. Open and short signaling line circuits and verify that the trouble signal actuates.
 6. Open and short notification appliance circuits and verify that trouble signal actuates.
 7. Ground all circuits and verify response of trouble signals.
 8. Check presence and audibility of tone at all alarm notification devices.
 9. Check installation, supervision, and operation of all intelligent smoke detectors using the walk test.
 10. Each of the alarm conditions that the system is required to detect should be introduced on the system. Verify the proper receipt and the proper processing of the signal at the FACP and the correct activation of the control points.
 11. When the system is equipped with optional features, the manufacturer's manual shall be consulted to determine the proper testing procedures. This is intended to address such items as verifying controls performed by individually addressed or grouped devices, sensitivity monitoring,

verification functionality and similar.

12. When the system is equipped with a Voice Evacuation Control panel, the manufacturer's manual shall be consulted to determine the proper testing procedures. This is intended to address such items as verifying voice messages.
13. Public address paging functionality and zones

- C. If system does not function properly schedule a second test within two weeks.

3.6 REMOVAL OF EXISTING CABLE AND EQUIPMENT

- A. After the new system has been completely tested and certified by the owner and engineer completely remove and dispose all existing cabling and equipment. Patch any openings and paint where exposed.

END OF SECTION 2831112

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SECTION 31 00 00 – SITE CLEARING

PART 1 GENERAL

1.1 This Section includes:

- A. Protecting existing trees and vegetation to remain.
- B. Removal of trees, shrubs, designated plant life and vegetation.
- C. Removal of topsoil and subsoil, rough grading, and site contouring.
- D. Clearing and grubbing.
- E. Temporary erosion and sedimentation control measures.
- F. Removal of above and below grade improvements and surface debris.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Section 31 20 00: Excavation and Fill
- C. Section 31 25 13: Erosion and Sediment Control

1.3 DEFINITIONS

- A. Topsoil: Natural or cultivated surface-soil layer containing organic matter and sand, silt, and clay particles; 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 more than 2 inches in diameter; and free of subsoil and weeds, roots, toxic materials, or other non-soil.
- B. Clearing: Removal of trees, shrubs, bushes, and other organic matter found at or above original ground level.
- C. Remove: Remove existing items from site and legally dispose of them off-site, unless indicated to be removed and reinstalled. Removal shall be completed daily.
- D. Existing to Remain: Existing items that are not to be removed and that are not otherwise indicated to be removed or removed and reinstalled.

1.4 SUBMITTALS

- A. Pre-Construction photographs sufficiently detailed, of existing conditions of trees, adjoining construction, and site improvements. Submit before work begins.
- B. Submit schedule indicating proposed trees to be removed or trimmed to Owner and Owner's Representative for review prior to commencement of work.

1.5 PROJECT 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 the Owner and authorities having jurisdiction.
 - 2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
 - 3. Provide clear and appropriate signage for alternate routes and proper notice to people.
- B. Maintain access to existing adjacent areas of the building, walkways, roads, and other adjacent occupied or used facilities.
 - 1. This is an active facility and phasing of the work will be required and with agreement of Owner to minimize disruptions to the existing operations.
 - 2. Do not close or obstruct adjacent areas of the building, walkways, roads, or other occupied or used facilities without agreement with the Owner and written permission from authorities having jurisdiction.
- C. Utility Locator Service: Notify utility locator service (Dig Safely New York – 811 or 800-962-7962) or retain services of a private utility locating firm for area where Project is located before site clearing.
- D. Hazardous Materials:
 - 1. If materials suspected of containing hazardous materials are encountered, do not disturb; immediately notify Owner's Representative and Owner. Hazardous materials shall be removed as per the characterization of hazard and disposed of in accordance with NYSDEC requirements.
- E. Storage of removed items or materials on-site will not be permitted, unless indicated to be removed and stockpiled on site.
- F. Utility Service: Maintain existing utilities in service and protect them against damage during selective demolition operations.
- G. Do not commence site clearing and demolition operations until temporary erosion and sedimentation control measures are in place.

1.5 DELIVERY AND STORAGE

- A. Deliver and store materials in a manner to prevent contamination or segregation.

1.6 QUALITY ASSURANCE

- A. Comply with hauling and disposal regulations of authorities having jurisdiction.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.1 PREPARATION AND PROTECTION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction. Damaged or lost benchmark, monuments and survey control points shall be replaced by a licensed New York State Registered Land Surveyor at the Contractor's expense.
- B. Survey existing conditions and correlate with requirements indicated to determine extent of selective demolition required.
- C. Protect existing site improvements to remain from damage during construction.
 - 1. Restore damaged improvements to their original condition, as acceptable to Owner.
- D. Identify trees to be removed and trimmed and confirm with Owner and Engineer prior to any demolition.
- E. When unanticipated conflicts with intended function or design are encountered, investigate, and measure the nature and extent of conflict. Promptly submit a written report to Engineer.
- F. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with adjacent areas of the building, roads, streets, walks, walkways, and other adjacent occupied and used facilities.
 - 1. Do not close or obstruct adjacent areas of the building, streets, walks, walkways, 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 governing regulations.
 - 2. Erect temporary protection, such as walks, ramps, fences, and railings where required to permit safe passage of people and vehicles.
 - 3. Protect existing building elements, appurtenances, and items to remain.
- G. Identify and protect existing utilities.
- H. Tree Protection: Erect and maintain a temporary fence around drip line of individual trees or around perimeter drip line of groups of trees to remain. Remove fence when construction is complete.
 - 1. Do not store construction materials, debris, or excavated material within drip line of remaining trees.
 - 2. Do not permit vehicles, equipment, or foot traffic within drip line of remaining trees.
 - 3. Do not excavate within drip line of trees, unless otherwise indicated.
- I. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people, damage to buildings and facilities to remain.
 - 1. Provide protection to ensure safe passage of people around selective demolition area.

3.2 CLEARING AND GRUBBING

- A. Install erosion control measures at the limits of clearing and grubbing or as indicated on the Contract Drawings prior to commencement of clearing and grubbing. Repair and or replace erosion control devices immediately if damaged during clearing and grubbing.
- B. Remove obstructions, grass, and other vegetation to permit installation of new construction. Removal includes digging out stumps and obstructions and grubbing roots.
- C. Do not remove trees, shrubs, and other vegetation unless indicated to be removed.
- D. Completely remove stumps, roots, obstructions, and debris extending to a depth of 18 inches below exposed subgrade.
- E. Carefully grub within drip line of remaining trees.
- F. 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 8-inch loose depth and compact each layer to a density equal to adjacent original ground.

3.3 TOPSOIL STRIPPING

- A. Remove sod and grass before stripping topsoil.
- B. Strip topsoil to whatever depths is encountered in a manner to prevent intermingling with underlying subsoil or other waste materials.
 - 1. Remove subsoil and non-soil materials from topsoil, including trash, debris, weeds, roots, and other waste materials.
- C. Stockpile topsoil materials away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust. Provide temporary erosion and sediment control measures as indicated on the Contract Drawings.
 - 1. Limit height of topsoil stockpiles to 72 inches.
 - 2. Do not stockpile topsoil within drip line of remaining trees.
 - 3. Stockpile surplus topsoil and allow for respreading deeper topsoil
 - 4. Dispose of unused topsoil at the end of the project as specified for waste material disposal.

3.4 TREE/STUMP REMOVAL

- A. Removal:
 - 1. Remove tree, stump, and root system in entirety.
 - 2. Remove material from the site daily.
 - 3. Dispose at authorized facility.

B. Restoration

1. Place fill, rough grade area and restore to existing conditions

3.5 REMOVAL AND DISPOSAL

A. Removal:

1. 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.
2. Remove material from the site daily.
3. Dispose at authorized facility.

B. Burning: Do not burn demolished materials.

C. Disposal: Transport demolished materials off Owner's property and legally dispose of them.

D. Dumping: No dumping shall be allowed in any stream, corridor, wetlands, surface waters, or at unspecified locations or at locations not approved by the Engineer or regulatory agencies.

E. Leave Work area in a neat and uncluttered condition.

3.5 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and as necessary to facilitate new construction. The Contractor shall temporarily relocate existing mailboxes, road signs, fences, landscaping, etc. during construction and re-install them at their original location once the work is completed.

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 length of existing pavement, slabs, sidewalks, curbs, and gutters to remain before removing existing pavement. Saw-cut faces vertically.

3.6 ROUGH GRADING

A. Identify required lines, levels, contours, and datum.

B. Identify known underground, above ground, and aerial utilities. Stake and flag locations.

C. Notify utility companies to paint out utility locations.

D. Excavate topsoil and subsoil from areas to be further excavated, re-landscaped, or re-graded.

E. Stockpile topsoil and subsoil in designated area(s).

END OF SECTION 31 00 00

SECTION 31 20 00 – EXCAVATION AND FILL

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes:
 - 1. Preparing subgrades for structures, walks, pavements, grasses, and plants.
 - 2. Subbase course for concrete slabs, walks and asphalt pavement.
 - 3. Excavating and backfilling trenches for utilities and structures.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Contract Plans and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Section 31 00 00: Site Clearing
- C. Section 32 90 00: Topsoil & Seeding

1.3 DEFINITIONS

- A. Earth Excavation: The removal of all surface and subsurface material not classified as rock as defined below.
- B. Unsatisfactory Soil: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487, or a combination of these groups. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction. Soil that may contain rock or gravel larger than 3 inches in any dimension, frozen materials, organic matter vegetation, soft, nondurable particles, elongated particles, or other deleterious matters.
- C. Contaminated Soil: Soil that may require specific disposal method/location as it may contain items such as but not limited to trace/detect chemical, oil or soft or loose bituminous asphalt tar.
- D. Construction Debris Soil: Soil containing debris, waste, rubbish, slag, cinders, ashes, metals, or other manmade or foreign materials.
- E. Rock: Limestone, sandstone, shale, granite, and similar material in solid beds or masses in its original or stratified position which can be removed only by blasting operations, drilling, wedging, or use of pneumatic tools, and boulders with a volume greater than 1.0 cu yd. Concrete building foundations and concrete slabs, not indicated, with a volume greater than 1.0 cu yd shall be classified as rock.
 - 1. Limestone, sandstone, shale, granite, and similar material in a broken or weathered condition which can be removed with an excavator or backhoe equipped with a bucket with ripping teeth or any other style bucket shall be classified as earth excavation.
 - 2. Masonry building foundations, whether indicated or not, shall be classified as earth excavation.

- F. Unclassified Earth Excavation: The excavation and disposal of all surface and subsurface materials of any description necessary to perform the work of this contract. This will include:
 - 1. All soil deposits of any description both above and below groundwater levels. These may be naturally deposited or placed by previous construction operations.
- G. Subgrade Surface: Surface upon which subbase or topsoil is placed.
- H. Subbase: Select granular material or subbase course Type 2 which is placed immediately beneath pavement or concrete slabs.
- I. Maximum Density: The dry unit weight in pounds per cubic foot of the soil at "Optimum Moisture Content" when determined by ASTM D 698 (Standard Proctor), or ASTM D 1557 (Modified Proctor).
- J. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
- K. Landscaped Areas: Areas not covered by structures, walks, roads, paving, or parking.
- L. Unauthorized Excavation: The removal of material below required elevation indicated on the Plans or beyond lateral dimensions indicated or specified without specific written direction by the Owner's Representative.
- M. Grading Limit Line (Shown on Plans): Limits of grading, excavations and filling required for the work of this contract. Unless specifically noted otherwise, the Grading Limit Line and Contract Limit Line will be considered the same.

1.4 SUBMITTALS

- A. Product Data:
 - 1. Filter Fabric: Manufacturer's catalog sheets, specifications, and installation instructions.
 - 2. Geogrid: Manufacturer's catalog sheets, specifications, and installation instructions.
- B. Quality Control Submittals:
 - 1. Subbase Materials: Material Test Reports: Classification according to ASTM D 2487, laboratory compaction curve according to ASTM D1557 and certified gradation analysis according to ASTM C136 for each soil material proposed for fill and backfill. Name and location of source and the DOT Source Number.
 - 2. Other Aggregates: Name and location of source and soil laboratory test results.

1.5 PROJECT CONDITIONS/COORDINATION AND SCHEDULING

- A. Existing Utilities:
 - 1. Coordinate the work to determine the extent of the areas of subsurface investigation required to locate all underground utilities and service connections in the areas of excavation.
 - 2. Coordinate the work with the Owner and Owner's Representative to minimize utility disruptions and facility operations. Provide a schedule for the Work required to the Owner and Owner's Representative for approval. Upon approval of the schedule, notify

the Owner and Owner's Representative a minimum of three (3) working days prior to performing the Work.

3. Within the areas of excavation, all underground utilities and service connections shall be field located, and their locations marked at least two (2) weeks prior to the performance of the required excavation work.

B. Existing Conditions:

1. Protect existing trees and plants during performance of the work unless otherwise indicated. Box trees and plants indicated to remain within the grading limit line with temporary steel fencing or solidly constructed wood barricades as required. Protect root systems from smothering. Do not store excavated material or allow vehicular traffic or parking within the branch drip line. Restrict foot traffic to prevent excessive compaction of soil over root systems.
2. Dewatering: Include the disposal of surface water and ground water, which may accumulate in open excavations, unfinished fills, or other low areas. Remove water by pumping, or other methods to prevent softening of exposed surfaces. Surface dewatering plan shall include the rerouting of any storm water runoff or natural drainage if necessary and shall comply with NYS DEC requirements.
3. Protection and Restoration of Surfaces: Protect newly graded areas from traffic, erosion, and settlements. Repair and reestablish damaged or eroded slopes, elevations or grades and restore surface construction prior to acceptance. Protect existing streams, ditches and storm drain inlets from water-borne soil by means of straw bale dikes. Conduct work in accordance with NYS DEC requirements.

C. Cold Weather Requirements:

1. Excavation: When freezing temperatures are anticipated, do not excavate to the final required elevations for concrete work unless concrete can be placed immediately.
2. Backfilling: Do not backfill with any frozen soil materials.

- D. Thru-traffic or fill placement with heavy construction vehicles or equipment which causes rutting or weaving to occur within the perimeter of a building will not be permitted. If rutting or weaving occurs during placement of fill, place specified fill in a stable area outside building perimeter and spread with tracked equipment to specified layer thickness.

1.5 DELIVERY AND STORAGE

- A. Deliver and store materials in a manner to prevent contamination or segregation.
- B. Protect filter fabric from sunlight during transportation and storage.

1.6 QUALITY ASSURANCE

- A. Geotechnical Testing Agency Qualifications: Qualified according to ASTM E 329 and ASTM D 3740 for testing indicated.
- B. Routine testing of existing soils and compacted material for compliance with these Specifications shall be performed by a testing agency acceptable to Engineer.
- C. Compacted material that does not meet density requirements shall be removed and/or re-compacted and retested.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Select Granular Fill Material: Stockpiled, sound, durable, sand, gravel, stone, or blends of these materials, free from organic and other deleterious materials. Comply with the gradation and material requirements specified below:

Sieve		Percent Passing
Sieve Size	Size opening (mm)	
2 inch	50.0	100
No. 40	0.425	0-70
No. 200	0.075	0-15

1. Magnesium Sulfate Soundness Test: 20 percent maximum loss by weight after four test cycles.
2. Plasticity Index: The plasticity index of the material passing the No. 40 mesh sieve will not exceed 5.0.
3. Elongated Particles: Not more than 30 percent, by weight, of the particles retained on a 1/2-inch sieve will consist of flat or elongated particles. A flat or elongated particle is defined as one which has its greatest dimension more than three times its least dimension.

- B. NYSDOT Subbase Course Type 2: Stockpiled, crushed ledge rock or approved blast furnace slag. Comply with the gradation and material requirements specified below:

Sieve		Percent Passing
Sieve Size	Size opening (mm)	
2 inch	50.0	100
1/4 inch	6.3	25-60
No. 40	0.425	5-40
No. 200	0.075	0-10

1. Magnesium Sulfate Soundness Test: 20 percent maximum loss by weight after four test cycles.
2. Plasticity Index: The plasticity index of the material passing the No. 40 mesh sieve will not exceed 5.0.

3. Elongated Particles: Not more than 30 percent, by weight, of the particles retained on a 1/2-inch sieve will consist of flat or elongated particles. A flat or elongated particle is defined as one which has its greatest dimension more than three times its least dimension.
- C. NYSDOT #1 Crushed Stone: Clean, durable, sharp-angled fragments of rock of uniform quality. Comply with the gradation and material requirements specified below:

Sieve		Percent Passing
Sieve Size	Size opening (mm)	
1 inch	25.0	100
1/2 inch	12.5	90 – 100
¼ inch	6.3	0-15

1. Magnesium Sulfate Soundness Test: 18 percent maximum loss by weight after ten test cycles.
- D. NYSDOT #2 Crushed Stone: Clean, durable, sharp-angled fragments of rock of uniform quality. Comply with the gradation and material requirements specified below:

Sieve		Percent Passing
Sieve Size	Size opening (mm)	
1-1/2 inch	37.5	100
1 inch	25.0	90 – 100
1/2 inch	12.5	0-15

1. Magnesium Sulfate Soundness Test: 18 percent maximum loss by weight after ten test cycles.
- E. NYSDOT #1 Screened Gravel: Clean, durable gravel free from coatings. Comply with the gradation and material requirements specified below:

Sieve		Percent Passing
Sieve Size	Size opening (mm)	
1 inch	25.0	100
1/2 inch	12.5	90 – 100

Sieve		Percent Passing
Sieve Size	Size opening (mm)	
¼ inch	6.3	0-15

1. Magnesium Sulfate Soundness Test: 18 percent maximum loss by weight after ten test cycles.

- F. NYSDOT #2 Screened Gravel: Clean, durable gravel free from coatings. Comply with the gradation and material requirements specified below:

Sieve		Percent Passing
Sieve Size	Size opening (mm)	
1-1/2 inch	37.5	100
1 inch	25.0	90 – 100
1/2 inch	12.5	0-15

1. Magnesium Sulfate Soundness Test: 18 percent maximum loss by weight after ten test cycles.

- G. Underdrain Filter Type 2 (NYSDOT 605.10, 733-2002): Material consisting of crushed stone, sand, gravel, or screened gravel. Comply with the gradation and material requirements specified below:

Sieve		Percent Passing
Sieve Size	Size opening (mm)	
1/2 inch	12.5	100
1/4 inch	6.3	20 – 100
No. 10	2.0	0-15
No. 20	.85	0-5

1. Magnesium Sulfate Soundness Test: 20 percent maximum loss by weight after ten test cycles.

- H. Selected Borrow/Fill: Sound, durable, sand, gravel, stone, or blends of these materials, free from organic and other deleterious materials. Comply with the gradation requirements specified below:

Sieve		Percent Passing
Sieve Size	Size opening (mm)	
4 inch	101.6	100
No. 40	0.425	0-70
No. 200	0.075	0-15

- J. Suitable Material (Fill and Backfill for Landscaped Areas): Material consisting of mineral soil (inorganic), blasted or broken rock and similar materials of natural or man-made origin, including mixtures thereof. Maximum particle size will not exceed 2/3 of the specified layer thickness prior to compaction. NOTE: Material containing cinders, industrial waste, sludge, building rubble, land fill, muck, and peat will be considered unsuitable for fill and backfill, except topsoil and organic silt may be used as suitable material in landscaped areas provided it is placed in the top layer of the subgrade surface.
- K. Flowable Fill: Shall consist of a mixture of Portland cement, sand, water and admixtures proportioned to provide a non-segregating, free-flowing, self-consolidating material that will result in a hardened, dense backfill.
 - 1. Shall have a 28-day compressive strength between 40 and 100 psi.
- L. Bioretention Soil: Material consisting of sand and organic material free of stones, stumps, roots, or other woody material over 1-inch diameter.
 - 1. Shall be classified as a USDA sandy loam, loamy sand, loam, or a loan/sand mix (with 35%- 60% sand).
 - 2. Less than 25% USDA clay.
 - 3. Minimum permeability = 0.5 feet/day
 - 4. pH range: 5.2 – 7.6
 - 5. Organic content: 3-7%

2.2 GEOTEXTILE

- A. Pavement Section Geogrid: Tensar TriAx Geogrid or approved equivalent.
- B. Erosion Control: Filter X, Mirafi 100X, Stabilinka T140N or approved equivalent.
- C. Separation: Amoco 2002 & 2004, Contech Construction Products Inc. C-180, Synthetic Industries Geotex 250ST & 315ST, Mirafi Geolon HP570 & HP1500 or approved equivalent.

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.

3.2 CLEARING AND GRUBBING

- A. Clear and grub the site within the grading limit line of trees, shrubs, brush, other prominent vegetation, debris, and obstructions except for those items indicated to remain. Completely remove stumps and roots protruding through the ground surface.
 - 1. Use only hand methods for grubbing inside the drip line of trees indicated to be left standing.
 - 2. Where roots and branches of trees indicated to be saved interfere with new construction, carefully and cleanly cut them back to point of branching.
- B. Fill depressions caused by the clearing and grubbing operations in accordance with the requirements for filling and backfilling unless further excavation is indicated.

3.3 REMOVAL OF TOPSOIL

- A. Remove existing topsoil from areas within the Work Limit Line where excavation or fill is required.
- B. Stockpile approved topsoil where directed until required for use. Place, grade, and shape stockpiles for proper drainage.
 - 1. Topsoil will be tested prior to stockpiling. Stockpile only quantities of topsoil approved in writing for re-use.

3.4 UNDERGROUND UTILITIES

- A. Locate existing underground utilities prior to commencing excavation work. Determine exact utility locations by hand excavated test pits. Support and protect utilities to remain in place.
- B. Do not interrupt existing utilities that are in service until temporary or new utilities are installed and operational.
- C. Utilities to remain in service: Will be re-routed as shown on the Contract Plans.
- D. Utilities abandoned beneath and five feet laterally beyond the structure's proposed footprint will be removed in their entirety. Excavations required for their removal will be backfilled and compacted as specified herein.
- E. Utilities extending outside the five feet limit specified above may be abandoned in place provided their ends are adequately plugged as described below.
 - 1. Permanently close open ends of abandoned underground utilities exposed by excavations, which extend outside the limits of the area to be excavated.
 - 2. Close open ends of metallic conduit and pipe with threaded galvanized metal caps or plastic plugs or other approved method for the type of material and size of pipe. Do not use wood plugs.
 - 3. Close open ends of concrete and masonry utilities with concrete or flow-able fill.

3.5 EXCAVATION

- A. Excavate earth as required for the Work.

- B. Install and maintain all erosion and sedimentation controls during all earthwork operations as specified on the Contract Plans.
- C. Maintain sides and slopes of excavations in a safe condition until completion of backfilling. Comply with Code of Federal Regulations Title 29 - Labor, Part 1926 (OSHA).
 - 1. Trenches: Deposit excavated material on one side of trench only. Trim banks of excavated material to prevent cave-ins and prevent material from falling or sliding into trench. Keep a clear footway between excavated material and trench edge. Maintain areas to allow free drainage of surface water.
- D. Stockpile excavated materials classified as suitable material where directed, until required for fill. Place, grade, and shape stockpiles for proper drainage as approved by the Engineer.
- E. Excavation for Structures: Conform to elevations, lines, and limits indicated. Excavate to a vertical tolerance of plus or minus 1 inch. Extend excavation a sufficient lateral distance to provide clearance to execute the work.
- F. Slabs and Floors: Excavate to the following depths below bottom of concrete for addition of select granular material:
 - 1. Interior Floors: 6 inches unless otherwise indicated.
 - 2. Exterior Slabs and Steps: 12 inches unless otherwise indicated.
- G. Pipe Trenches: Open only enough trench length to facilitate laying pipe sections. Unless otherwise indicated on the Plans, excavate trenches approximately 24 inches wide plus the outside pipe diameter, equally divided on each side of pipe centerline. Cut trenches to cross section, elevation, profile, line, and grade indicated. Accurately grade and shape trench bottom for uniform bearing of pipe in undisturbed earth. Excavate at bell and coupling joints to allow ample room for proper pipe connections.
 - 1. Trench in Rock: Excavate an additional 6 inches below bottom of pipe for bed of cushion material under the piping.
- H. Open Ditches: Cut ditches to cross sections and grades indicated.
- I. Pavement: Excavate to subgrade surface elevation.
- J. Unauthorized Excavations: Unless otherwise directed, backfill unauthorized excavation under footings, foundation bases, and retaining walls with compacted select granular material without altering the required footing elevation. Elsewhere, backfill and compact unauthorized excavation as specified for authorized excavation of the same classification, unless otherwise directed by the Engineer.
- K. Notify the Owner's Representative upon completion of excavation operations. Do not proceed with the work until the excavation is inspected and approved. Inspection of the excavation by the Engineer will be made on three working days' notice.
- L. Removal of Unsuitable Material Beneath Structures and Other Improvements: Excavate encountered unsuitable materials, which extend below required elevations, to additional depth as directed by the Engineer. Have cross sections taken to determine the quantity of such excavation. Do not backfill this excavation prior to quantity measurement.

3.6 DEWATERING

- A. Prior to the performance of any excavations provide dewatering methods such that the groundwater table is maintained at an elevation that is beneath the excavated depth.
- B. Prevent surface and subsurface water from flowing into excavations and trenches and from flooding the site and surrounding area.
- C. Do not allow water to accumulate in excavations or trenches. Remove water from all excavations immediately to prevent softening of undercutting footings, and soil changes detrimental to the stability of subgrades. Furnish and maintain pumps, sumps, suction and discharge piping systems, and other system components necessary to convey the water away from the Site.
- D. Convey water removed from excavations, and rainwater, to collecting or run-off area. Cut and maintain temporary drainage ditches and provide other necessary diversions outside excavation limits for each structure. Do not use trench excavations as temporary drainage ditches.
- E. Provide temporary controls to restrict the velocity of discharged water as necessary to prevent erosion and siltation of receiving areas.

3.7 SUBGRADE SURFACE FOR WALKS AND PAVEMENT

- A. Shape and grade subgrade surface as follows:
 - 1. Walks: Shape the surface of areas under walks to required line, grade and cross section, with the finish surface not more than 1 inch above or below the required subgrade surface elevation.
 - 2. Pavements: Shape the surface of areas under pavement to required line, grade and cross section, with the finish surface not more than 1/2 inch above or below the required subgrade surface elevation.
- B. Grade Control: During construction, maintain lines and grades including crown and cross-slope of subbase course.
- C. Thoroughly compact subgrade surface for walks and pavement by mechanical rolling, tamping, or with vibratory equipment as approved to the density specified.

3.8 PLACING GEOTECH FABRIC

- A. Place and overlap geotech fabric in accordance with the manufacturer's installation instructions, unless otherwise shown.
- B. Cover tears and other damaged areas with additional fabric layer extending three feet beyond the damage.
- C. Do not permit traffic or construction equipment directly on fabric.
- D. Backfill over fabric within two weeks after placement. Backfill in accordance with the fabric manufacturer's instructions and in a manner to prevent damage to the fabric.

3.9 PLACING FILL AND BACKFILL

- A. Surface Preparation of Fill Areas: Strip topsoil, remaining vegetation, and other deleterious materials prior to placement of fill. Remove all asphalt pavement in its entirety from areas requiring the placement of fill or break up old pavements to a maximum size of four inches.

Prior to placement of fill, smooth out and compact areas where wheel rutting has occurred due to stripping or earthwork operations.

- B. Place backfill and fill materials in layers not more than eight inches thick in loose depth unless otherwise specified. Before compaction, moisten or aerate each layer as necessary to facilitate compaction to the required density. Do not place backfill or fill material on surfaces that are muddy, frozen, or covered with ice.
 - 1. Place fill and backfill against foundation walls, and in confined areas such as trenches not easily accessible by larger compaction equipment, in maximum six-inch-thick loose depth layers.
 - 2. For large fill areas, the layer thickness may be modified by the Engineer, at the Contractor's written request, if in the Engineer's judgment, the equipment used is capable of compacting the fill material in a greater layer thickness. This request will include the type and specifications of compaction equipment intended for use.
- C. Under Exterior Concrete Slabs and Steps:
 - 1. Up to Subgrade Surface Elevation: Place selected fill when fill or backfill is required.
 - 2. Subbase Material: Place 12 inches of select granular material over subgrade surface.
- D. Under Pavements and Walks:
 - 1. Up to Subgrade Surface Elevation: Place selected fill when fill or backfill is required.
 - 2. Subbase Material: Place as indicated.
- E. Landscaped Areas: Place suitable material when required to complete fill or backfill areas up to subgrade surface elevation. Do not use material containing rocks over four inches in diameter within the top 12 inches of suitable material.
- F. Plastic Pipe in Trenches: Place cushion material a minimum of six inches deep under pipe, 12 inches on both sides, and 12 inches above top of pipe. Complete balance of backfill as specified.
 - 1. Trench in Rock: Place a minimum six-inch-deep bed of cushion material under pipe.
- G. Backfilling Excavation Resulting from Removal of Unsuitable Material Beneath Structures and Other Improvements: Backfill the excavation with compacted select granular material.

3.10 COMPACTION

- A. All materials with exception of open graded stone:
 - 1. Compact each layer of fill and backfill for the following area classifications to the percentage of maximum density specified below and at a moisture content suitable to obtain the required densities, but at not less than three percent drier or more than two percent wetter than the optimum content as determined by ASTM D 698 (Standard Proctor) or 1557 (Modified Proctor).
 - a. Structures (entire area within ten feet outside perimeter): 95 percent (Modified)
 - b. Concrete Slabs and Steps: 95 percent (Modified)
 - c. Landscaped Areas: 90 percent (Standard)

- d. Pavements and Walks: 95 percent (Modified)
 - e. Pipes and Tunnels: 95 percent (Modified)
 - f. Pipe Bedding: 95 percent (Modified)
2. When the existing ground surface to be compacted has a density less than that specified for the particular area classification, break up and pulverize, and moisture condition to facilitate compaction to the required percentage of maximum density.
3. Moisture Control:
- a. Where fill or backfill must be moisture conditioned before compaction, uniformly apply water to the surface and to each layer of fill or backfill. Prevent ponding or other free water on surface subsequent to, and during compaction operations.
 - b. Remove and replace, or scarify and air dry, soil that is too wet to permit compaction to specified density. Soil that has been removed because it is too wet to permit compaction may be stockpiled or spread and allowed to dry. Assist drying by discing, harrowing, or pulverizing, until moisture content is reduced to a value which will permit compaction to the percentage of maximum density specified.
4. If a compacted layer fails to meet the specified percentage of maximum density, the layer will be recompacted and retested. If compaction cannot be achieved the material/layer will be removed and replaced. No additional material may be placed over a compacted layer until the specified density is achieved.

3.11 ROUGH GRADING

- A. Exterior Grading: Trim and grade area within the grading limit line and excavations outside the limit line, required by this Contract, to a level of 4 inches below the finish grades indicated unless otherwise specified herein or where greater depths are indicated. Provide smooth uniform transition to adjacent areas.
- 1. Slope cut and fill in transition areas, outside of the grading limit line, to meet corresponding levels of existing grades at a slope of 1 vertical to 2 horizontals unless otherwise indicated.
 - 2. Landscaped Areas: Provide uniform subgrade surface within 1 inch of required level to receive topsoil thickness specified. Compact fill as specified to within three inches of subgrade surface. Remove objectionable material detrimental to proper compaction or to placing full depth of topsoil. If the top three inches of subgrade has become compacted before placement of topsoil, harrow or otherwise loosen rough graded surface to receive topsoil to a depth of three inches immediately prior to placing topsoil.

3.12 FINISH GRADING

- A. Uniformly grade rough graded areas within limits of the grading limit line to finish grade elevations indicated.
- B. Grade and compact to smooth finished surface within tolerances specified, and to uniform levels or slopes between points where finish elevations are indicated or between such points and existing finished grade.
- C. Grade areas adjacent to building lines so as to drain away from structures and to prevent ponding.

- D. Finish surfaces free from irregular surface changes, and as follows:
1. Grassed Areas: Finish areas to receive topsoil to within one inch above or below the required subgrade surface elevations.
 2. Walks: Place and compact subbase material as specified. Shape surface of areas under walks to required line, grade, and cross section, with the finish surface not more than 1/2 inch above or below the required subbase elevation.
 3. Pavements: Place and compact subbase material as specified. Shape surface of areas under pavement to required line, grade and cross section, with the finish surface not more than 1/2 inch above or below the required subbase elevation.

3.13 MAINTENANCE AND RESTORATION

- A. Restore grades to indicated levels where settlement or damage due to performance of the work has occurred. Correct conditions contributing to settlement. Remove and replace improperly placed or poorly compacted fill materials.
- B. Restore pavements, walks, curbs, lawns, and other exterior surfaces damaged during performance of the work to match the appearance and performance of existing corresponding surfaces as closely as practicable.
- C. Water seeded areas as required until physical completion of the work.

3.14 DISPOSAL OF EXCESS AND UNSUITABLE MATERIALS

- A. Remove from property and dispose of excess and unsuitable materials, including materials resulting from clearing and grubbing and removal of existing improvements.
- B. Transport excess and unsuitable materials, including materials resulting from clearing and grubbing and removal of existing improvements, to spoil areas on property, and dispose of such materials as directed.
- C. Transport excess topsoil to areas on property designated by the Owner's Representative. Smooth grade deposited topsoil.

3.15 FIELD QUALITY CONTROL

- A. Special Inspections: A qualified special inspector shall 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 and maximum lift thickness comply with requirements.
 3. Determine, at the required frequency, that in-place density of compacted fill complies with requirements.
- B. Testing Agency: A qualified geotechnical engineering testing agency shall 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. 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.

3.16 PROTECTION

- A. Protect graded areas from traffic and erosion and keep them 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 Owner's Representative; 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.

END OF SECTION 31 20 00

SECTION 31 23 16 – ROCK REMOVAL

PART 1 GENERAL

1.1 RELATED WORK SPECIFIED ELSEWHERE

- A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Section 31 20 00: Excavation and Fill

1.2 DEFINITIONS

- A. Rock: Limestone, sandstone, shale, granite, and similar material in solid beds or masses in its original or stratified position which can be removed only by blasting operations, drilling, wedging, or use of pneumatic tools, and boulders with a volume greater than 1.0 cu yd. Concrete building foundations and concrete slabs, not indicated, with a volume greater than 1.0 cu yd shall be classified as rock.
 - 1. Limestone, sandstone, shale, granite, and similar material in a broken or weathered condition which can be removed with an excavator or backhoe equipped with a bucket with ripping teeth or any other style bucket shall be classified as earth excavation.
 - 2. Masonry building foundations, whether indicated or not, shall be classified as earth excavation.
- B. Unauthorized Rock Removal:
 - 1. The removal of any rock prior to performing the measurements/work required to determine quantities (Paragraph 3.1 B).
 - 2. The removal of material below required elevation indicated on the Drawings or beyond lateral dimensions indicated or specified without specific written direction by the Owner.

- C. General Rock Removal: Quantities of rock removal will be paid for as General Rock Removal when:
 - 1. The width of rock removed, as per measurement limits, is greater than or equal to the total excavation depth required.
 - 2. Boulders removed have a volume greater than 1.0 cu yd.
- D. Trench and Pier Rock Removal: Quantities of rock removal will be paid for as Trench and Pier Rock Removal when the width of rock removed, as per measurement limits, is less than the total excavation depth required.

1.3 SUBMITTALS

- A. Rock Removal Procedure: Submit a detailed outline of intended rock removal procedure for the Owner's information. This submittal will not relieve the Contractor of responsibility for the successful performance of method used.
 - 1. Where blasting is permitted, show drill hole pattern, method of blasting, explosive types, and amount of explosive load.
- B. Quality Control Submittals:
 - 1. Certificates: Competency affidavit required under Quality Assurance Article.
 - 2. Blasters Qualifications Data: Submit the following for each blaster:
 - 3. Name, and employer's name, business address and telephone number.
 - 4. Names and addresses of the required number of similar projects which meet the experience criteria.
- C. Measurement data for quantities of rock removal.

1.4 QUALITY ASSURANCE

- A. Blasters' Qualifications: The persons performing the blasting operations shall be personally experienced in the handling and use of explosives, shall furnish satisfactory evidence of competency in performing in a safe manner the type of blasting required, and shall have performed blasting operations on 5 similar projects.
- B. Regulatory Requirements: Obtain the proper Permit to Blast from authorities having jurisdiction before explosives are bought to the site.

- C. Certifications: Affidavit, for each blaster, certifying that blaster is competent in performing the type of blasting required.
- D. Pre-Rock Removal Conference: Before the rock removal work is scheduled to commence, a conference will be called by the Owner's Representative at the site for the purpose of reviewing the Contract Documents and discussing requirements for the Work. The conference shall be attended by the Contractor's Representative and the person supervising the rock removal operations.

1.4 PROJECT CONDITIONS

- A. Blasting and the use of explosive materials will not be permitted unless a Contractor-prepared Blasting Plan and Safety Plan have been approved by the Engineer and accepted by the Owner.
 - 1. Contractor shall secure and maintain all permits and regulatory approvals if blasting is approved.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.1 EXAMINATION, VERIFICATION & MEASUREMENT

- A. Examination of Existing Property and Construction: Prior to starting rock removal Work, thoroughly examine the existing property and construction at the site and record, with notes and drawings or other documentation, existing defects and deterioration. Make this information available to the Engineer upon request.
- B. Prior to removing material classified as rock, excavate test pits down to rock for the purpose of verifying the presence of sound rock and determining top of rock elevations.
 - 1. Verification of Sound Rock: Demonstrate to the Engineer that materials to be classified as rock cannot be removed utilizing a backhoe or excavator equipped with any form of bucket, including a bucket equipped with ripping teeth.
 - 2. Required Measurements: Take elevations and measurements as required for the purpose of determining the quantities of rock removal. Record all measurement data and submit a copy of the data to the Engineer. Backfill

test pits prior to rock removal as directed. Unless otherwise indicated or directed, excavate test pits as follows:

- a. For Structures: One pit for each structure or one pit for each 1000 sq ft, whichever is greater.
- b. For Paved Areas: 3 pits for each 2500 sq ft.
- c. For Utility Lines: One pit for each 100 lin ft.

3.2 SITE PREPARATION

- A. Schedule a site meeting with the Engineer and facility personnel to review the rock removal procedures in detail.
- B. If required, have seismographs in place and operational as well as all safety equipment and/or fencing.

3.3 ROCK REMOVAL

- A. Remove rock as required and necessary for the installation of the work on as shown on the Contract Drawings. Make sufficient clearance, within the limits specified, for the proper execution of the work.
- B. Volume Determination: Top of Rock Elevations established prior to the performance of any rock removal (Section 3.01 B) will be used to determine the depth of rock removed. Measurements for the base and width of the rock excavation shall be taken of the actual rock cut, as required for the Work, or to the specified measurement limits, whichever is smaller. Unless otherwise directed in writing, measurement limits for this work shall be as follows:
 1. Cast-In-Place Concrete:
 - a. Vertical Limit: Bottom of rock cut for cast-in-place concrete bearing on rock shall be the bottom of concrete elevation indicated on the Drawings.
 - b. Horizontal Limit: Limit measurement between vertical side surfaces at bottom of rock cut to the following:

Actual Depth of Rock Cut	Distance Beyond Edge of Concrete in Each Direction
Under 3 Feet	18 Inches
3 to 15 Feet	24 Inches
Over 15 Feet	30 Inches

2. Precast Concrete Structures: Measurement will be based on the size of the precast concrete structure specified or indicated on the Drawings.
 - a. Vertical Limit: Bottom of rock cut for precast concrete structure shall be 12 inches below the required bottom of structure elevation.
 - b. Horizontal Limit: Limit measurement between vertical side surfaces at bottom of rock cut to the following:

Actual Depth of Rock Cut	Distance Beyond Edge of Concrete in Each Direction
Under 5 Feet	12 Inches
5 to 15 Feet	18 Inches
Over 15 Feet	24 Inches

3. Pipe:
 - a. Vertical Limit: Bottom of rock cut for pipe in trench shall be 6 inches below the required pipe invert elevation, with depth measured from the mean surface of the rock.
 - b. Horizontal Limit: Limit measurement between vertical side surfaces at bottom of rock cut to the following:

Actual Depth of Rock Cut	Trench Width
Under 10 Feet	24 Inches plus Pipe OD
10 to 15 Feet	36 Inches plus Pipe OD
Over 15 Feet	48 Inches plus Pipe OD

3.4 FIELD QUALITY CONTROL

- A. Provide the Engineer with the recorded top of rock elevations. Prior to the performance of any rock removal operations obtain, in writing, that the Engineer as reviewed the information and is in agreement with the measurements taken.
- B. Notify the Engineer at least 3 work days in advance of all phases of blasting operations.
- C. Allow time for visual inspection of bottom of rock cut required for the work.

3.3 DISPOSAL OF EXCESS AND UNSUITABLE MATERIALS

- A. Remove from site and dispose of excess and unsuitable rock materials.
- B. Transport excess and unsuitable rock materials to spoil areas on site designated by the Engineer, and dispose of such materials as directed.

3.4 ADJUSTING

- A. Unauthorized Rock Removal:
 - a. Horizontal Direction: Backfill and compact unauthorized rock removal in the horizontal direction as specified for authorized excavation of the same classification, unless otherwise directed.
 - b. Vertical Direction: Immediately report unauthorized rock removal in the vertical direction to the Engineer. Correct unauthorized rock removal in the vertical direction in accordance with directions of the Engineer.

3.4 CLEANING

- A. Where footings and walls will rest entirely on rock, clean rock surfaces free of soil and loose rock.

END OF SECTION 31 23 16

SECTION 31 23 19 – DEWATERING

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes construction dewatering.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Section 31 20 00: Excavation and Fill

1.3 SUBMITTALS

- A. Field quality-control reports.
- B. Existing Conditions: Using photographs, show existing conditions of adjacent construction and site improvements that might be misconstrued as damage caused by dewatering operations. Submit before work begins.
- C. Record Drawings: Identify locations and depths of abandoned-in-place dewatering equipment.
- D. Shop Drawings: Submit drawings and diagrams, with all pertinent data, showing the dewatering system proposed for use. Indicate the spacing and location of wellpoints and reading wells, and location of header lines, pumps, valves and discharge lines.

1.4 QUALITY ASSURANCE

- A. Qualifications: The work of this Section shall be performed by a firm experienced in wellpoint dewatering work. The firm shall have satisfactorily completed such work for at least 3 projects of comparable size.
- B. The dewatering system shall consist of equipment, appliances and materials designed or suitable for controlling groundwater in construction work.

1.5 PROJECT CONDITIONS

- A. Blasting and the use of explosive materials will not be permitted.

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.

3.2 INSTALLATION

- A. Install the dewatering system in accordance with approved shop drawings and as required by site conditions. Locate elements of the system to allow a continuous dewatering operation without interfering with the installation of any permanent project work.
 - a. Space well points or wells at intervals required to provide sufficient dewatering.
 - b. Use filters or other means to prevent pumping of fine sands or silts from the subsurface.
- B. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction. 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 OPERATIONS

- 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.
 - a. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.
 - b. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.

- c. 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 below overlying construction.

3.4 FIELD QUALITY CONTROL

- A. Maintain a careful check to detect any settlement in existing adjacent Work. Notify the Engineer of any signs of settlement. Establish settlement point benchmarks and take periodic readings when directed.
- B. Provide continual observation to ensure that subsurface soils are not being removed by the dewatering operation. Prepare reports of observations.

3.5 PROTECTION

- A. Protect and maintain dewatering system during dewatering operations. Promptly repair damages to adjacent facilities caused by dewatering.

3.6 REMOVAL

- A. When the dewatering system is no longer required and when directed, dismantle and remove the system and all appurtenances from the site.

END OF SECTION 31 23 19

SECTION 31 25 13 – EROSION AND SEDIMENT CONTROLS

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes:

1. Furnish, install, inspect, maintain, and remove soil erosion and sediment control measures during construction as shown on the Contract Documents prepared for this project.
2. Minimize the potential short-term adverse environmental impacts associated with construction activity in environmentally sensitive areas.
3. Assure the quantity and quality of stormwater runoff is not substantially altered due to construction activities.
4. Stabilize slopes and protect offsite areas by the installation and maintenance of stabilization and erosion control measures.
5. Dewatering operation procedure.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Contract Plans and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Section 31 20 00: Excavation and Fill

1.3 REFERENCE STANDARDS

- A. New York Standards and Specifications for Erosion and Sediment Control, NYSDEC, latest edition.
- B. NYSDEC: Reducing the Impacts of Stormwater Runoff for New Development, latest edition.
- C. NYSDEC Environmental Conservation Law, Article 17. Titles 7, 8 and Article 70.
- D. 6 NYCRR Parts 611 – 613 and all additions.

- E. OSHA 40 CFR Part 258 and all additions. New York State: Standards and Specifications for Erosion and Sediment Control, latest edition.

1.4 PROJECT CONDITIONS

- A. An Erosion and Sediment Control plan (ESC) has been prepared for this project. Install and maintain the temporary storm water and diversion control items as shown on the Plans before starting any grading or excavation and maintain compliance with all SPDES regulations. Provide any temporary sediment and erosion control measures that may be required within limits of the work, including any staging areas, throughout construction in conformance with the plan, and as directed by the Owner's Representative. Place the permanent control practices required before the removal of the temporary storm water diversion and control items.
- B. During construction conduct operations in such a manner as to prevent or reduce to a minimum any damage to any water body from pollution by debris, sediment, chemical or other foreign material, or from the manipulation of equipment and/or materials in or near a stream or ditch flowing directly to a stream. Any water which has been used for wash purposes or other similar operations which become polluted with sewage, silt, cement, concentrated chlorine, oil, fuels, lubricants, bitumens, or other impurities shall not be discharged into any water body.
- C. In the event of conflict between these specifications and the regulation of other Federal, State, or local jurisdictions, the more restrictive regulations shall apply.
- D. The Contractor shall adhere to all requirements of the Erosion and Sediment Control plan.
- E. The Contractor will submit copies of certificates documenting that on-site workers have completed a NYS Department of Environmental Conservation endorsed Erosion & Sediment Control training as required by State Pollutant Discharge Elimination System (SPDES) General Permit for Stormwater Discharges from Construction Activity (GP-0-25-001).
- F. The Work shall consist of furnishing, installing, inspecting, maintaining, and removing soil and erosion control measures as shown on the contract documents or as ordered by the Owner's Representative during the life of the contract to provide erosion and sediment control.

- G. Temporary structural measures provide erosion control protection to a critical area for an interim period. A critical area is any disturbed, denuded slope subject to erosion. These are used during construction to prevent offsite sedimentation. Temporary structural measures shall include check dams, construction road stabilization, stabilized construction entrance, dust control, earth dike, level spreader, perimeter dike/swale, pipe slope drain, portable sediment tank, rock dam, sediment basin, sediment traps, silt fence, storm drain inlet protection, straw/hay bale dike, access waterway crossing, storm drain diversion, temporary swale, turbidity curtain, water bars or other erosion control devices or methods as required.
- H. Permanent structural measures also control protection to a critical area. They are used to convey runoff to a safe outlet. They remain in place and continue to function after completion of construction. Permanent structural measures shall include debris basins, diversion, grade stabilization structure, land grading, lined waterway (rock), paved channel, paved flume, retaining wall, riprap, rock outlets, and stream bank protection or other erosion control devices or methods as required.
- I. Vegetative measures shall include brush matting, dune stabilization, grassed waterway, vegetating waterway, mulching, protecting vegetation, seeding, sod, straw/hay bale dike, stream bank protection, temporary swale, topsoil, and vegetating waterways.
- J. Biotechnical measures shall include wattling (live fascines, brush matting, brush layering, live cribwall, and branchpacking) vegetated rock gabions, live staking, tree revetment, and fiber rolls.
- K. Weekly inspections will be completed by the Engineer on behalf of the Owner. Contractor shall retain their own inspector to perform weekly inspections on behalf of the contractor. Comply with and correct all deficiencies found as a result of these inspections. At the end of the construction season when soil disturbance activities will be finalized or suspended until the following spring, the frequency of the inspections may be reduced. If soil disturbance is completely suspended and the site is properly stabilized, a minimum of monthly inspections must be maintained. The stabilization activities must be completed before snow cover or frozen ground. If vegetation is required, seeding, planting and/or sodding must be scheduled to avoid die-off from fall frosts and allow for proper germination/establishment. Weekly inspections must resume no later than March 15.

1.5 DEFINITIONS

- A. Stabilized Construction Entrance: A stabilized pad of aggregate underlain with geo-textile where traffic enters a construction site to reduce or eliminate tracking of sediment to public roads.
- B. Dust Control: Prevent surface and air movement of dust from disturbed soil surfaces.
- C. Portable Sediment Tank: A compartmented tank to which sediment laden water is pumped to retain sediment before pumping the water to adjoining drainage ways.
- D. Sediment Basin: A barrier constructed across a drainage way to intercept and trap sediment.
- E. Sediment Traps: A control device formed by excavation to retain sediment at a storm inlet or other points of collection.
- F. Silt Fence: A barrier of geo-textile fabric installed on contours across the slope to intercept runoff by reducing velocity. Replace after 1 year.
- G. Storm Drain Inlet Protection: A semi-permeable barrier installed around storm inlets to prevent sediment from entering a storm drainage system.
- H. Straw/Hay Bale Dike: Intercept sediment laden runoff by reducing velocity. Replace after 3 months.
- I. Storm drain Diversion: The redirection of a storm drain line or outfall channel for discharge into a sediment trapping device.
- J. Temporary Swale: A temporary excavated drainage swale.
- K. Protecting Vegetation: Protecting trees, shrubs, ground cover and other vegetation from damage.
- L. Temporary Seeding: Erosion control protection to a critical area for an interim period. A critical area is any disturbed, denuded slope subject to erosion.

M. Permanent Seeding: Grasses established and combined with shrubs to provide perennial vegetative cover on disturbed, denuded, slopes subject to erosion.

N. Sod: Used where a quick vegetative cover is required.

1.6 SUBMITTALS

- A. Product Data: Manufacturer's catalog cuts, specifications and installation instructions.
- B. Contingency Action Plan for prompt remedial action in the event spillage of petroleum products or other pollutants should occur. Contingency Action Plan shall be submitted to the Engineer for acceptance prior to the start of construction.
- C. Name and location of all material suppliers.
- D. Certificate of compliance with the standards specified above for each source of each material.
- E. List of disposal sites for waste and unsuitable materials and all required permits for use of those sites.
- F. Where a Stormwater Pollution Prevention Plan has been prepared, the Engineer shall file a Notice of Intent (NOI) with NYSDEC prior to commencing construction activities and a Notice of Termination (NOT) with NYSDEC following construction.
- G. Where a Stormwater Pollution Prevention Plan and/or Erosion and Sediment Control Plan has been prepared, the Contractor will submit copies of certificates documenting that on-site workers have completed a NYS Department of Environmental Conservation endorsed Erosion & Sediment Control training as required by General Permit GP-0-25-001. The Contractor will submit copies of certificates documenting that on-site workers have completed a NYS Department of Environmental Conservation endorsed Erosion & Sediment Control training as required by General Permit GP-0-25-001.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Silt Fence
 - 1. Mirafi, Envirofence365 South Holland Drive, Pendergrass, Ga, 30567, (888) 795-0808, <http://www.tencategeo.us/en-us/>
 - 2. Filter X
 - 3. Stabilinka T140N
 - 4. Approved equivalent
- B. Filter fabric inlet protection
- C. Stone and block inlet protection
- D. Temporary filters for inlet protection
- E. Hardwood staking material
- F. Stone material
- G. Dry Rip Rap
 - 1. NYSDOT Standard Specification Section 620

PART 3 EXECUTION

3.1 PREPARATION

- A. Prior to any construction activities, install temporary erosion and sediment control barriers or measures as indicated on the Contract Plans, per manufacturer's specifications.
- B. The Contractor shall comply with all provisions of the Erosion and Sediment Control Plan and/or Stormwater Pollution Prevention Plan prepared by Passero Associates.
- C. The Contractor shall be required to protect and preserve existing trees and shrubs within the Limit of Disturbance. Contractor shall replace any tree or shrubs damaged in kind to the satisfaction of the Owner.
- D. The Contractor shall contact the Engineer once the erosion and sediment control structures have been installed.
- E. Prior to commencement of construction, the Owner's Representative shall conduct an assessment of the site and certify that the appropriate erosion and

sediment control structures as shown on the Contract Plans have been adequately installed and implemented.

- F. Staging of Earthwork Activities: All earthwork shall be scheduled so that the smallest possible areas will be unprotected from erosion for the shortest time feasible.
- G. Vegetation adjacent to or outside of access roads or rights-of-way shall not be damaged.
- H. The Engineer has the authority to limit the surface area of erodible earth exposed by earthwork operations and to direct the Contractor to provide immediate temporary or permanent erosion measures to minimize damage to property and contamination of watercourses and water impoundments. Under no circumstances will the area of erodible earth material exposed at one time exceed 5 acres. The Engineer may increase or decrease this area of erodible earth material exposed at one time as determined by their analysis of project, weather and other conditions. The Engineer may limit the area of clearing and grubbing and earthwork operations in progress commensurate with the Contractor's demonstrated capability in protecting erodible earth surfaces with temporary, permanent, vegetative or biotechnical erosion control measures.
- I. Schedule the work so as to minimize the time that earth areas will be exposed to erosive conditions. Provide temporary structural measures immediately to prevent any soil erosion.
- J. Provide temporary seeding on disturbed earth or soil stockpiles exposed for more than 7 days or for any temporary shutdown of construction. In spring, summer or early fall apply rye grass at a rate of 1 lb/ 1000 sq.ft. In late fall or early spring, apply certified Aroostook Rye at a rate of 2.5 lbs./ 1000 sq. ft. Apply hay or straw at a rate of 2 bales/ 1000 sq. ft. or wood fiber hydromulch at the manufacturer's recommended rate. Hay or straw shall be anchored.
- K. Provide temporary grading to facilitate dewatering and control of surface water.
- L. Coordinate the use of permanent controls or finish materials shown with the temporary erosion measures.
- M. After final stabilization has been achieved, temporary sediment and erosion controls must be removed. Areas disturbed during removal must be stabilized immediately.
- N. Disposal of spoil material shall not be in any flood plain, wetland, stream, brook, or sensitive environmental area. The Contractor shall dispose of spoils within staging areas and provide sediment control barriers accordingly.

3.2 CLEARING

- A. Tree trunks and roots, vegetation, and project debris shall not be buried on site.
- B. Staging areas (for storage of materials and stockpiles) shall be located as shown on the plans. Where areas must be cleared for staging area temporary structures, provisions shall be made for regulating drainage and controlling erosion.
- C. All abandoned or useless objects including equipment, supplies, personal property, rubbish, (including those present prior to construction activities) should be removed from the project work area and properly disposed of in accordance with local, state, and federal regulations.

3.3 COMPLIANCE

- A. The Owner shall have a qualified professional, as described in the NYSDEC SPDES General Permit for Stormwater Discharge from Construction Permit No. GP-0-20-001, conduct a site inspection following the commencement of construction at least every 7 calendar days.
- B. All erosion and sediment control devices must be maintained in working order until the site is stabilized. All preventative and remedial maintenance work, including clean out, repair, replacement, re-grading, re-seeding, or re-mulching, must be performed immediately.
- C. The Contractor shall, at the direction of the Engineer, use necessary methods to minimize erosion within access roads, especially in areas that drain to watercourse areas.
- D. Cuts, fills, and other disturbed areas will be maintained to prevent erosion until adequate vegetative/impervious cover is established.
- E. Water, resulting from dewatering operations that will reduce the quality of receiving waters shall not be directly discharged. The Contractor shall provide, install, and maintain sump pits where necessary to dewater operations as detailed on the plans. Stone used within the sump pits shall be washed clean stone. The Contractor shall provide, install and maintain dewatering bags, as deemed necessary to control sediment deposits at critical environmental areas. Lifting straps shall be placed under the unit to facilitate removal after use. Dewatering bags shall be placed on stabilized areas over grass. Discharge hose from pump shall be inserted a minimum of six inches and tightly secured with attached strap

to prevent water from flowing out of the unit without being filtered. Water from dewatering operations shall be treated to eliminate the discharge of sediment and other pollutants to streams and watercourses. The unit shall be replaced when it is half full of sediment or when the sediment has reduced the flow rate of the pump discharge to an impractical rate. Remove and dispose of sediment and dewatering bag off-site.

- F. Silt fence, where identified on plans, shall be installed at down gradient locations to control sediment deposits off-site at critical environmental areas. The silt fence shall be staked (unless noted otherwise), anchored and set as per manufactures specifications. The silt fence shall be inspected on a daily basis and after a rain fall event and repaired as necessary.
- G. A stabilized construction entrance shall be installed and maintained for vehicular access on and off site. The entrance shall be constructed in accordance with the NYSDEC Erosion and Sediment Control Standards and the Contract Plans. The condition of the entrance shall be inspected daily and repaired as necessary.
- H. Dust control shall be controlled by the use of water, or calcium chloride application. Water application shall be applied at a rate where mud is not produced. The rate of application of the calcium chloride shall not exceed Federal, State and Local application rates or manufactures recommendations. Dust control shall be applied on adjacent public streets.
- I. Dry rip-rap shall conform to the lines, grades and thicknesses indicated on construction plans. It shall be a well-graded mass of variable size stones with no areas of uniform size material. Align stones to obtain a close fit and to minimize voids. Fill spaces between stones with spalls of suitable size.
- J. Paved areas within access corridors and parking areas shall be swept on a regular basis (minimum twice per week) as needed to minimize sediment and dust tracked from the work area. Should sediment and dust be tracked off-site, Contractor shall be responsible for sweeping public streets.
- K. During the final site restoration, the Contractor shall remove all sediment and debris deposited in the temporary and permanent erosion and sediment control barriers or measures including but not limited to all culverts and drainage swales, at no additional cost to the Owner.
- L. When all disturbed areas are stable, all temporary erosion and sediment control measures shall be removed per the approval of the Engineer. The measures are temporary and shall be removed and the areas restored to its original condition when they are no longer required, at no additional cost to the Owner.

- M. The Owner and Contractor shall maintain a record of all erosion and sediment control inspection reports at the site in a log book. The site log book shall be maintained on the site and be made available to the permitting authority. The Owner / Contractor shall post at the site, in a publicly accessible location, a summary of the site inspection activities on a monthly basis.
- N. The Contractor is fully responsible for maintaining, repairing, and protecting his work throughout the project, at no additional cost to the Owner, until the Owner accepts the work.

END OF SECTION 31 25 13

SECTION 32 12 16 – ASPHALT PAVING

PART 1 GENERAL

1.1 SUMMARY

- A. Hot-mixed asphalt pavement for roads
- B. Hot-mixed asphalt patching

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Section 31 20 00: Excavation and Fill
- C. Section 32 17 23: Pavement Marking

1.3 REFERENCE STANDARDS

- A. New York State Department of Transportation (DOT) Specification Section 40X, latest edition.

1.4 PROJECT CONDITIONS

- A. Environmental Requirements:
 - 1. Discontinue paving when surface temperatures fall below requirements listed in DOT Table 402-1 unless otherwise specified in the General Conditions of this Contract or as directed by the Engineer.
 - 2. Do not place asphalt concrete on wet surfaces, or when weather conditions otherwise prevent the proper handling or finishing of bituminous mixtures as determined by the Engineer.
 - 3. Pavement is restricted by dates listed in the General Conditions or by temperatures.

1.5 SUBMITTALS

- A. Product Data:
 - 1. Paving Synthetics: including Manufacturer's name, specifications, MSDS as required and installation instructions (including adhesion type and rate) for each item specified.
 - 2. Asphaltic Pavement: Include mix design from NYSDOT approved Batch Plant, Mix Design Test results that are less than 6 months old
- B. Batch plant name, NYSDOT Plant Number, and location of asphalt plant.
- C. Pavement Quality Control Submittals: Material Delivery Tickets

1. At the time of delivery, a copy of the delivery ticket must be presented to the Director's Representative with the following minimum information:
 - a. Ticket Number.
 - b. Plant Identification.
 - c. Project Name.
 - d. Mix Type.
 - e. Quantity of material in vehicle.
 - f. Date and Time.
- D. Qualification Data: For manufacturer and testing agency.
- E. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A paving-mix manufacturer registered with and approved by authorities having jurisdiction or the NYSDOT.
- 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 NYSDOT for asphalt paving work.
- D. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

PART 2 PRODUCTS

2.1 AGGREGATES

- A. All aggregate used in design mixes shall be as specified in DOT Specification Section 401-2.02 B.; Coarse Aggregate Type F2 Conditions.
- B. Coarse Aggregate: ASTM D 692, sound; angular crushed stone, crushed gravel.
- C. Fine Aggregate: ASTM D 1073 or AASHTO M 29, sharp-edged natural sand or sand prepared from stone, gravel.

2.2 ASPHALT MATERIALS

- A. General: Use locally available materials and gradations that exhibit a satisfactory record of previous installations.
- B. Asphalt Pavement: Paving materials shall comply with the New York State Department of Transportation Standard Specification dated "Current Version." Section 404 – Hot Mix Asphalt.
- C. Trueing & Leveling Course: DOT Table 401-1 Composition of Hot Mix Asphalt Mixtures, Type 5 (Shim).

- D. Asphalt Cement: ASTM D 3381 for viscosity-graded material. ASTM D 946 for penetration-graded material.
- E. Asphalt Cement Tack Coat: Material shall conform to NYSDOT Section 407 – Tack Coat.
- F. Prime Coat: Cut-back asphalt type, ASTM D 2027; MC-30, MC-70 or MC-250.

2.3 AUXILIARY MATERIALS

- A. Sand: ASTM D 1073 or AASHTO M 29, Grade Nos. 2 or 3.
- B. Joint Sealant: ASTM D 3405 or AASHTO M 301, hot-applied, single-component, polymer-modified bituminous sealant.
- C. Paving Synthetics: A non-woven fabric designed for use in pavement rehabilitation to reduce reflective cracking, act as a vapor barrier and have one side heat bonded only.
 - 1. Geogrid: Mirafi HP370
 - 2. Tencate
 - 3. Propex Fabrics
 - 4. Fibertex
 - 5. Approved equivalent

2.4 MIXES

- A. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction; designed according to procedures in AI MS-2, "Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types"; and complying with the following requirements:
 - 1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
 - 2. Base Course: NYSDOT (Type 37.5 F9 Base Course HMA, series 80 compaction) per Contract Drawings.
 - 3. Binder Course: NYSDOT (Type 19 F9 Binder Course HMA, series 80 compaction) per Contract Drawings.
 - 4. Top Course: NYSDOT (Type 9.5 F2 Top Course HMA, series 80 compaction) per Contract Drawings.
 - 5. True and Leveling Course: Binder Course mix to be used in placed in a lift greater than 2 inches thick. Top Course mix to be used in a lift less than 2 inches thick.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify that sub-grade is dry and in suitable condition to support paving and imposed loads.

- B. Proof-roll subgrade in accordance with Specification Section 312000: Excavation and Fill
- C. Proceed with paving only after unsatisfactory conditions have been corrected.

3.2 SURFACE PREPARATION

- D. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving
- E. Sweep loose granular particles from surface of unbound-aggregate base course. Do not dislodge or disturb aggregate embedded in compacted surface of base course.
- F. Tack Coat: If top course is not placed within twenty-four (24) hours of binder placement, a tack coat shall be applied to clean surface prior to placement of top course. Apply uniformly to surfaces of pavement at a rate of 0.05 to 0.15 gal./sq. yd.
- G. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
- H. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.3 HOT-MIX ASPHALT PLACING

- A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off using a self-propelled paving machine with vibrating screed. Place asphalt mix by hand to 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. Clean cracks and joints in existing hot-mix asphalt pavement.
 - 2. Place hot-mix asphalt base course in number of lifts and thicknesses indicated.
 - 3. Spread mix at 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.

3.4 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 12 inches.
 4. Construct transverse joints as described in AI MS-22, "Construction of Hot Mix Asphalt Pavements."
 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.

3.5 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 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: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent nor 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.

3.6 INSTALLATION TOLERANCES

- A. Thickness: Compact each course to produce the thickness indicated within the following tolerances:
 - 1. Binder Course: Plus or minus 1/2 inch.
 - 2. Surface Course: Plus 1/4 inch, no minus.
- B. 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.

3.7 PATCHING

- A. Hot-Mix Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Re-compact existing unbound-aggregate base course to form new sub-grade.
- B. Tack Coat: Apply uniformly to vertical surfaces abutting or projecting into new, hot-mix asphalt paving 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.
- C. Patching: 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.

3.8 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.

3.9 FIELD QUALITY CONTROL

- A. Special Inspections: Contractor shall engage a qualified special inspector to perform the following special inspections:
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Thickness: In-place compacted thickness of hot-mix asphalt courses shall be determined according to ASTM D 3549.
- D. Surface Smoothness: Finished surface of each hot-mix asphalt course shall be tested for compliance with smoothness tolerances.
- E. In-Place Density: Testing agency shall take samples of uncompacted paving mixtures and compacted pavement according to ASTM D 979.
 - 1. Reference maximum theoretical density shall 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 shall be determined by testing core samples according to ASTM D 1188 or ASTM D 2726.
 - a. One core sample shall 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.
- F. Replace and compact hot-mix asphalt where core tests were taken.
- G. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

END OF SECTION 32 12 16

SECTION 32 17 23 – PAVEMENT MARKING

PART 1 GENERAL

1.1 RELATED WORK SPECIFIED ELSEWHERE

- A. Contract Plans and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Section 32 12 16: Asphalt Paving

1.2 REFERENCE STANDARDS

- A. New York State Department of Transportation (DOT) Specification Section 400, latest edition.

1.4 PROJECT CONDITIONS

- A. Perform the painting operations after working hours, on weekends or at such time so as not to interfere with the flow of traffic. Provide temporary barriers to prevent vehicles from driving over newly painted areas.
- B. Apply paint on dry pavement surface, when the air temperature is above 40 degrees F and not exceeding 95 degrees F, or as recommended by the manufacturer.

1.5 SUBMITTALS

- A. Product Data: Include technical data and tested physical and performance properties. Indicate pavement markings to be used, colors, dimensions and symbols.

1.6 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with materials, workmanship, and other applicable.
- B. Requirements of NYSDOT for pavement-marking work and the "National Manual on Uniform Traffic Control Devices" latest edition and the "NYS Supplement."

PART 2 PRODUCTS

2.1 MATERIALS

- A. Paint: DOT Section 640-2, yellow or white as indicated, or if not indicated as directed. Delete reference to Glass Beads.
- B. Rapid Dry Paint:
 - 1. Aexcel Corp., www.aexcelcorp.com, 72W-A042 White, 72Y-A082 Yellow
 - 2. Sherwin-Williams, www.swpavementmarkings.com, TM2152 White, TM2153 Yellow, TM2224 Blue.
 - 3. Franklin Paint Company, Inc., www.franklinpaint.com, 2014 White, 2015 Yellow.
 - 4. Approved equivalent

PART 3 EXECUTION

3.1 PREPARATION

- A. Remove dust, dirt, and other foreign material detrimental to paint adhesion.
- B. Mark layout of stripes and lines with chalk or paint.

3.2 APPLYING PAVEMENT MARKING

- A. Apply paint in accordance with DOT Section 640-3.02, except as follows:
 - 1. Delete references to Glass Beads.
- B. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Owner's Representative.
- C. Allow paving to cure for 30 days before starting pavement marking.
- D. Sweep and clean surface to eliminate loose material and dust.
- E. Apply paint with mechanical equipment to produce pavement markings of dimensions indicated with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

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 32 17 23

SECTION 32 31 13 – CHAIN LINK FENCE AND GATE

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes:

1. Fence framework, fabric and accessories.
2. Excavation for post bases and center drop for gates.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Section 033000: Cast in Place Concrete
- C. Section 312000: Excavation and Fill

1.3 REFERENCE STANDARDS

- A. ASTM A 53 for requirements of Schedule 40 piping.

1.4 SUBMITTALS

- A. Shop Drawings: Complete detailed drawings for each height and style of fence and gate required. Include separate schedule for each listing all materials required and technical data such as size, weight, and finish, to ensure conformance to specifications.
- B. Product Data: Manufacturer's catalog cuts, specifications, and installation instructions for each item specified.
- C. Samples:
1. Fence Fabric: Minimum one square foot.
 2. Fence and Gate Posts: Two each, one foot long, if requested.
 3. Miscellaneous Materials and Accessories: One each, if requested.
- D. Quality Control Submittals:
1. Certificates: Affidavit required under Quality Assurance Article.

1.1 QUALITY ASSURANCE

- A. Comply with standards of the Chain Link Fence Manufacturer's Institute.

- B. Fence shall be installed in accordance with ASTM F-567 and gates shall be installed in accordance with ASTM F-900.
- C. Provide steel fence and related gates as a complete compatible system including necessary erection accessories, fittings, and fastenings.
- D. Posts and rails shall be continuous without splices.

1.2 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which installer agrees to repair or replace components of chain-link fences that fail in materials or workmanship within specified warranty period.
- B. Failures include, but are not limited to, the following:
 - 1. Faulty operation of gate operators and controls.
 - 2. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - 3. Warranty Period: Five years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 STEEL FRAMEWORK

- A. All pipe shall be Schedule 40, conforming with ASTM F-1083.
- B. End Posts, Corner Posts and Pull Posts:
 - 1. 4' Fence Height Pipe: 2 inches O.D.
 - 2. 6' and 8' Fence Height Pipe: 3 inches O.D.
 - 3. 10' Fence Height Pipe: 6 inches O.D.
- C. Line Posts:
 - 1. 4' Fence Height Pipe: 2 inches O.D.
 - 2. 6' and 8' Fence Height Pipe: 2 1/2 inches O.D.
 - 3. 10' Fence Height Pipe: 3 inches O.D.
- D. Rails and Post Braces:
 - 1. 4' Fence Height Pipe: 1 5/8 inches O.D.
 - 2. 6' and 8' Fence Height Pipe: 1 5/8 inches O.D.
 - 3. 10' Fence Height Pipe: 1 5/8 inches O.D.
- E. Metallic Coating for Steel Framework:
 - 1. Type B: Zinc with organic overcoat, consisting of a minimum of 0.9 oz./sq. ft. of zinc after welding, a chromate conversion coating, and a clear, verifiable polymer film.

2. External, Type B: Zinc with organic overcoat, consisting of a minimum of 0.9 oz./sq. ft. of zinc after welding, a chromate conversion coating, and a clear, verifiable polymer film. Internal, Type D, consisting of 81 percent, not less than 0.3-mil thick, zinc-pigmented coating.
3. Coatings: Any coating above.

2.2 STEEL FABRIC

- A. One-piece widths for fence heights up to 12'-0".
- B. Chain link, 2 inch mesh, No. 9 gauge
- C. Selvages: Top edge; bottom edge knuckled.
- D. Zinc-Coated (galvanized) Fabric: ASTM A 392, Type II, Class 1, 1.2 oz./sq. ft. with zinc coating applied after weaving.
- E. Aluminum wire ties shall not be allowed.

2.3 PRIVACY SLATS:

- A. Slats shall be 1-1/4" wide, single wall UV stabilized PVC.
- B. Slats shall lock at bottom and top of fence and be secured with wire ties.
- C. Owner/Architect to select color.

2.4 BANDS:

- A. 6' Fence Height: 6 each bands per fence direction.
- B. 8' Fence Height: 8 each bands per fence direction.
- C. 10' Fence Height: 10 each bands per fence direction.

2.5 SWING GATE POSTS

- A. Single width of gate up to 6'-0" wide and less than 10'-0" high:
 1. Pipe: 2.875 inches OD (Schedule 40).
- B. Single width of gate 6'-0" to 12'-0" wide or over 10'-0" high:
 1. Pipe: 4 inches OD (Schedule 40).

2.6 SWING GATE FRAMES

- A. Up to 6'-0" high, and leaf width 8'-0" or less.
 1. Pipe: 1.660 inches OD (Schedule 40).
- B. Height: 6'-0" - 12'-0", or leaf width exceeding 8'-0":
 1. Pipe: 1.90 inches OD (Schedule 40).

- C. Assemble gate frames by welding or with special steel fittings and rivets for rigid connections. Install mid-height horizontal rails on gates over 10 feet high. When width of gate leaf exceeds 10 feet, install mid-distance vertical bracing of the same size and weight as frame members. When either horizontal or vertical bracing is not required, provide truss rods as cross bracing to prevent sag or twist.

2.7 SWING GATE HARDWARE

- A. Hinges: Non-lift-off type, offset to permit 180 degree swing, and of suitable size and weight to support gate. Provide 1-1/2 pair of hinges for each leaf over 6 feet high.
- B. Latch: Forked type for single gates 10 feet wide or less. Drop bar type with keeper for double gates and single gates over 10 feet wide complete with flush plate set in concrete. Drop bar length shall be 2/3 the height of the gate. Padlock eye shall be an integral part of latch construction.

2.8 MISCELLANEOUS MATERIALS AND ACCESSORIES

- A. Rails and Post Braces:
 - 1. Pipe: 1.660 inches OD, 2.27 pounds per linear foot (Schedule 40).
- B. Fittings and Post Tops: Steel, wrought iron, or malleable iron.
 - 1. Fasteners: Tamper-resistant cadmium plated steel screws.
- C. Stretcher Bars: One piece equal to full height of fabric, minimum cross-section 3/16 inch by 3/4 inch.
- D. Metal Bands (for securing stretcher bars): Steel, wrought iron, or malleable iron.
- E. Wire Ties: Conform to American Steel Wire gauges.
 - 1. For tying fabric to line posts, rails and braces: 9 gauge (.1483 inch) steel wire.
- F. Truss Rods: 3/8 inch diameter.
- G. Concrete: Portland Cement concrete having a minimum compressive strength of 4000 psi at 28 days.
 - 1. Terminal/ End/ Corner Post Foundations:
 - a. 4' and 6' Fence Height Foundations: 3'-6" deep post embedment in 4' deep concrete footing, 12" inches diameter.
 - b. 8' Fence Height Foundations: 4'-6" deep post embedment in 5' deep concrete footing, 18" inches diameter.
 - c. 10' and greater Fence Height Foundations: 5'-0" deep post embedment in 5' deep concrete footing, 18" inches diameter.

2. Line Post Foundations:
 - a. 4' and 6' Fence Height Foundations: 3'-6" deep post embedment in 4'-0" deep concrete footing, 12" inches diameter.
 - b. 8' Fence Height Foundations: 4'-6" deep post embedment in 5' deep concrete footing, 12" inches diameter.
 - c. 10' and greater Fence Height Foundations: 5'-0" deep post embedment in 5' deep concrete footing, 12" inches diameter.
 - H. Spiral Paper Tubes:
 1. Sonotube by Sonoco Products Co., North Second St., Hartsville, SC 29550, (800) 377-2692.
 2. Slek/tubes by Jefferson Smurfit Corp., P.O. Box 66820, St. Louis, MO 63166, (314) 746-1100.
 3. Approved equivalent
 - I. Cold Galvanizing Compound: Single component compound giving 93 percent pure zinc in the dried film, and meeting the requirements of DOD-P-21035A (NAVY).
- 2.9 FINISHES
- A. Steel Framework:
 1. Pipe: Galvanized in accordance with ASTM A 53, 1.8 ounces zinc per square foot.
 - B. Fabric
 1. Galvanized Finish: ASTM A 392 class II zinc coated after weaving, with 2.0 ounces per square foot.
 - C. Fence and Gate Hardware, Miscellaneous Materials, Accessories:
 1. Wire Ties: Galvanized Finish, ASTM A 90 1.6 ounces zinc per square foot, or aluminized finish, ASTM A 809 0.40 ounces per square foot.
 2. Hardware and Miscellaneous Items: Galvanized Finish, ASTM A 153 (Table 1).

PART 3 EXECUTION

3.1 PREPARATION

- A. Clear and grub along fence line as required to eliminate growth interfering with alignment. Remove debris from State property.
- B. Do not begin installation of fence in areas to be cut until finished grading has been completed.

3.2 APPLYING PAVEMENT MARKING

- A. Install chain-link fencing according to ASTM F 567 and more stringent requirements specified.
- B. Space posts equidistant in the fence line with a maximum of 10 feet on center. For fences 16 feet and higher space posts a maximum of 8 feet on center.
- C. Setting Posts in Earth: Drill holes for post footings. If existing grade at the time of installation is below finished grade, provide spiral paper tubes to contain concrete to finish grade elevation. Set posts in center of hole and fill hole with concrete. Plumb and align posts. Vibrate or tamp concrete for consolidation. Finish concrete in a dome shape above finish grade elevation to shed water. Do not attach fabric to posts until concrete has cured a minimum of 7 days.
- D. Setting Posts in Rock: Drill holes into solid rock one inch wider than post diameter, 18 inches deep for end, pull, corner, and gate posts, and 12 inches deep for line posts. Set posts into holes and fill annular space with shrink-resistant grout.
- E. Locate corner posts at corners and at changes in direction. Use pull posts at all abrupt changes in grade and at intervals no greater than 500 feet. On runs over 500 feet, space pull posts evenly between corner or end posts. On long curves, space pull posts so that the strain of the fence will not bend the line posts.
- F. Install top rail continuously through post tops or extension arms, bending to radius for curved runs. Install expansion couplings as recommended by fencing manufacturers.
- G. Install bottom and intermediate rails in one piece between posts and flush with post on fabric side using special offset fittings where necessary.
- H. Brace corner posts, pull posts, end posts, and gate posts to adjacent line posts with horizontal rails.
- I. Diagonally brace corner posts, pull posts, end posts, and gate posts to adjacent line posts with truss rods and turnbuckles.
- J. Attach fabric to security side of fence. Maintain a 2 inch clearance above finished grade except when indicated otherwise. Thread stretcher bars through fabric using one bar for each gate and end post and 2 for each corner and pull post. Pull fabric tight so that the maximum deflection of fabric is 2 inches when a 30

pound pull is exerted perpendicular to the center of a panel. Maintain tension by securing stretcher bars to posts with metal bands spaced 15 inches oc. Fasten fabric to steel framework with wire ties spaced 12 inches oc for line posts and 24 inches oc for rails and braces. Bend back wire ends to prevent injury. Tighten stretcher bar bands, wire ties, and other fasteners securely.

- K. Position bolts for securing metal bands and hardware so nuts are located opposite the fabric side of fence. Tighten nuts and cut off excess threads so no more than 1/8 inch is exposed. Peen ends to prevent loosening or removal of nuts.
 - 1. Secure post tops and extension arms with tamper-resistant screws.
- L. Install gates plumb and level and adjust for full opening without interference. Install ground-set items in concrete for anchorage, as recommended by fence manufacturer. Adjust hardware for smooth operation and lubricate where necessary.
- M. Tension Wire: Support bottom edge of fabric with tension wire. Weave tension wire through fabric or fasten with hog rings spaced 24 inches oc. Tie tension wire to posts with 9 gauge wire ties.
- N. Wire brush and repair welded and abraded areas of galvanized surfaces with one coat of cold galvanizing compound.
- O. Restore disturbed ground areas to original condition. Topsoil and seed to match adjacent areas.

3.3 GATE INSTALLATION

- A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation.

3.4 ADJUSTING

- A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.
- B. Lubricate hardware and other moving parts.

END OF SECTION 323113

SECTION 329200 – TOPSOIL AND SEEDING

PART 1 GENERAL

1.1 SUMMARY

- A. This Section includes:
 - 1. Topsoil.
 - 2. Soil Amendments.
 - 3. Fertilizing.
 - 4. Mulches.
 - 5. Lawn.
 - 6. Lawn Restoration.
 - 7. Erosion Control Materials.
 - 8. Maintenance.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Contract Plans and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 312000: Excavation and Fill.

1.3 SUBMITTALS

- A. Product Certification: Certification signed by manufacturers certifying that their products comply with specified requirements.
 - 1. Manufacturer's certified analysis for standard products.
 - 2. Analysis for other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.
- B. Certification of grass seed from seed vendor stating the botanical and common name and percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.
- C. Material test reports from qualified independent testing agency indicating and interpreting test results relative to compliance of the following materials with requirements indicated. Include percentages of organic matter, inorganic matter (silt, clay, and sand), deleterious material, pH, and mineral and plant-nutrient content.
 - 1. Analysis of existing surface soil.
 - 2. Analysis of imported topsoil.

- D. Report suitability of existing surface soil and imported topsoil for lawn and plant growth. State recommended quantities of soil amendments to be added to produce satisfactory results.

1.4 DEFINITIONS

- A. Weeds: Vegetative species other than specified species to be established in given area.
- B. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

1.5 CLOSEOUT SUBMITTALS

- A. Before expiration of required maintenance periods, Contractor is to submit maintenance instructions recommending procedures to be performed by Owner for maintenance of landscape during an entire year.

1.6 QUALITY ASSURANCE

- A. Provide seed mixture in containers showing percentage of seed mix, germination percentage, inert matter percentage, weed percentage, year of production, net weight, date of packaging, and location of packaging.

1.7 QUALIFICATIONS

- A. Seed Supplier: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing work of this section with minimum three years documented experience and a record of successful landscape establishment.
 - 1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on the Project site during times that work of this section is in progress.
- C. Testing Agency: To qualify for acceptance, an independent testing agency must demonstrate to Owner's satisfaction, based on evaluation of agency-submitted criteria conforming to ASTM E 699, that it has the experience and capability to satisfactorily conduct the testing indicated without delaying the work.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver packaged materials in sealed containers showing weight, analysis, and name of manufacturer.
- B. Protect materials from deterioration during delivery and while stored at site.

1.9 PROJECT CONDITIONS

- A. Utilities: Determine location of above grade and underground utilities prior to the start of Work. Perform Work in a manner which will avoid damage. Hand excavate, as required. Maintain grade stakes until removal is mutually agreed upon by the Engineer.
- B. Excavation: When conditions detrimental to lawn growth are encountered, such as rubble fill, adverse drainage conditions, or obstructions, notify the Engineer before planting.

1.10 COORDINATION AND SCHEDULING

- A. Coordinate with other site operations to avoid conflict and damage to new work.
- B. Time for seeding: Optimum period to sow permanent grass seed is generally between April 1 and May 15 or between August 15 and October 1. Schedule application for when weather conditions permit.
 - 1. Provide temporary seed and mulch when final grading is complete and waiting for optimal seeding period.
 - 2. Provide temporary seed and mulch for temporary cover on disturbed ground not to be worked on for more than seven days.
 - 3. Provide temporary seed and mulch on disturbed earth prior to temporary shutdown of construction.

1.11 WARRANTY

- A. General: The guarantee specified in this Section shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.
- B. Guarantee: Upon completion and acceptance of the landscaping, guarantee the materials for two years. Guarantee shall include material and labor costs. At the end of the guarantee period, the Owner's onsite representative shall inspect all planter materials. The Contractor shall promptly make all required replacements with plant materials meeting specifications.

1.12 LAWN MAINTENANCE

- A. Begin maintenance immediately after each area is planted and continue until acceptable lawns and plants are established, but for not less than the following periods:
 - 1. Lawns and Seeded Areas: 120 days after date of Substantial Completion.

2. When full maintenance period has not elapsed before end of planting season, or if lawn is not fully established at that time, continue maintenance during the next planting season.
- B. Maintain and establish seeded areas by watering, weeding, replanting, and other operations. Roll, re-grade, and replant bare or eroded areas and re-mulch to produce a uniformly smooth surface.
- C. Watering: Provide and maintain temporary piping, hoses, and watering equipment to convey water from sources and to keep grass uniformly moist to a depth of 4 inches. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
 1. Water all seeded areas at the minimum rate of 1 inch per week.
- D. Mow lawns as soon as there is enough top growth to cut with mower set at specified height for principal species planted. Repeat mowing as required to maintain specified height without cutting more than 40 percent of the grass height. Remove no more than 40 percent of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain a grass height of 1½ to 2½ inches.

PART 2 PRODUCTS

2.1 PLANTING BACKFILL

- A. Mixture shall be 4 parts topsoil (on-site or imported), 1 part peat moss, ½ part well-rotted manure and 10 pounds 5-0-5 planting fertilizer, mixed thoroughly per cubic yard.

2.2 TOPSOIL

- A. Source: Provide topsoil from existing stockpiles stripped from the project site and approved by the Engineer.
- B. Where existing topsoil is not available, provide topsoil conforming to the following:
 1. Original loam topsoil, well drained homogeneous texture and of uniform grade, without the admixture of subsoil material and entirely free of dense material, hardpan, sod, or any other objectionable foreign material.
 2. Containing not less than 5 percent nor more than 20 percent organic matter in that portion of a sample passing a 1/4-inch sieve when determined by the wet combustion method on a sample dried at 105 degrees C.

3. Containing a pH value within the range of 6.5 to 7.5 on that portion of the sample that passes a 1/4-inch sieve.
4. Containing the following gradations:

SIEVE DESIGNATION	PERCENT PASSING
1 inch	100
1/4 inch	97 - 100
No. 200	20 - 60

2.3 SOIL AMENDMENTS

- A. Lime: ASTM C 602, Class T, agricultural limestone containing a minimum 85 percent calcium carbonate equivalent, with a minimum 90 percent passing a No. 10 mesh sieve and a minimum 50 percent passing a No. 100 mesh sieve.
 1. Provide lime in the form of dolomitic limestone.
 2. Add lime soil as necessary to achieve a soil pH between 5.5 – 7.0.
- B. Aluminum Sulfate: Commercial grade, unadulterated.
- C. Herbicides: EPA registered and approved, of type recommended by manufacturer.
- D. Sand: Clean, washed, natural or manufactured, free of toxic materials.
- E. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 3/4-inch sieve; soluble salt content of 5 to 10 decimeters/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
 1. Organic Matter Content: 50 to 60 percent of dry weight.

2.4 FERTILIZER

- A. Application of any fertilizer is prohibited between December 1st and April 1st and cannot be applied within 20' of a water body.
- B. Fertilizer: Mixed commercial fertilizers shall contain total nitrogen, available phosphoric acid and soluble potash in the ratio of 10-0-10. No fertilizer containing phosphorus is permitted on site.
- C. Other fertilizers meeting DOT Specification Section 713-03 Fertilizer can be used.

2.5 MULCH

- A. Dry Application, Straw: Stalks of oats, wheat, rye or other approved crops that are free of noxious weed seeds. Weight shall be based on a 15 percent moisture content.

- B. Hydro Application: Colored wood cellulose fiber product specifically designed for use as a hydro-mechanical applied mulch. Acceptable Product: Conwed Hydro Mulch, Conwed Fibers, 231 4th Street SW, Hickory, NC or approved equivalent.

2.6 SEED

- A. Furnish fresh, clean, new-crop seed mixed in the proportions specified for species and variety and conforming to Federal and State Standards.
- B. Acceptable material in a seed mixture other than pure live seed consists of nonviable seed, chaff, hulls, live seed of crop plants and inert matter. The percentage of weed seed shall not exceed 0.1 percent by weight.
- C. All seed will be rejected if the label or test analysis indicates any of the following contaminates: Timothy, Orchard Grass, Sheep Fescue, Meadow Fescue, Canada Blue Grass, Alta Fescue, Kentucky 31 Fescue, and Bent Grass.
- D. Provide seed mixture equal to Scotts Pure Premium Sun and Shade North Grass Seed Mixture or approved equal. Install in accordance with manufacturer's recommendations.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive landscaping for compliance with requirements and for conditions affecting performance of work of this Section. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PLANTING SOIL PREPARATION

- A. Before mixing, clean topsoil of roots, plants, sods, stones, clay lumps, and other extraneous materials harmful to plant growth.
- B. Mix soil amendments and fertilizers with topsoil as necessary to meet applicable ASTM standards.
- C. For lawns, mix planting soil either prior to planting or apply on surface of topsoil and mix thoroughly before planting.
 - 1. Mix lime with dry soil prior to mixing fertilizer. Prevent lime from contacting roots of acid-tolerant plants.
 - 2. Apply lime per manufacturer instructions based on soil pH.

3.3 LAWN AREA PLANTING PREPARATION

- A. Limit sub-grade preparation to areas that will be planted in the immediate future.
- B. Loosen sub-grade to a minimum depth of 4 inches. Remove stones larger than 1-1/2 inches in any dimension and sticks, roots, rubbish, and other extraneous materials.
- C. Spread topsoil to depth (4 inches minimum) required to meet the thickness, grades, and elevations shown, after light rolling and natural settlement. Do not spread if planting soil or sub-grade is frozen.
 - 1. Place approximately 1/2 the thickness of planting soil mixture required. Work into top of loosened sub-grade to create a transition layer and then place remainder of planting soil mixture.
- D. Grade lawn and grass areas to a smooth, even surface with loose, uniformly fine texture. Roll (112-pound roller maximum) and rake, remove ridges, and fill depressions to meet finish grades. Limit fine grading to areas that can be planted in the immediate future. Remove trash, debris, stones larger than 1-1/2 inches in any dimension, and other objects that may interfere with planting or maintenance operations.
- E. Moisten prepared lawn and grass areas before planting when soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
- F. Restore prepared areas if eroded or otherwise disturbed after fine grading and before planting.

3.4 FERTILIZING

- A. The soil shall be tested for pH and lime added as necessary. All amendments shall be checked and approved by the Landscape Architect before amendments are made.
- B. Apply fertilizer at a rate of 20 LBS/1,000 SF.

3.5 SEEDING

- A. Contractor shall assume all risks when seed is sowed before approval of seed analysis.
- B. Sow seed by hand broadcasting or hydroseeding. Do not broadcast or drop seed when wind velocity exceeds 5 mph. Evenly distribute seed by sowing equal quantities in 2 directions at right angles to each other.
 - 1. Do not use wet seed or seed that is moldy or otherwise damaged in transit or storage.
 - 2. Do not sow immediately following rain, when ground is too dry, or during windy periods.

- C. Sow seed at the following rates:
 - 1. Per manufacturer recommendations
 - 2. Low Maintenance Fescue Lawn, Seeding Rate: 6 lbs per 1000 sq. ft.
 - 3. Seed Mix for Wet Locations, Seeding Rate: 4 lbs per 1000 sq. ft.
- D. Rake seed lightly into top 1/8 inch of topsoil, roll lightly, and water with fine spray, immediately after each area has been mulched. Saturate to 4 inches of soil.
- E. Protect seeded areas with slopes less than 1:3 against erosion by spreading mulch after completion of seeding operations.
 - 1. Mulch rates.
 - a. Oat or wheat straw applied at a minimum rate of 2 tons per acre to form a continuous blanket 1-1/2 inches loose depth over seeded areas. Spread by hand, blower, or other suitable equipment.
 - b. Fill tank with water and agitate while adding seeding materials. Use sufficient fertilizer, mulch, and seed to obtain the specified application rate. Add seed to the tank after the fertilizer and mulch have been added. Maintain constant agitation to keep contents in homogenous suspension. Prolonged delays in application or agitation that may be injurious to the seed will be the basis of rejection of material remaining in tank.
 - c. Apply slurry uniformly to all areas to be seeded in a one-step process. Apply mulch at a minimum rate of 57 gal/1000 sf (2500-lb/acre dry weight but not less than the rate required to obtain specified seed-sowing rate.
- F. Anchor mulch by spraying with asphalt-emulsion tackifier at the rate of 10 to 13 gal. per 1000 sq. ft. Take precautions to prevent damage or staining of structures or other plantings adjacent to mulched areas. Immediately clean damaged or stained areas.

3.6 LAWN RESTORATION

- A. Renovate existing lawn within work limit.
- B. Renovate existing lawn damaged by Contractor's operations, such as storage of materials or equipment and movement of vehicles.
- C. Reestablish lawn where settlement or washouts occur or where minor regrading is required.
 - 1. Install new planting soil as required.
- D. Remove lawn from diseased or unsatisfactory existing lawn areas; do not bury in soil.

- E. Remove topsoil containing foreign materials such as oil drippings, fuel spills, stones, gravel, and other construction materials resulting from Contractor's operations, and replace with new planting soil.
- F. Where substantial lawn remains, mow, dethatch, core aerate, and rake. Remove weeds before seeding.
- G. Remove weeds before seeding. Where weeds are extensive, apply selective herbicides as required. Do not use pre-emergence herbicides.
- H. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and lawn, and legally dispose of them off Owner's property.
- I. Till stripped, bare, and compacted areas thoroughly to a soil depth of 6 inches.
- J. Apply soil amendments and fertilizers required for establishing new lawn and mix thoroughly into top 4 inches of existing soil. Install new planting soil to fill low spots and meet finish grades.
- K. Apply seed and protect with straw mulch as required for new lawn.
- L. Provide lawn maintenance as required for new lawn.

3.7 SATISFACTORY LAWNS, GRASS, AND LAWN RESTORATION

- A. Satisfactory Lawns, Grass, and Lawn Restoration: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 95 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches.
- B. Reestablish those that do not comply with requirements and continue maintenance until satisfactory.

3.8 CLEANUP AND PROTECTION

- A. During landscaping, keep pavements clean and work area in an orderly condition.
- B. Protect landscaping from damage due to landscape operations, operations by other contractors and trades, and trespassers. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged landscape work as directed.

3.9 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Disposal: Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of it off the Owner's property.

END OF SECTION 329200

SECTION 33 11 02 - WATER UTILITY DISTRIBUTION PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. These specifications cover the installation of water distribution piping and appurtenances.

1.2 RELATED SECTIONS

- A. Section 31 00 00 - Earthwork

1.3 REFERENCED STANDARDS

- A. Recommended Standards for Water Works (Ten States Standards), latest Edition, Great Lakes Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers, as amended.
- B. AWWA/ANSI C151/A21.51 - Ductile Iron Pipe.
- C. AWWA/ANSI C600 – Installation of Ductile Iron Water Mains and their Appurtenances.
- D. AWWA/ANSI C104/A21.4 - Cement Mortar Lining for ductile iron pipe and fittings.
- E. AWWA C508 - Swing-Check Valves for Waterworks Service, 2 in. Through 24 in. NPS.
- F. AWWA C509 - Resilient-Seated Gate Valves for Water-Supply Service.
- G. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
- H. ASTM D1557 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (6,000 ft-lbf/ft³).
- I. ASME B16.22 - Wrought Copper and Bronze Solder-Joint Pressure Fittings.

1.4 SUBMITTALS

- A. General: Submit the following in accordance with the Contract Document requirements.
- B. Product data for pipe materials, pipe fittings, valves, hydrants, tapping sleeve, valve boxes, curb boxes, corporation valves, curb stops and accessories. Provide manufacturer's catalog information. Indicate valve data and ratings.
- C. Product data for check valves, utility vaults and accessories.
- D. Manufacturer's certificates.
- E. Project record documents.
- F. Pressure, Flushing and Disinfection Test Reports performed as well as any laboratory results received as part of this work. Specifically:

1. Pressure Report:
 - a. Hydrostatic Test Pressure.
 - b. Dates and time for start and completion of pressure testing.
 - c. Pressure results at start and finish of each section tested.
 - d. Amount of Water Used during testing.
 - e. Signature of person performing tests and signature of witness.
2. Flushing Report
 - a. Dates and times for flushing of each water main section.
 - b. Length of flushing time, pipe size and flushing flow rate.
3. Disinfection report:
 - a. Type and form of disinfectant used.
 - b. Date and time of disinfectant injection start and time of completion.
 - c. Test locations.
 - d. Initial and final disinfectant residuals (quantity in treated water) in ppm for each outlet tested.
 - e. Date and time of flushing start and completion.
 - f. Disinfectant residual after flushing in ppm for each outlet tested.
 - g. Procedure for neutralizing disinfectant and for discharge of flushed water.
 - h. Signature of person performing tests and signature of witness.
4. Bacteriological report:
 - a. Date issued, project name, and testing laboratory name, address, and telephone number.
 - b. Time and date of water sample collection.
 - c. Name of person collecting samples.
 - d. Test locations.
 - e. Initial and final disinfectant residuals in ppm for each outlet tested.
 - f. MFT Coliform bacteria test results for each outlet tested. (Other testing methods are not acceptable).
 - g. Certification that water conforms, or fails to conform, to bacterial standards of Orange County Department of Health.

G. Operation and maintenance data.

H. Spare parts and maintenance materials.

I. Warranties.

1.5 QUALITY ASSURANCE

- A. Environmental Compliance: Comply with applicable portions of local health department and environmental agency regulations pertaining to water service systems.
- B. Utility Compliance: Comply with Owner regulations and standards pertaining to water service.

- C. Ensure products and installations of specified products are in conformance with recommendations and requirements of the following organizations:
 - National Sanitation Foundation (NSF).
 - American Society of Mechanical Engineers (ASME).
 - National Electrical Manufacturer's Association (NEMA).
 - Underwriters Laboratories (UL).
- D. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- E. Comply with NSF 61 for materials for water-service piping and specialties for domestic water.
- F. Perform Work in accordance with Orange County Department of Health requirements.
- G. Valves: Manufacturer's name and pressure rating marked on valve body.
- H. All products shall be produced within the United States of America and/or the Dominion of Canada and in new condition

1.6 PROJECT CONDITIONS

- A. Location of Water Service Piping: The location, elevations, and grades of water service piping are shown on the Drawings and shall be adhered to as closely as possible. If, during construction of the project, it becomes necessary to make changes in the location or grades of the piping, the Owner's representative will issue appropriate directions after being contacted by the Contractor.
- B. Site Information: Contractor shall inspect the Work site, research public utility records, and verify existing utility locations. Verify that water service piping may be installed in compliance with original design and referenced standards.
- C. 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 Engineer and Owner's Representative not less than three days in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without Owner's Representative's permission.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, protect and handle products at site under provisions of the General Conditions. Elevate above grade.
- B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- C. Provide temporary protective coating on cast iron and steel valves.
- D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

- E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system
- F. Products lost or damaged by the Contractor shall be replaced at the sole cost of the Contractor.

1.8 SEQUENCING AND SCHEDULING

- A. Coordinate connection to existing water systems as per Drawings.
- B. Coordinate with other utility work.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

- A. General: Provide pipe and pipe fitting materials compatible with each other. Where more than one type of materials or products is indicated, selection is Installer's option.
- B. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the products specified.
 - 2. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.
- C. Water distribution piping 4" and larger: Ductile iron pipe shall be Class 52, cement lined, rubber-gasket, locking type for push-on joints, or mechanical restrained-joint type, rated for 350 psi working pressure, with mechanical joint cast iron/ductile iron fittings conforming to the following specifications:

1. Rubber gaskets joints	AWWA/ANSI C111/A21.11
2. Ductile iron and gray iron fittings	AWWA/ANSI C110/A21.10
3. Ductile iron compact fittings	AWWA/ANSI C153/A21.53
4. Ductile iron pipe	AWWA/ANSI C151/A21.51
- D. End Caps: Ductile iron, AWWA C110 as manufactured by U.S. Pipe and Foundry, American Ductile Iron Pipe Company, Clow or approved equal.
- E. Joint Restraint: AWWA C111. Joint restraints shall be U.L. listed and Factory Mutual approved to withstand a minimum pressure of 250 psi. The joint restraints shall be provided for ductile iron push on or mechanical joint pipe with twist off indicators and shall be as manufactured by EBAA Iron Megalug for mechanical joint pipe, U.S. Pipe and Foundry FIELD LOK 350 for push on joint, or approved equal.

F. Transition Couplings:

1. Underground Piping, NPS 1-1/2 and Smaller: Manufactured fitting or coupling same size as, with pressure rating at least equal to and ends compatible with, piping to be joined. Connecting copper CTS tubing shall be completed using Mueller110 compression coupling H-15403. Connecting copper tubing (CTS) to iron pipe size (IPS) piping shall be completed using McDonald compression coupling model 74758-22-55.
2. Underground Piping, NPS 2 and Larger: AWWA C219, metal, sleeve-type coupling same size as, with pressure rating at least equal to and ends compatible with, piping to be joined, Dresser Style 38, Smith-Blair 411, or approved equal. These flexible couplings are not intended to be used in unrestrained pipe conditions where potential pullout of pipe ends can occur. For restraint of pipe and fittings are required, provide Roma Style 501 transition coupling with RomaGrip.

G. Concrete for cradles, pipe encasement, and special structures shall conform to ACI-318, with minimum compressive strength of 3,000 psi at 28 days, 5% to 7% entrained air, w/c ratio less than 0.45, 3/4 inch max size aggregate, and four (4) inch slump, unless otherwise noted.

H. Steel reinforcement embedded in concrete shall conform to ASTM A615, Grade 40 or 60, deformed bars, unless otherwise noted.

2.2 VALVES AND ACCESSORIES

A. General: Ductile iron by Clow, Mueller, Fairbanks, or approved equal.

B. AWWA, Cast-Iron Gate Valves:

1. Available Manufacturers and Models: Mueller, Clow (Model 2639/2640), American Flow Control (Series 2500).
2. Nonrising-Stem, Resilient-Seated Gate Valves: AWWA C509, gray- or ductile-iron body and bonnet; with bronze or gray- or ductile-iron gate, resilient seats, bronze stem, shall open by turning to the left (counterclockwise), shall be furnished with 2" square operating nut and wrench and shall be designed to take full pressure on either face with no pressure on the opposite face.
 - a. Minimum Working Pressure: 250 psig.
 - b. End Connections: Mechanical joint.
 - c. Interior Coating: Complying with AWWA C550.

C. Valve Boxes: Valve boxes shall be manufactured by Tyler Pipe Co., Ford, or Bingham & Taylor and shall be from one manufacturer. Valve boxes shall be of the sliding adjustable telescope type with a barrel not less than 5 1/4" in diameter with a round or oval base to fit the valve on which it is to be installed. Two "T" type valve wrenches of proper size shall be furnished for each type of valve. Wrenches shall be long enough to reach the deepest valve on the project with "T" handle three to five feet above grade. Valve boxes shall be provided with mating cast-iron drop covers. The

direction of opening of the valve shall be indicated by an arrow in the direction of opening the word "open", cast in the cover. The word "water" shall be cast in the cover.

2.3 FIRE HYDRANTS

- A. Manufacturer and Model: Clow Centurion Medallion.
- B. Hydrants shall comply with AWWA C502 standards and conform to City of Newburgh standards. Hydrant shall be of the compression type, with the main valve opening against water pressure. The hydrant shall be dry-top, the bonnet and stuffing box shall be sealed from contact with water in the upper barrel. Hydrant shall be rated for a working pressure of 250 psig. Hydrants shall be traffic type with breakable safety flange.
- C. Hydrant shall be furnished with two (2) 2 ½" national standard thread hose nozzles and one (1) 4 ½" national standard thread pumper nozzle. Nozzles shall be field replaceable. Outlets shall have cast iron caps with non-kinking steel chains.
- D. Hydrant shall have minimum main valve opening of 5 ¼" and have a 6" mechanical joint inlet foot piece.
- E. Hydrant shall open counter clockwise (left) and shall be so marked on the hydrant bonnet. Operating nut: Pentagon 1 ½" point to flat.
- F. Hydrant shall have the name monogrammed or initialed by the manufacturer.
- G. Minimum bury depth shall be five (5) feet measured from the top of the valve body to the finished ground surface.
- H. Hydrant Extensions: Provide hydrant barrel extension in multiples of 6 inches with rod and coupling to increase barrel length as required to match finished grade at hydrant location.
- I. Finish: Primer and two coats of red enamel in color, color subject to approval by the Owner's Representative.
- J. As a general rule, hydrants should be oriented with the pumper outlet perpendicular to the curb or edge of pavement.

2.4 IDENTIFICATION

- A. Detectable Warning Tapes: Acid- and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide by 4 mils thick, solid blue in color with continuously inscribed caption in black letters "CAUTION-WATER LINE BURIED BELOW", with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep.
- B. Install warning tape directly above pipe, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

2.5 CONCRETE AS CONTROLLED BACKFILL

- A. General: Concrete for use in trenches as controlled backfill shall conform to NYSDOT Standard Specifications. All other concrete shall conform to NYSDOT Standard

specification 500.

2.6 INSPECTION OF MATERIALS

- A. The manufacturers of materials shall furnish the Owner's Representative a Certificate of Inspection, certified by factory inspector, or reports of tests made by an independent testing laboratory, in three copies, showing that materials furnished conform to applicable specifications set out herein. Each inspection certificate or laboratory report shall identify the materials by number of pieces shipped and date of invoice.
- B. A careful field inspection shall be made of all material before installation, and any material found to be damaged in shipment or not meeting the requirements of the Specifications will be rejected and replaced.

PART 3 - EXECUTION

3.1 ALIGNMENT, LINES, AND GRADES

- A. The Contractor will be responsible for the proper execution of the work to the alignment, lines and grades established. Wherever obstructions not shown on the Drawings are encountered during the progress of the work and interfere to such an extent that an alteration of the line and/or grade is required, the Owner's representative shall have the authority to order a deviation from the line and grade.

3.2 AS-BUILT DRAWINGS

- A. The Contractor is to maintain detailed notes and a red-line as-built set of marked-up Contract Drawings throughout construction. Prior to the close of the contract, the Contractor will be required to provide the Owner with a copy of the field notes and red-line as-built drawings.
- B. The Contractor shall legibly mark and record actual locations, elevations, and dimensions of installed Work on a single set of the Contract Drawings. Installed Work includes, but is not limited to, water mains and fittings such as bends and tees, valves, curb box, and individual water service lines.
- C. Location of installed work shall be determined from cross tie measurements from at least two (2) fix objects such as utility pole, building corner, monument, etc....

3.3 PREPARATION OF FOUNDATION FOR BURIED WATER SERVICE

- A. Grade trench bottom to provide a smooth, firm, stable, and rock-free foundation, throughout the length of the pipe.
- B. Remove unstable, soft, and unsuitable materials at the surface upon which pipes are to be laid, and backfill with clean sand or pea gravel to indicated level as directed by the Owner's representative.
- C. Shape bottom of trench to fit bottom of pipe. Fill unevenness with tamped sand backfill. Dig bell holes at each pipe joint to relieve the bells of all loads and to ensure continuous bearing of the pipe barrel on the foundation.

3.4 INSTALLATION, GENERAL

- A. General Locations and Arrangements: Drawings (plans and details) indicate the general location and arrangement of the water service piping. Location and arrangement of piping layout take into account many design considerations. Install the piping as indicated, to the extent practical. Establish elevations of buried piping to ensure not less than 5 ft of cover, or as specified in the contract plans. If, during construction of the project, it becomes necessary to make changes in the location or grades, the Owner's representative will issue appropriate directions after being contacted by the Contractor.
- B. Use proper size increasers, reducers, and couplings, where different size or material of pipes and fittings are connected.

3.5 WATER MAINS RELATION TO EXISTING SEWERS

- A. Maintain separation of water main from sewer and other utilities in accordance with contract plans and Orange County Department of Health requirements.
- B. Horizontal Separation: Whenever possible, water mains shall be laid at least 10 feet, horizontally, from any existing or proposed gravity and force main sewers. The distance shall be measured edge to edge.
- C. Vertical Separation: Whenever water mains must cross sewers, the water mains shall be laid to provide a minimum clear vertical distance of 18 inches between the outside of the water main and the outside of the sewer. This shall be the case where the water main is either above or below the sewer. At crossings, one full length of water main should be centered over the sewer so that both joints will be as far from the sewer as possible.
- D. Special Conditions: When it is impossible to obtain proper horizontal and vertical separation as stipulated above:
 - 1. The water main should be constructed of a slip-on or mechanical-joint ductile iron pipe, and the sewer constructed of mechanical-joint ductile iron pipe conforming to AWWA standards and both pressure tested to assure water tightness, OR
 - 2. Concrete encasement and/or offsetting of the waterline shall be required.

3.6 PIPE JOINT CONSTRUCTION AND INSTALLATION

- A. Make pipe joints according to the following:
 - 1. Ductile-Iron Piping, Gasketed Joints for Water-Service Piping: AWWA C600 and AWWA M41.
- B. Join and install pipe as follows:
 - 1. Restrained Pipe and fittings: Restrained push-on joint gaskets and/or mechanical joint restraint as per ANSI A21-51.
 - 2. Where required for thrust restraint, provide and install restrained joint gaskets such as FieldLok 350 [U.S. Pipe] or Grip [American Pipe] for push-on pipe joints and mechanical joint restraints such as Megalug [EBAA Iron] or Uni-Flange [Ford Meter Box Company] for mechanical joint fittings and valves in accordance with manufacturer's recommendations.
- C. Dissimilar Materials Piping Joints: Join different types of pipe with standard manufactured couplings and fittings intended for that purpose. Use adapters

compatible with both piping materials, with OD, and with system working pressure.

3.7 PIPE INSTALLATION, GENERAL

- A. Install in accordance with manufacturer's instructions and in conformance to AWWA C600.
- B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
- C. Route piping in orderly manner and maintain gradient.
- D. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- E. To insure electrical conductivity, install a minimum of 3 bronze wedges at each mechanical or push on joint.

3.8 INSTALLATION – VALVES AND HYDRANTS

- A. Valves
 - 1. Set valves on solid concrete block.
 - 2. Center and plumb valve box over valve. The boxes shall be fitted together securely and set so that the cover is flush with the surface of the ground and street. Before permanent paving or surface restoration is placed, the Contractor shall, if necessary, raise or lower the valve boxes so that the covers shall be even with the final surface of the permanent paving or surface restoration.
- B. Hydrants
 - 1. Set hydrants plumb; locate pumper nozzle perpendicular to and facing roadway.
 - 2. Set hydrants to grade, with nozzles at least 20 inches above ground.
 - 3. Provide a drainage pit 36 inches square by 24 inches deep filled with crushed stone. Encase elbow of hydrant in crushed stone to 6 inches (150 mm) above drain opening. Do not connect drain opening to sewer. Hydrant drains shall be plugged in areas of high ground water. Hydrants with plugged drains shall be noted on the as constructed drawings.

3.10 FIELD QUALITY CONTROL

- A. Cleaning: Clear interior of piping and structures of dirt and other superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed.
- B. Place plugs in ends of uncompleted pipe at the end of the day or whenever work stops.

- C. Flush piping to remove collected debris.
- D. Interior Inspection: Inspect piping to determine whether line displacement or other damage has occurred.
- E. Make inspections after pipe has been installed and approximately 2 feet of backfill is in place, and again at completion of project.
- F. If inspection indicates poor alignment, debris, displaced pipe, infiltration, or other defects, correct such defects and reinspect.

3.11 TESTING, FLUSHING, CLEANING AND DISINFECTION

- A. Installation and testing of the proposed water mains shall be inspected and certified by the Owner's representative. The Contractor shall notify the Owner's representative 3 working days prior to commencing work, and again 3 working days hours prior to performing the required testing.
- B. After completion of construction and before any user is permitted to connect, the water main shall be tested for pressure and leakage in accordance with AWWA C600 (latest edition) for 4 hours. All mains, including hydrants shall be included in the pressure and leakage test. Fill piping and conduct piping tests after thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water. Pressure and leakage tests shall be performed on sections between valves of not more than 1,500 feet in length. All equipment and labor for the hydrostatic test shall be provided by the Contractor.
- C. Clean interior of piping systems. Remove dirt and debris as work progresses.
- D. The Contractor will be allowed to use reasonable amounts of water from the existing Owner's distribution system for filling, flushing, pressure testing and disinfection of water mains. However, the Contractor will be required to coordinate this operation with the Owner's Operation's Department a minimum of 3 working days prior to each use to allow the Owner to maximize storage in the system so existing customers are not impacted. Water required due to Contractor's failure to meet testing specifications will be billed to the Contractor by the Owner at twice the Owner's standard water rate.
- E. Pressure Testing:
 - 1. Prior to starting work, verify system is complete, flushed and clean.
 - 2. Perform pressure testing at 1.5 times the operating pressure for the system, at not less than 150 psi and in accordance with AWWA C600 standards for a minimum of 4 hours. Perform the pressure testing in conformance with the pressure test requirements as indicated in the contract plans. Test pressure shall be maintained by the addition of water such that the minimum test pressure is maintained at all times.
 - 3. The Owner's Representative shall witness all pressure testing and all pressure test results shall be subject to review and approval of the Owner's Representative and the Orange County Department of Health.

4. The section to be tested shall be slowly filled with water and the specified pressure applied by pump. Provisions shall be made to relieve air trapped at high points in the system through service lines or adjacent hydrants or through taps installed for this purpose by the Contractor as may be necessary.
5. The maximum allowable leakage shall be per AWWA C-600.
6. If leakage in system exceeds the specified amount, the Contractor shall, at no added cost to the Owner, locate, repair, and/or replace defect(s) and re-test piping system.

F. Flushing.

Perform flushing operations as follows:

1. Flushing water shall be obtained from the existing water system and directional flushing shall proceed from the water source into the new water mains, isolating sections not being flushed or not required to supply water.
 2. The water mains shall be flushed at a minimum velocity of 2.5 feet per second for a minimum duration of 30 minutes.
 3. The Contractor is alerted that all water shall be discharged in accordance with the following maximum chlorine residual levels as measured by the free chlorine content:
 - a. In no case shall the chlorine residual be greater than 0.005ppm.
 - b. Where the water is discharged to a trout spawning stream or its drainage basin, the chlorine residual shall not be greater than 0.001 ppm.
 4. The Contractor shall provide and maintain all required de-chlorination facilities, including but not limited to holding tanks, chemical holding tanks and feed systems, test materials and or devices, and all piping and appurtenances as necessary to meet the above prescribed limits.
- G. Disinfect water-distribution piping as follows: Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in AWWA C651 as described below except that the tablet method shall not be used:
1. Fill system or part of system with water/chlorine solution containing at least 50 ppm of chlorine; isolate and allow to stand for 24 hours. After 24 hour holding period, free chlorine residual shall be measured. Free chlorine residual after 24 hour holding shall not be less than 25 mg/L. Should this level not be achieved, re-chlorination is required.

2. After standing time and achieving required free chlorine residuals, flush system with clean, potable water until chlorine residual matches water coming from system. The discharge, chlorine residual and de-chlorination requirements for this flushing water shall be the same as listed in Section 3.10 C above.
3. Submit water samples in sterile bottles to independent testing laboratory approved by the Owner. Provide two (2) sets of sample results with a second sample collected approximately 24 hours after the first sample. The Owner's Representative shall witness all disinfection sampling.
4. If any of the above samples fail to meet the standards of the Orange County Department of Health for drinking water, the water main shall be re-flushed, re-disinfected and re-sampled until satisfactory results are obtained. Water required for re-flushing or retesting shall be at the Contractor's expense.

H. Prepare reports of pressure testing, flushing and disinfecting activities.

3.12 INSTALLATION OF IDENTIFICATION

- A. Install continuous plastic underground warning tape during backfilling of trench for underground mains and water service piping. Install warning tape directly above pipe, 12 inches below finished grade, except 6 inches below subgrade under pavements and sidewalks.

3.13 CLEANING UP

- A. As work progresses, the Contractor shall clean up the streets and rights-of-way, and the backfill shall be rounded within the limits of the excavation. Soft trenches shall be marked and protected with signs and adequate lights, and subsequent settlement shall be promptly refilled.
- B. All backfill trenches and surrounding areas of work in progress shall be maintained as clean and dust-free as practical, as determined by the Owner's Representative. Water, mechanical sweepers or other means as may be required shall be employed by the Contractor to satisfy the Owner's Representative.
- C. Upon the completion of the work, all dirt, debris and rubbish shall be hauled and disposed of at an approved disposal site provided by the Contractor and the construction site left clean to the satisfaction of the Owner's Representative. All surplus materials furnished by the Contractor and all tools and temporary structures shall be removed from the site by the applicant.

3.14 RESTORATION AND MAINTENANCE OF PAVEMENTS, DAMAGED SURFACES AND PROPERTY

- A. The Contractor shall restore or replace all removed or damaged paving, curbing, sidewalks, paved and grassed swales, gutters, graveled and paved driveways, mailboxes, shrubbery, grass, fences, sod or other disturbed surfaces or structures in a condition equal to that before the work began and to the satisfaction of the Owner's Representative and shall furnish all labor and material incidental thereto. In restoring

improved surfaces, new pavement shall be laid, except that granite paving blocks, sound brick or sound concrete paving blocks may be reused.

- B. Pavement replacement shall be made in accordance with the Contract Drawings and in accordance with the specifications and directions of State, County or Town authorities having jurisdiction over the pavement.
- C. After the certification by the Owner's Representative of the completion of work, the Contractor shall maintain the surface of unpaved trenches and adjacent curbs and gutters, sidewalks, shrubbery, fences, sod and grass areas, and other disturbed surfaces until full restoration is established. The Contractor shall maintain, for one (1) year after certification of completion, areas that have been repaved and curbs, gutters and sidewalks that have been replaced, unless otherwise required by State, County or Town officials having jurisdiction. All material and labor required for the maintenance of affected areas shall be supplied by the Contractor, and the maintenance shall be done in a manner satisfactory to the Owner's Representative.

END OF SECTION 33 11 02

SECTION 33 41 00 – STORMWATER UTILITY DRAINAGE PIPING

PART 1 GENERAL

1.1 SUMMARY

- A. Under this section the Contractor shall provide all labor, equipment and material necessary to furnish, install and test all storm utility drainage pipe and fittings as shown on the Contract Plans.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Contract Plans and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Section 31 20 00: Excavation and Fill
- C. Section 33 49 00: Storm Drainage Structures

1.3 PROJECT CONDITIONS

- A. Location of Sewers and Sewer Structures: The location, elevation, and grades of sewers and sewer structures are shown on the Contract Plans and shall be adhered to as closely as possible. If during construction of the project, it becomes necessary to make changes in the location or grades of the sewers, the Engineer will issue appropriate directions after being contacted by the Contractor.
- B. Site Information: Perform site survey, research public utility records, and verify existing utility locations. Verify that storm sewerage system piping may be installed in compliance with original design and referenced standards.

1.4 SUBMITTALS

- A. Shop Drawing: Pipes and associated fittings.
- B. Product Data: Manufacturer's specifications, including dimensions, allowable height of cover information, and installation instructions.
- C. Manufacturer's product literature, installation instructions and shop Plans for infiltration systems.
- D. As-built record Plans at project closeout of installed storm sewerage piping and products. An as-built survey prepared by licensed NYS Surveyor depicting the installed storm sewer piping and structures including rim and invert elevations of structures pipe size, pipe type, and invert of all piping. Both hard copy and electronic copy shall be provided to the Owner and Engineer.

1.5 QUALITY ASSURANCE

- A. Comply with standards of the Chain Link Fence Manufacturer's Institute.
- B. Provide steel fence and related gates as a complete compatible system including necessary erection accessories, fittings, and fastenings.
- C. Posts and rails shall be continuous without splices.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of the General Conditions.
- B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.7 SEQUENCING AND SCHEDULING

- A. Coordinate with other utility work.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Corrugated Polyethylene Pipe (HDPE, Dual Wall with Smooth Interior): Conform to AASHTO M-294.
 - 1. Classification: Soil-tight, integral bell and spigot joints. Joints shall be sealed with factory installed rubber O-ring gaskets that meet ASTM F-477.
 - 2. Coefficient of Roughness (interior pipe surface): 0.012 maximum (Manning formula).
 - 3. Joint Couplings (Soil-tight): Polyethylene, bell-and-spigot type couplers utilizing an elastomeric gasket conforming to ASTM F-477.
 - 4. Fittings:
 - a. High density polyethylene meeting the properties specified for the pipe.
 - b. Either molded or fabricated.
 - c. Designed specifically for the pipe furnished and manufactured by the pipe manufacturer.

5. Acceptable Manufacturer:
 - a. ProLink ST (N-12 IB ST), Smooth Interior Pipe & Fittings by Advanced Drainage Systems, Inc., (ADS) 3300 Riverside Dr., Columbus, OH 43221; (614) 457-3051
 - b. Approved equivalent.
- B. High Density Polyethylene Pipe (HDPE) Perforated Pipe: Perforated double wall smooth interior pipe complying with the following:
 1. 4" to 10" diameter pipe to conform to AASHTO M 252.
 2. 12" to 36" diameter pipe to conform to AASHTO M 294
 3. Coefficient of Roughness (Interior Pipe Surface): 0.012 maximum (Manning Formula).
 4. Classification: Type S
 5. Joint Couplings: Polyethylene, bell and spigot type couplers utilizing an elastometric gasket conforming to ASTM F 477. Snap on type or split collar through 24" diameter.
 6. Corrugated to match pipe corrugations, width not less than one half the pipe diameter.
 7. Split couplings shall engage an equal number of corrugations on each side of the joint.
 8. Fittings: Either molded or fabricated, high density polyethylene components meeting the properties specified for, and designed specifically for the pipe manufactured by the pipe manufacturer.
 9. Perforated Pipe: Conform to AASHTO M-252 or AASHTO M-294, Type SP with Class I perforations.
 10. Specifications have been based on products manufactured by Advanced Drainage Systems, Inc, Columbus, Ohio (Tel. #614-457-3051) or Hancor, Inc., Findlay, Ohio (Tel. #800-847-5880).
- C. Polyvinyl Chloride (PVC) Pipe for in-line drain piping, solid: Conform to ASTM D-3034 and ASTM F1336 (SDR-35)
 1. Conform to shape, dimensions, and thickness shown on the Contract Drawings.
 2. Provide fittings of the same size and pressure rating as the pipe to which they are connected.
 3. Rubber gasketed joints manufactured in accordance with ASTM D-3139.
 4. Rubber gaskets shall comply with ASTM D3212 Internal Pressure Test and Vacuum Test at 5 degrees of gasket joint deflection.

5. AdvanEdge Pipe and Couplings, as manufactured by Advanced Drainage Systems, Inc., (ADS) 3300 Riverside Dr., Columbus, OH 43221; (614) 457-3051, or approved equivalent.

D. Synthetic Turf Flat Panel Composite Drain

1. Flat panel underdrain system complying with the following:
 - a. 1-1/2" X 12" flat panel underdrain, wrapped in geotextile fabric.
 - b. End connectors fabricated for use with 5" solid HDPE riser pipe.
 - c. Solid HDPE collector pipe.
 - d. Materials manufactured by Multi-Flow Drainage Systems (Model #12000) or approved equal.
2. Fittings: Either molded or fabricated, high density polyethylene components meeting the properties specified and designed specifically for and by the same manufacturer as the flat panel underdrain system.
 - a. Flat panel underdrain tee connection: Multi-Flow Drainage Systems (Model #12CTH) or approved equal.
 - b. Snap coupler connection: by Multi-Flow Drainage Systems or approved equal.
 - c. Flat panel underdrain end cap: Multi-Flow Drainage Systems (Model #12001) or approved equal.
 - d. Specifications have been based on Multi-Flow Drainage System products manufactured by Varicore Technologies, Inc, Prinsburg, Mn. Approved equivalents acceptable.

2.2 NON-WOVEN GEOTEXTILE FABRIC

- A. Continuous filament fabric consisting of polypropylene fibers and heat bonded nylon sheathed polypropylene fibers.

2.3 STORM SEWER PIPE, COLLECTOR PIPE, RISER PIPE, AND FITTINGS

- A. General: Provide pipe and pipe fitting materials compatible with each other. Where more than one type of materials or products is indicated, provide as indicated on plans.
- B. High Density Polyethylene Pipe (HDPE): smooth interior corrugated polyethylene type pipe, Type ADS N-12 as manufactured by Advanced Drainage Systems, Inc. of Columbus, Ohio or equal. Pipe and fittings shall be made of polyethylene compounds which

conform with the physical requirements of Type III, Category 3, 4 or 5, P23, P33 or P34, Class C, with the applicable requirements defined in ASTM D1248. Approved equivalents acceptable.

- C. Polyethylene (HDPE) Plastic Pipe and Fittings, ADS N-12 ProLink WT Couplers.
- D. Couplings: Rubber or elastomeric sleeve and stainless steel band assembly fabricated to match outside diameters of pipes to be joined or
 - 1. Sleeves: ASTM F477, elastomeric seal for plastic pipe. Sleeves for dissimilar or other pipe materials shall be compatible with pipe materials being joined.
 - 2. Bands: Stainless steel, one at each pipe insert.

PART 3 EXECUTION

3.1 MAINTENANCE OF EXISTING STORMWATER FLOWS

- A. Provide all temporary facilities required to safely and adequately bypass existing stormwater flows from the Work area during construction.
- B. The bypassing of such flows shall prevent any hazards to public health and welfare when the stormwater flows are bypassed from the Work area during construction.
- C. The Contractor is fully responsible for any and all damages to construction, adjacent properties, utilities, and/or buildings in the area caused by these operations.

3.2 INSPECTION

- A. Inspect pipe and fittings before installation. Remove defective materials from the Site.
- B. Concrete pipes shall be free from fractures, cracks, and surface roughness.
- C. Pipe with damaged ends will not be accepted when such damage would prevent making a satisfactory joint.

3.3 INSTALLATION

- A. General Locations and Arrangements: Contract Plans (plans and details) indicate the general location and arrangement of the underground storm sewerage system piping. Location and arrangements of piping layout take into account many design considerations. Install the piping as indicated, to the extent practical. If, during construction of the project, it becomes necessary to make changes in the location or grades of the sewers, the Engineer will issue appropriate directions after being contacted by the Contractor.
- B. Install piping beginning at low point of systems, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install

gaskets, seals, sleeves, and couplings in accordance with manufacturer's recommendations for use of lubricants, cements, and other installation requirements. Maintain swab or drag in line and pull past each joint as it is completed.

- C. Use manholes or catch basins for changes in direction, except where a fitting is indicated. Use fittings for branch connections, except where direct tap into existing sewer is indicated.
- D. Use proper size increasers, reducers, and couplings, where different size or material of pipes and fittings are connected. Reduction of the size of piping in the direction of flow is prohibited.
- E. Install piping pitched down in direction of flow, at minimum slope of 1 percent, except where indicated otherwise.
- F. Extend storm sewerage system piping to connect to building storm drains, of sizes and in locations indicated.
- G. Fill excess excavation with suitable materials and tamp.

3.4 STORM SEWER RELATION TO WATER PIPE

- A. Horizontal Separation: Storm sewers should be laid at least 10 feet, horizontally, from any existing or proposed water or sanitary sewer pipe.
- B. Vertical Separation: Whenever sewers must cross water or sanitary sewer pipe, the storm sewer shall be laid at such so there is an 18-inch vertical separation between the two lines. When the elevation of the sewer cannot be varied to meet the above requirements, the water main shall be relocated to provide this separation or reconstructed with push-on joint pipe for a distance of 10 feet on each side of the sewer. One full length of water main should be centered over the sewer so that both joints will be as far from the sewer as possible.

3.5 PROTECTING PIPE

- A. During the progress of the Work keep pipe clean from all sediment, debris, and other foreign material.
- B. Close all open ends of pipes and fittings securely with removable plugs at end of Work day, during storms, when the Work is left at any time, and at such times as Owner's Representative may direct.

3.6 TAP CONNECTIONS

- A. Make connections to existing piping and underground structures so that finished work will conform as nearly as practicable to the requirements specified for new work.

- B. 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 3000-psi 28-day compressive-strength concrete.
- C. Make branch connections from side into existing 4- to 21-inch piping by removing section of existing pipe and installing wye fitting, into existing piping. Encase entire wye with not less than 6 inches of 3000-psi 28-day compressive-strength concrete or,
- D. Make branch connections from side into existing 24-inch or larger piping or to underground structures by cutting opening into existing unit sufficiently large 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 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.
 - 1. Provide concrete that will attain minimum 28-day compressive strength of 3000 psi, unless otherwise indicated.
 - 2. Use epoxy bonding compound as interface between new and existing concrete and piping materials.
 - a. Protect existing piping and structures to prevent concrete or debris from entering while making tap connections. Remove debris, concrete, or other extraneous material that may accumulate.

3.7 FIELD QUALITY CONTROL

- A. Cleaning: Clear interior of piping and structures of dirt and other superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed.
 - 1. In large, accessible piping, brushes and brooms may be used for cleaning.
 - 2. Place plugs in ends of uncompleted pipe at end of day or whenever work stops.
 - 3. Flush piping between manholes, if required by local authority, to remove collected debris.
- B. Interior Inspection: Inspect piping to determine whether line displacement or other damage has occurred.
 - 1. Make inspections of pipe between manholes/fittings, after pipe has been installed and approximately 2 feet of backfill is in place, and again at completion of project.

2. If inspection indicates poor alignment, debris, displaced pipe, infiltration, or other defects, correct such defects and re-inspect.
- C. Water Tightness of Sewer Structures: It is the intent of the Contract Plans and these Specifications that the completed storm sewer lines shall be as watertight and free from infiltration as practical, unless specified otherwise. All visible leaks or points of infiltration shall be repaired.

END OF SECTION 33 41 00

SECTION 33 49 00 – STORM DRAINAGE STRUCTURES

PART 1 GENERAL

1.1 This Section includes:

- A. Under this section the Contractor shall provide all labor, equipment and material necessary to furnish, install and test all storm utility drainage structures and fittings as shown on the Contract drawings, specified herein and approved by the Engineer.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Section 31 20 00: Excavation and Fill
- C. Section 33 41 00: Storm Drainage Piping

1.3 REFERENCES

- A. American Association of State Highway and Transportation Officials (AASHTO)
- B. American Society for Testing and Materials (ASTM)

1.4 PROJECT CONDITIONS

- A. Location of Sewers and Sewer Structures: The location, elevation, and grades of sewers and sewer structures are shown on the Contract Drawings and shall be adhered to as closely as possible. If during construction of the project, it becomes necessary to make changes in the location or grades of the sewers, the Engineer will issue appropriate directions after being contacted by the Contractor.
- B. Site Information: Perform site survey, research public utility records, and verify existing utility locations. Verify that storm sewerage system may be installed in compliance with original design and referenced standards.

1.5 SUBMITTALS

- A. Shop drawings for precast concrete storm drainage structures, including cast iron frames, grates, covers, precast dry well and infiltrator system components. Submittal shall include installation, inspection and maintenance instructions for the infiltration system.
- B. Product Data: Manufacturer's catalog cuts, specifications, and installation instructions and manufacturer's certificates.

- C. As-built record drawings at project closeout of installed storm sewerage piping and products. An as-built survey prepared by licensed NYS Surveyor depicting the installed storm sewer piping and structures including rim and invert elevations of structures pipe size, pipe type, and invert of all piping. Both hard copy and electronic copy shall be provided to the Owner and Engineer.

1.6 QUALITY ASSURANCE

- A. Manufacturer data: All products must be produced by a facility that demonstrates five (5) years of experience in the production of similar products.
- B. All material utilized in construction of structures shall comply with all applicable ASTM and NYSDOT standards.
- C. Environmental Compliance: Comply with applicable portions of local health department and environmental agency regulations pertaining to storm sewerage systems.
- D. Utility Compliance: Comply with local utility regulations and standards pertaining to storm sewerage.
- E. All storm sewer system components shall be installed in accordance with applicable plumbing code requirements and in accordance with all license requirements.
- F. All storm sewer construction shall be subject to inspection by the Engineer prior to backfilling.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Contractor shall check all materials upon delivery to assure that the proper materials have been received.
- B. Contractor shall check the structures for shipping damage prior to installation. Units that have been damaged must not be installed. Contractor shall contact manufacturer immediately upon discovery of any damage.
- C. All material shall be delivered to the site and unloaded with handling that conforms to the manufacturer's instructions for reasonable care.
- D. Protect material from dirt and damage.
- E. All material shall be protected against impact, shock and free fall, and only equipment of sufficient capacity and proper design shall be used in the handling of the pipe. Storage of the structure on the job shall be in accordance with the manufacturer's recommendations.

PART 2 PRODUCTS

2.1 MATERIALS

A. Precast Rectangular Reinforced Concrete Drainage Structures:

1. Structure shall be manufactured by the Fort Miller Co. Inc. or approved equivalent.
2. Structure shall be designed for HS20-44 vehicular loading plus 25% impact if indicated on the Contract Plans.
3. Riser Sections: ASTM C 478.
4. Joints Between Riser Sections - One of the following:
 - a. Rubber Gaskets: ASTM C-443.
 - b. Butyl Joint Sealant: ConSeal CS-202 by Concrete Sealants, Inc., or approved equivalent.
5. Concrete for Precast Units: Air content 6% by volume with an allowable tolerance of 1.5% +/- . Minimum compressive strength of 4,500 PSI after 28 days.
6. Concrete Reinforcement: Reinforcement for structure shall be designed by a Licensed New York State Professional Engineer prior to construction.
 - a. Welded Wire Fabric: ASTM A 185.
 - b. Steel Bars: ASTM A 615, Grade 60.
7. Steps:
 - a. Reinforced Plastic: 1/2-inch steel reinforced (ASTM A-615, Grade 60) polypropylene, or other plastic material complying with NYSDOT 725-02.01.
 - b. Capable of withstanding a 300 lb. concentrated live load without permanent distortion and with rungs a minimum 10 inches wide designed to prevent feet from slipping off the ends.
 - c. Manufactured by MA Industries or approved equivalents.

B. Precast Square Reinforced Concrete Drainage Structure

1. Structure shall be manufactured by the Fort Miller Co. Inc. or approved equivalent.

2. Structure shall be designed for HS20-44 vehicular loading plus 25% impact if indicated on the Contract Plans.
 3. Structure shall have integral base.
 4. Riser Sections: ASTM C 890, height and width as indicated on the Contract Documents.
 5. Concrete for Pre-Cast Units: Air content 6% by volume with an allowable tolerance of +/-1.5%. Minimum compressive strength of 4,500 psi after 28 days.
 6. Pre-Cast Concrete Structure Load Rating: AASHTO HS-20 with 30% impact and 130 lb/cf equivalent soil pressure.
 - a. Casting Load Rating: AASHTO H20 wheel loading requirements. Manufacture, workmanship, and certified proof-load tests shall conform to AASHTO M306-89 Standard Specification for Drainage Structure Castings.
 - b. Coatings: Minimum one shop coat of asphaltum to be applied to all frame and grate surfaces.
 - c. Acceptable Casting: As indicated on Contract Drawings.
- C. Frames, Grates, and Covers for Precast Reinforced Concrete Drainage Structures:
1. Style: Heavy Duty Frame and Grate Assembly
 2. Size: As required for structure size shown on Contract Plans.
 3. Frame and Grate: Provide castings of uniform quality, free from blow holes, porosity, hard spots, shrinkage defects, cracks or other injurious defects. Manufacture all castings true to pattern and free from surface imperfections. Provide heavy duty frames and grates with machined horizontal bearing surfaces.
 4. Design of each shall be the same throughout the project unless otherwise specified or indicated on the Contract Drawings.
 5. Units shall meet AASHTO HS20-44 vehicular loading plus 25% impact. Manufacturer, workmanship, and certified proof-load tests shall conform to AASHTO M306-89-Standard Specification for Drainage Structure Castings.
 6. A.D.A. and Bicycle compliant.
 7. Material:
 - a. Cast iron: ASTM A48, Class 30B or 35B.

- b. Delivered to site free of any coatings, unless otherwise specified.
- D. Basin and Grate for Yard Inlet Basins:
 - 1. In-Line Drain and Grate: As manufactured by Nyloplast-ADS or approved equal,
 - 3. Acceptable Drainage Structure Basin and Grate: Pattern 1899CGD and 0899CGD by NYLOPLAST, or approved equal.
- E. Frame, Grate and Cover for Storm Manholes:
 - 1. Heavy Duty, Round Frame and Grate or Frame and Cover Assembly
 - 2. Grates shall be A.D.A. and Bicycle compliant.
 - 3. Material:
 - a. Cast iron: ASTM A48, Class 30B or 35B.
 - b. Delivered to site free of any coatings, unless otherwise specified.
- F. Slot Drain System: Basis of design is ACO System 3000. Approved equivalents are acceptable.
 - 1. Physical & Mechanical Characteristics:
 - a. Overall width - 5.75 inches
 - b. Internal width - 4.09 inches
 - c. Unit depth - 5.67 inches
 - d. Unit length - 39.37 inches
 - e. Compressive strength - 14,000 psi
 - f. Flexural strength - 4,000 psi
 - g. Water absorption rate - <0.1% by weight.
 - h. Inlet slot - 0.5 inches - ADA compliant
 - 2. Channel Profile - Each unit will feature a full radius in the trench bottom and male to female interconnecting ends. Units shall have horizontal cast-in anchoring features on outside walls to ensure maximum mechanical bond to surrounding bedding material. Each unit shall have a 0.5-inch longitudinal inlet slot on the top surface.

3. Radius Channels - Shall be manufactured to enable a radius of 36.5 meters, per IAAF guidelines.
4. In-line Catch Basins - Shall be manufactured from polymer concrete, be 21.75" in length.

G. Pipe-to-Drainage Structure Connection:

1. Non-shrink cement mortar, ASTM C 270, Type M.
2. Concrete Coating: Waterborne, non-flammable, VOC Compliance, 3 mil dry film thickness, cationic asphalt emulsion (55% - 60% petroleum asphalt), PGS 96 by Pipe Gasket & Supply Co., 2701 South Coliseum Boulevard, Suite 1010, Fort Wayne, Indiana, 46003, (219) 426-4575, or approved equivalent.

H. Materials for use in mortar shall conform to the following requirements:

1. Cement: Cement shall conform to the Standard Specifications for Portland Cement, ASTM Serial Designation C150 with latest amendments.
2. Sand: Sand shall be sharp, clean, free from deleterious substances and shall be uniformly graded and shall conform to the "Standard Specification for Aggregate for Masonry Mortar", ASTM C144 with the latest amendments.
3. Water: Water used in making mortar or concrete shall be clean and free from oil, alkali, sugar or other deleterious substances. When potable water is in reach, no other water shall be used.

I. Stormwater Water Quality Unit

1. General: Stormwater water quality unit (SWTU) standard of quality to be "CDS Unit" Model Number 3030 as manufactured by Contech Construction Products Inc. Approved equivalents are acceptable.
2. SWTU components to be installed within a precast concrete structure. Installation of unit shall be in accordance with the manufacture's installation requirements.

2.2 INSPECTION OF MATERIALS

- A. The manufacturers of materials shall furnish the Engineer a Certificate of Inspection, certified by factory inspector, or reports of tests made by an independent testing laboratory, in three copies, showing that materials furnished conform to applicable specifications set out herein. Each inspection certificate or laboratory report shall identify the materials by number of pieces shipped and date of invoice.

- B. A careful field inspection shall be made of all material before installation, and any material found to be damaged in shipment or not meeting the requirements of the Specifications will be rejected and replaced.

PART 3 EXECUTION

3.1 STRUCTURE INSTALLATION

- A. Construct structures with precast reinforced riser sections to the dimensions shown on the Contract Drawings. Seal joints between precast riser sections with material specified. Install steps 12 inches o.c. from top to bottom and in a manner capable of withstanding a lateral pull of 1,000 lbs.
- B. Position tops of structures flush with finished grade.
- C. All lifting holes shall be sealed by driving a tapered rubber plug into to hole and filling the remaining void with a non-shrink grout.
- D. Cast iron frames, grates and covers shall be set to the proper elevation in a full bed of mortar. The frame shall be completely mortared onto the manhole as shown on the Contract Drawings.
- E. Temporary Shoring: Provide and maintain shoring, bracing, or structural support to preserve stability and prevent movement, settlement, or collapse of existing structures and construction to remain. Strengthen or add new supports when required during progress of selective demolition.

3.2 SLOT DRAIN INSTALLATION

- A. Install in accordance with manufacturer's recommendations.
- B. Excavate an area wide enough and deep enough to accommodate the channel and sufficient depth for concrete encasement to provide support beneath channel.
- C. Top of channel must be evenly aligned to the surface of the surrounding slab.
- D. Install channel sections from the outlet or catch basins. Insert channels from above to allow ends to interconnect.
- E. Channel sections shall be placed on brick, rebar basket, low slump concrete slurry, or with installation devices, to obtain correct finished elevation.
- F. Cutting will be made, if required, by masonry or concrete saw.
- G. Use tape or plastic to protect top surface of channel from concrete splash during concrete pour. Place concrete in a manner that will not dislodge the channels.
- H. Finishing and Clean-up - Following final set of concrete, remove protection covering the top of channel and thoroughly flush system to remove debris.

3.3 BRICK TO BRING STORM DRAINAGE STRUCTURE TO GRADE

- A. Brick shall be used in conjunction with precast concrete spacers to bring frames to grade for heights under twelve (12) inches in the following manner:
 - 1. Bricks shall be thoroughly wet when used and each brick shall be laid in a full bed of mortar including side and end joints. Normal 3/8-inch joints shall be used except when the brick is laid radially, in which case the narrowest part of the joint will not exceed 1/4 inch. Brick shall be laid neatly with sufficient width to adequately support the cast iron frame. The entire stack shall be completely plastered on the exterior side when initially constructed. The brick work shall be kept moist for a period of five (5) days after completion and adequately protected to prevent freezing during cold weather. The interior of the brick shall be neatly plastered once final grading and paving is completed so that the frame and cover will not be disturbed by additional work.

3.4 FIELD QUALITY CONTROL

- A. Cleaning: Clear interior of structures of dirt and other superfluous material as work progresses.
- B. Flush piping between manholes, if required by local authority, to remove collected debris.
- C. Interior Inspection: Inspect piping to determine whether line displacement or other damage has occurred.
- D. Make inspections of pipe between manholes/fittings, after pipe has been installed and approximately 2 feet of backfill is in place, and again at completion of project.
- E. If inspection indicates poor alignment, debris, displaced pipe, infiltration, or other defects, correct such defects and re-inspect.
- F. Water Tightness of Storm Sewer Structures: It is the intent of the Contract Drawings and these Specifications that the completed storm sewer structure shall be as watertight and free from infiltration as practical. All visible leaks or points of infiltration shall be repaired.

3.5 INSPECTION AND MAINTENANCE

- A. Slot drain in-line catch basins shall have resilient track surface topping that is scored and identifiable to allow for removal of catch basin cover for regular maintenance and removal.

END OF SECTION 33 49 00

SECTION 335900 – SANITARY SEWER PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Under this section the Contractor shall provide all labor, equipment and material necessary to furnish, install and test all sanitary sewer utility pipe and fittings as shown on the Contract Drawings.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Section 312000: Excavation and Fill
- C. Section 335903: Sanitary Sewer Structures

1.3 SUBMITTALS

- A. Shop Drawing: Pipes and associated fittings.
- B. Product Data: Manufacturer's specifications, including dimensions, allowable height of cover information, and installation instructions.
- C. Manufacturer's product literature, installation instructions and shop drawings for infiltration systems.
- D. As-built record drawings at project closeout of installed sanitary sewerage piping and products. An as-built survey prepared by licensed NYS Surveyor depicting the installed sanitary sewer piping and structures including rim and invert elevations of structures pipe size, pipe type, and invert of all piping. Both hard copy and electronic copy shall be provided to the Owner and Engineer.

1.4 QUALITY ASSURANCE

- A. Environmental Compliance: Comply with applicable portions of local health department and environmental agency regulations pertaining to sanitary sewerage systems.
- B. Utility Compliance: Comply with local utility regulations and standards pertaining to sanitary sewerage.
- C. All sanitary sewer system components shall be installed in accordance with applicable plumbing code requirements and in accordance with all license requirements.
- D. All sanitary sewer construction shall be subject to inspection by the Engineer prior to backfilling.

1.5 PROJECT CONDITIONS

- A. Location of Sewers and Sewer Structures: The location, elevation, and grades of sewers and sewer structures are shown on the Contract Drawings and shall be adhered to as closely as possible. If during construction of the project, it becomes necessary to make changes in the location or grades of the sewers, the Engineer will issue appropriate directions after being contacted by the Contractor.
- B. Site Information: Perform site survey, research public utility records, and verify existing utility locations. Verify that storm sewerage system piping may be installed in compliance with original design and referenced standards.
- C. 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 and Engineer 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.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of the General Conditions.
- B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.7 SEQUENCING AND SCHEDULING

- A. Coordinate with other utility work.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. PVC Sewer Piping
 - 1. Pipe: ASTM D 3034, SDR 35, PVC Type PSM sewer pipe with bell-and-spigot ends for gasketed joints.
 - 2. Laterals: SDR 21 PVC
 - 3. Fittings: ASTM D 3034, PVC with bell ends.
 - 4. Gaskets: ASTM F 477, elastomeric seals.
- B. Preinsulated PVC Gravity Sewer Pipe
 - 1. Preinsulated Gravity Sewer: PVC Carrier Pipe - 160 psi (SDR 26) PVC pipe meeting ASTM D1784; PVC Casing Pipe - Material ASTM D1784, Pipe - SDR 1 or heavier - ASTM D2241; Rubber sealing rings (gaskets) - molded solid compression type seal; Foam -

polyurethane - 1.5 to 2.5 lb./cu. Ft., 90 percent closed cell content, K value - 0.14 Btu/inch/hr./degree F/sq. ft.

2. Provide rubber end seals on all full and cut-down sections to protect insulation.
3. Utilize SDR 26 gasketed PVC fittings. Encase in concrete following leakage testing.
4. Acceptable Manufacturer: Thermal Pipe Systems, Inc., 5205 W. Woodmill Dr., Suite 33, Wilmington, DE 19808, (302) 999-1588, www.thermalpipesystems.com or approved equivalent

PART 3 - EXECUTION

3.1 INSPECTION

- A. Inspect all pipe and fittings before installation. Remove defective pipe and fittings from the site.
- B. Pipe with damaged ends will not be accepted when such damage would prevent making a satisfactory joint.
- C. Do not backfill before installation is inspected by the Engineer.

3.2 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Section 312000 – Earthwork.

3.3 INSTALLATION

- A. Install Contract Drawings indicate location and arrangement of underground sanitary sewer piping. Where specified location and arrangement is not allowable due to unforeseen conditions, please notify the Engineer as soon as possible.
- B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Lay pipe to indicated line and grade with a firm uniform bearing for the entire length of the pipe. 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 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.
- D. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.
- E. Install gravity-flow, nonpressure, drainage piping according to the following:
 1. Install piping pitched down in direction of flow, at minimum slope of 0.40 percent unless otherwise indicated.
 2. Install piping with 48-inch minimum cover.
 3. Install PVC Type PSM sewer piping according to ASTM D 2321 and ASTM F 1668.
- F. Arrange for installation of green warning tapes directly over piping.

1. Use warning tape or detectable warning tape over ferrous piping.
2. Use detectable warning tape over nonferrous piping.

3.4 PIPE JOINT CONSTRUCTION

- A. Wipe inside of sockets and outside of pipe to be jointed, clean and dry.
- B. Install rubber gaskets in accordance with the manufacturer's specifications.
- C. 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.
- D. Pipe couplings, expansion joints, and deflection fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
 1. Use nonpressure flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.
 - a. Flexible couplings for pipes of same or slightly different OD.
 - b. Unshielded, increaser/reducer-pattern, flexible couplings for pipes with different OD.
 - c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

3.5 LEAKAGE TEST

- A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.
 1. Submit separate report for each system inspection.
 2. Defects requiring correction include the following:
 - a. Alignment: Less than full diameter of inside of pipe is visible between structures.
 - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
 - c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
 - d. Infiltration: Water leakage into piping.
 - e. Exfiltration: Water leakage from or around piping.
 3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
 4. Reinspect and repeat procedure until results are satisfactory.

- B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
 - 1. Do not enclose, cover, or put into service before inspection and approval.
 - 2. Test completed piping systems according to requirements of authorities having jurisdiction.
 - 3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
 - 4. Submit separate report for each test.
 - 5. Hydrostatic Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction and the following:
 - a. Fill sewer piping with water. Test with pressure of at least 10-foot head of water, and maintain such pressure without leakage for at least 15 minutes.
 - b. Close openings in system and fill with water.
 - c. Purge air and refill with water.
 - d. Disconnect water supply.
 - e. Test and inspect joints for leaks.
 - 6. Air Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction, and the following:
 - a. Option: Test plastic gravity sewer piping according to ASTM F 1417.
- 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.
- E. Additional leakage tests and a final test shall be performed as directed by the Engineer.

3.6 CLEANING

- A. Clean dirt and superfluous material from interior of piping. Flush with potable water.

END OF SECTION 335900

SECTION 335903 – SANITARY SEWER STRUCTURES

PART 1 - GENERAL

1.1 SUMMARY

- A. Under this section the Contractor shall provide all labor, equipment and material necessary to furnish, install and test all sanitary sewer structures as shown on the Contract Drawings.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Section 312000: Excavation and Fill
- C. Section 335900: Sanitary Sewer Piping

1.3 SUBMITTALS

- A. Shop Drawing: Structures including manholes, septic tanks and cleanouts
- B. Product Data: Manufacturer's specifications, including dimensions, and installation instructions.
- C. Manufacturer's product literature, installation instructions and shop drawings.
- D. As-built record drawings at project closeout of installed sanitary sewerage products. An as-built survey prepared by licensed NYS Surveyor depicting the installed sanitary sewer structures including rim and invert elevations of structures pipe size, pipe type, and invert of all piping. Both hard copy and electronic copy shall be provided to the Owner and Engineer.

1.4 QUALITY ASSURANCE

- A. Environmental Compliance: Comply with applicable portions of local health department and environmental agency regulations pertaining to sanitary sewerage systems.
- B. Utility Compliance: Comply with local utility regulations and standards pertaining to sanitary sewerage.
- C. All sanitary sewer system components shall be installed in accordance with applicable plumbing code requirements and in accordance with all license requirements.
- D. All sanitary sewer construction shall be subject to inspection by the Engineer prior to backfilling.

1.5 PROJECT CONDITIONS

- A. Location of Sewers and Sewer Structures: The location, elevation, and grades of sewers and sewer structures are shown on the Contract Drawings and shall be adhered to as closely as possible. If during construction of the project, it becomes necessary to make

changes in the location or grades of the sewers, the Engineer will issue appropriate directions after being contacted by the Contractor.

- B. Site Information: Perform site survey, research public utility records, and verify existing utility locations. Verify that storm sewerage system piping may be installed in compliance with original design and referenced standards.
- C. 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 and Engineer 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.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of the General Conditions.
- B. Provide temporary closures on openings. Maintain in place until installation.
- C. Protect structures from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.7 SEQUENCING AND SCHEDULING

- A. Coordinate with other utility work.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. PVC Cleanouts
 - 1. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping, as indicated on plans.
 - 2. Frame and Cover – EJ Group Frame PN#00156446 and Cover PN#00156411 or approved equal.
- B. Standard Precast Concrete Manholes
 - 1. Description: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
 - 2. Diameter: As indicated on schedule sheet.
 - 3. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
 - 4. Base Section: 6-inch minimum thickness for floor slab and 6-inch minimum thickness for walls and base riser section; with separate base slab or base section with integral floor.

5. Riser Sections: 6-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 990, bitumen or butyl rubber.
8. Resilient Pipe Connectors: ASTM C 923 cast or fitted into manhole walls, for each pipe connection.
9. Steps: Wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12 to 16-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches.
10. Adjusting Rings: Interlocking HDPE rings, with level or sloped edge in thickness and diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope. Include sealant recommended by ring manufacturer.
11. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, with diameter matching manhole frame and cover, and with height as required to adjust manhole frame and cover to indicated elevation and slope.

C. Manhole Frame and Cover

1. Description: Ferrous; 24-inch ID by 7- to 9-inch riser, with 4-inch minimum-width flange and 26-inch diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "SANITARY SEWER."
2. Material: Cast iron unless otherwise indicated. Manufactured by EJ Group or approved equal.

D. Concrete

1. General: Cast-in-place concrete complying with ACI 318, and the following:
 - a. Cement: ASTM C 150, Type II.
 - b. Fine Aggregate: ASTM C 33, sand.
 - c. Coarse Aggregate: ASTM C 33, crushed gravel.
 - d. Water: Potable.

E. Portland Cement Design Mix: 4000 psi minimum, with 0.5 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

F. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi minimum, with 0.5 maximum water/cementitious materials ratio. Include channels and benches in manholes.

G. Grease Trap: Basis of Design: Elliptical Fiberglass (FRP) grease interceptor construction, as manufactured by Zurn. Approved equivalents acceptable.

1. Include accessways, tanks, and piping and baffle openings to retain grease and solids.

2. Factory installed Schedule 40 PVC cement welded type socket ports, or straight pipe, fitted into interceptor walls for each pipe connection.
3. Accessway Extension Collar: 24-inch Fiberglass risers (EC2)
4. Accessway Frames and Covers: Round cover with non-slip cover finish, gasketed and non-vented.
5. Cast Iron: AASHTO M306, HS20 Traffic load rated. 24 inch- (610-mm-) diameter cover with 0.25" (6-mm-) gasket. Two closed pickholes. Non-Bolted option. Weight 249 lbs. ASTM A48 CL35B. 36-inch (915-mm) optional alternate is acceptable to match fiberglass risers.
6. Watertight Flexible Caulking: Sikaflex 255 or Sikaflex 221 or approved alternate to provide watertight seal at extension collar joints.
7. Capacity
 - a. Total Wet Volume = 1,000 gallons
 - b. Maximum Grease Capacity = 577 gallons
 - c. Maximum Solids Capacity = 295 gallons

PART 3 - EXECUTION

3.1 INSPECTION

- A. Inspect all structures before installation. Remove defective structures from the site.
- B. Do not backfill before installation is inspected by the Engineer.

3.2 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Section 312000 – Earthwork.

3.3 MANHOLE INSTALLATION

- A. General: Install manholes complete with appurtenances and accessories indicated on the Contract Drawings. Where specified location and arrangement is not allowable due to unforeseen conditions, please notify the Engineer as soon as possible.
- 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.
- F. Arrange for installation of green warning tapes at outside edges of underground manholes.
 1. Use detectable warning tape over outside edges of underground manholes.

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 use cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
 - 1. Use Light-Duty, top-loading classification cleanouts in earth or unpaved foot-traffic 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, 17 by 17 by 7-1/2 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.

3.5 CLEANING

- A. Clean dirt and superfluous material from interior of structure. Flush with potable water.

END OF SECTION 335903