Project Manual
Volume 2 of 2
Divisions 21-33

PELHAM UNION FREE SCHOOL DISTRICT
314 Pelhamdale Avenue, Pelham, New York 10803

INFRASTRUCTURE IMPROVEMENTS

SIWANOY ELEMENTARY SCHOOL
489 Siwanoy Pl, Pelham, NY 10803 SED Control No. 66-16-01-03-0-004-014

12 November 2026 **ISSUE FOR BID**

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THE UNDERSIGNED CERTIFIES THAT TO THE BEST OF HIS KNOWLEDGE, INFORMATION AND BELIEF, THE PLANS AND SPECIFICATIONS ARE IN ACCORDANCE WITH APPLICABLE REQUIREMENTS OF THE NEW YORK STATE UNIFORM FIRE PREVENTION AND BUILDING CODE, THE STATE ENERGY CONSERVATION CONSTRUCTION CODE, AND BUILDING STANDARDS OF THE EDUCATION DEPARTMENT, AND THAT THE PLANS AND SPECIFICATIONS REQUIRE THAT NO ASBESTOS CONTAINING MATERIAL SHALL BE USED.

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PART 1 - GENERAL

1.1 SECTION INCLUDES

A. These basic Requirements apply to all Division 21 Sections.

B. The work of this Section consists of providing all materials, labor and equipment, and the like necessary and/or required for the complete execution of all Fire Protection and related work for this project, as required by the contract documents.

1.2 RELATED DOCUMENTS

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

1.3 ACTION SUBMITTALS

A. Product Data: For each type of the following:

1. Steel pipe and fittings, and specialties
2. Joining material.
3. Equipment
4. Sprinkler heads and specialties

B. Delegated-Design Submittal:

1. DELEGATED DESIGN: Sprinkler systems under this project are to comply with performance requirements and design criteria outlined in the contract documents. It shall be the contractor's responsibility to perform a Delegated Design of the sprinkler and standpipe systems.
2.
    a. Perform a current hydrant flow test. Submit all data and test results.
    b. Hydraulic analysis of the system. Signed and sealed by the qualified Licensed Professional Engineer, (in the state where work is being performed), responsible for their preparation. This shall include sprinkler system and standpipe system hydraulic calculations, pipe size, and equipment selections, piping, sprinkler, and equipment layout.

1.4 REFERENCES

A. ASME - American Society of Mechanical Engineers.

B. UL - Underwriters Laboratory.

C. NFPA - National Fire Protection Association.

1.5 REGULATORY REQUIREMENTS

A. All equipment and installation methods shall conform to the applicable standards and/or recommendations set forth in the New York State Building Code, Local Codes as well as all Codes and Standards listed in the General and Supplemental Conditions sections of the specification, as well as the following specific codes
   1. NFPA 13, 13R
   2. NY State Building Code
   3. NY State Fire Prevention Code
   4. All Local Codes
   5. Factory Mutual
   6. SED Planning Manual

1.6 FEES & PERMITS

A. The Contractor shall be responsible for filing drawings, paying necessary fees, and obtaining all permits related to the scope of work.

1.7 QUALITY ASSURANCE

A. The Contractor shall have the work indicated on the drawings and/or specified in each section performed by vendors or mechanics experienced and skilled in its implementation or by a “Specialist”, “Specialty Contractor,” or “Specialty Subcontractor” under contractual agreement with the Contractor. These terms mean an individual or firm of established reputation, or, if newly organized, whose personnel have previously established a reputation in the same field, which is regularly engaged in, and which maintains a regular force of workmen skilled in either manufacturing or fabricating items required by the Contract, installing items required by the Contract, or otherwise performing work required by the Contract.

B. Where the Contract Specifications require installation by a "Specialist," that term shall also be deemed to mean either the manufacturer of the item, an individual or firm licensed by the manufacturer, or an individual or firm who will perform such work under the manufacturer's direct supervision.

1.8 PROJECT/SITE CONDITIONS

A. Install Work in locations shown on Drawings, unless prevented by Project conditions.

B. Prepare drawings showing the proposed arrangement of Work to meet Project conditions, including changes to Work specified in other Sections.

1.9 SCOPE OF WORK

A. This Contractor shall be responsible for coordinating his work with all other trades.

B. The Contractor shall provide all materials, labor, equipment, tools, appliances, services, hoisting, scaffolding, supervision, and overhead for the furnishing and installing of all mechanical work and related work, including but not limited to the following:

1. Demolition of existing work, including piping, sprinkler heads, fire pump, Jockey Pump, and miscellaneous equipment.
2. Dry sprinkler heads
3. Sprinkler piping valves and specialties
4. Sprinkler Heads
5. Flexible heads.
6. Hydraulic calculations
7. Hydrant flow test
8. Filing
9. Pipe and Equipment Supports
10. Automatic controls.
11. Protection.
12. Identification.
13. Coordination.
14. Phasing.
15. Rigging.
16. Shop Drawings.
17. As-Built Drawings and Maintenance Manuals.
18. Warrantees.
19. Commissioning

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 GENERAL

A. Construct all apparatus of materials and pressure ratings suitable for the conditions encountered during continuous operation.

B. Construct all equipment in accordance with the requirements of all applicable codes. All pressure vessels and safety devices that fall within the scope of the ASME Code shall conform to the Code and bear the ASME label or stamp.

C. Match and balance all system components to achieve compatibility of equipment or satisfactory operation and performance throughout the entire operating temperature and control ranges. All installations shall be in accordance with the manufacturer's recommendations.

D. Provide all controls, wiring, piping, valves, accessories, and other components necessary to make all systems complete and operable.

E. The contractor shall warranty all work, including labor and materials, and equipment furnished and installed as part of this contract for a minimum period of a year from the date of acceptance by the owner, in writing. Certain equipment, such as underground fuel tanks, may have longer warranties as indicated in the specifications. In such cases, the longer of the two warranties shall prevail.

3.2 SHOP DRAWINGS AND SUBMITTALS (COORDINATE WITH DIVISION 1 and 2)

A. Shop drawings and samples shall be prepared and submitted in accordance with the requirements established in the contract documents and shall consist of all items listed in the following paragraphs.

B. Manufacturer's data or shop drawings giving full information as to dimensions, materials, and all information pertinent to the adequacy of the submitted equipment shall be submitted for review. Shop drawings shall include, but not be limited to the following:

C. Submit all Fire Suppression equipment noted and scheduled on plans including but not limited to the following:

1. Dry sprinkler heads
2. Sprinkler piping valves and specialties
3. Sprinkler Heads
4. Flexible heads.
5. Hydraulic calculations
6. Hydrant flow test
7. Pipe and Equipment Supports
8. Piping and sprinkler head layout and floor plans
9. Sprinkler riser diagrams
10. Automatic controls.
11. Identification.
12. Coordination.
13. Phasing plan
14. Rigging plan
15. As-Built Drawings and Maintenance Manuals.
16. Warrantees.

D. The contractor shall, upon award, submit a schedule for the engineer's review indicating when each of the above shop drawings shall be submitted. Submittals shall be made promptly as the project progresses in accordance with the Construction Manager or General contractor's work schedules. The contractor shall allow sufficient time for the

engineers to perform their review. A minimum of 10 business days shall be required. Untimely submittals shall be cause for the owner to make a delay against the contractor.

E. Demolition, purchase, and or installation shall not begin until shop drawings pertaining to the equipment associated with any related portion of the work have been approved.

F. Piping shop drawings shall indicate all existing and/or new lights, walls, piping, structural elements, existing work, etc., and dimension locations of ductwork, including elevations in relation to these items.

G. Where shop drawings have been reviewed by the Engineer, such review shall not be considered as a guarantee of measurements or building conditions. Where drawings have been reviewed, said the review does not mean that drawings have been checked in detail; said review does not substantiate any quantities and in any way relieve the Contractor from his responsibility nor the necessity of furnishing materials or performing work required by the Contract Drawings and Specifications. It does not relieve the contractor of the responsibility to perform all work to accepted industry standards and in a code-compliant manner. Approval of shop drawings containing errors does not relieve the contractor from making corrections at his expense.

H. Where substitutions are submitted for approval, the review shall be for general performance compared to the specified product. Products shall not be reviewed for size, clearance, or coordination with other trades. Coordination with other trades shall be the responsibility of the contractor. And changes to existing conditions or changes required to the work of other trades such as a result of substituted material or equipment approved or not shall be the responsibility of this contractor.

I. Approval of shop drawings

1. The Contractor shall be specifically responsible for checking equipment dimensions and clearances and confirming that equipment will fit into the designated space and connect properly to adjoining equipment and/or materials.

2. Submittals marked "Make Corrections Noted" give authority to proceed in accordance with the notes. However, if drawings are also marked "Amend and Resubmit", corrected drawings must be resubmitted for final review.

3. Submittals marked "Rejected" do not give authority to proceed with any portion of the work shown thereon. Drawings must be resubmitted.

4. Submittals marked "Rejected" or "Amend and Resubmit" shall include a specific written response to the engineer’s comments. Resubmission of a submittal without a written response to the engineer’s comments will be considered incomplete and shall be returned unreviewed.

3.3 CHARTS AND TAGS

A. The Contractor shall provide single line diagrams and plans of all piping systems indicating the number and location of valves, controls, and equipment etc.

B. All valves, and controls shall be designated with brass tags. Refer to section 21 05 23 Identification for Fire Protection Piping and equipment

3.4 FEES & PERMITS

A. The Contractor shall obtain all permits and pay all fees required related to this scope of work

3.5 PAINTING

A. All field-erected apparatus, stands, supports, and supplemental steel and hangers shall be painted with one coat of primer and one coat of machinery enamel black or grey, or they shall be galvanized. All finishes shall be cleaned and touched up to repair any damage incurred during construction. All factory-manufactured and assembled apparatus and equipment shall be factory-painted with the manufacturer's standard coating, suitable for the environment in which the equipment will be used.

B. All piping shall be painted in colors conforming to OSHA Standards. And labeled according to specifications.

C. All fasteners, nuts, bolts, hanger rods, and “Kindorf” shall be galvanized steel or nickel plated.

3.6 RIGGING

A. Furnish all labor, materials, and equipment required to rig equipment and materials.

B. The rigger shall secure any necessary permits and comply with all applicable Federal, State, and local safety regulations. A copy of permits to be kept at both the project site and the Engineer's Office.

C. The rigger shall have a minimum of five (5) years of practical experience and hold a master riggers license if required.

D. The procedure for rigging shall be submitted to the Engineer for review. All possible precautions should be taken to prevent damage to the structure, streets, sidewalks, curbs, lawns, etc.

3.7 CUTTING AND PATCHING

A. All cutting and patching required for piping, control conduits, etc., passing through walls, floors, and roof shall be provided by this Contractor under this contract unless otherwise noted. This Contractor shall be responsible for any damage done to the structure due to his negligence.

B. Patching materials and application shall match existing construction.

C. Where applicable, new holes for piping installation shall be core drilled.

D. Pipe Sleeves & Fire-stopping:

1. Provide for all pipes, conduits ducts, and other elements passing through floors, walls, partitions and structural elements, sleeves as specified. Sleeves shall be of adequate diameter to allow for a minimum of 3/4 inches clear all around the sleeve and pipe. When pipe, conduit ducts, or other such element penetrates other than fire-rated assembly and is insulated, insulation shall pass continuously through sleeves with 1/2-inch clearance between insulation and sleeve.

2. Where pipes, conduits, and other such elements penetrate fire-rated assemblies, or where holes or voids are created to extend mechanical systems through fire-rated assemblies (walls, floors, ceilings, structure, etc.); sleeves and fire-stopping systems shall be installed.

E. Furnish access doors, to the General Contractor for installation where required in finished walls, partitions, and the like for access to junction boxes, controls, valves, etc, concealed behind finished construction.

F. Submit location drawings and sizes for review before installation.

3.8 PROTECTION-COORDINATE WITH DIVISION 1

A. Special protection is required for the installation of a Derrick or other device for rigging purposes. This Contractor shall coordinate with the rigger to facilitate rigging work.

B. Recommendations and Provisions of ANSI Bulletin A10.2 and OSHA shall be complied with in so far as applicable to the work.

C. The Contractor shall provide temporary partitions or tarpaulins to protect adjacent spaces and/or equipment. He shall be responsible for any damage or injury to person or property of any character resulting from any act, omission, neglect, or misconduct in his manner or method of executing his work.

D. The Contractor shall restore at his own expense such property to a condition similar or equal to that existing before such damage or injury acceptably.

E. The Contractor, furthermore, shall conduct his operations in such a manner as to prevent dust and debris from transferring on to the adjoining property or into existing spaces.

F. All openings cut in walls, floors, roof, or ceilings of the building, for conduit, pipe,

G. etc., shall be closed off with box-type temporary protective enclosures of ¼" tempered hardboard, except when mechanics are working at the particular opening. Enclosures shall be constructed of fireproof 2x4 frame, four (4) sides covered, and made completely dust and watertight.

H. All finished floor areas through which the contractor must pass with materials or equipment shall be protected with a layer of ¼" hardboard, "Masonite", “Ramboard” laid with joints taped together.

I. The roof shall be protected with ½” plywood in all areas of work.

3.9 EQUIPMENT SUPPORTS

A. Provide supplementary steel dunnage, curbs, angle iron stands, etc., to properly set and install all equipment, including supports necessary to properly pitch piping.

B. Existing dunnage shall be supplemented with angle iron supports and cross members as required to support new equipment at all supports point or continuously as recommended by the manufacturer. Provide spring isolators under all-new dunnage-mounted equipment.

C. Concrete Bases: Anchor equipment to concrete base according to the equipment manufacturer's written instructions and according to seismic codes at Project.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than the supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through the concrete base, and anchor into the structural concrete floor.
4. Place and secure anchorage devices. Use the supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to the anchor-bolt manufacturer's written instructions.
7. Use 4000-psi, 28-day compressive-strength concrete and reinforcement.

3.10 WELDING

A. A.Welding and equipment shall conform to the American Welding Society’s Code for Welding in Building Construction, latest edition as well as state and local laws and ordinances.

B. The handling and storage of all welding materials, acetylene and oxygen tanks, burners, and other equipment required for the execution of welding and cutting work shall be subject at all times to the approval of the Owner and/or Architect. All welding materials and gas tanks shall be promptly removed from the premises upon completion of each day’s work or stored in a manner satisfactory to the owner. Welding and equipment shall conform to the American Welding Society’s Code for Welding in Building Construction, latest edition as well as state and local laws and ordinances.

C. Provide all temporary ventilation and ventilation air systems required during welding operations as required by OSHA.

3.11 AS-BUILT DRAWINGS

A. The Contractor shall provide a complete set of As-Built drawings showing actual installation and locations of all new and existing equipment, piping, and ductwork in the entire building. Schedules shall be revised to indicate actual equipment installed.

B. As-Built drawings shall be submitted as per contract requirements in accordance with Division 1 and shall be submitted in paper format for review. Accepted as-builts shall then be submitted in PDF format electronically.

3.12 CONDITIONS

A. Inspection: Before all work of this Section, carefully inspect the installed work of all other trades and verify that all such work is complete to the point where this installation may properly commence. Verify that the work of this Section may be completed in strict accordance with all pertinent codes and regulations, the approved Shop Drawings, and the Manufacturers' recommendations.

B. Discrepancies: In the event of a discrepancy, immediately notify the Engineer. Do not proceed in areas of the discrepancy until all such discrepancies have been fully resolved.

3.13 INSTALLATION OF EQUIPMENT

A. Locations: Install all equipment in the locations shown on the approved Shop Drawings except where specifically otherwise approved on the job by the Owner and/or Engineer.

B. Interferences: Avoid interference with structure, and with work of other trades, preserving adequate headroom and clearing all doors and passageways to the approval of the Engineer.

C. Inspection: Check each piece of equipment in the system for defects, verify that all parts are properly furnished and installed, and that all items function properly, and that all adjustments have been made.

3.14 CLOSING-IN OF UNINSPECTED WORK

A. General: Do not allow or cause any of the work to be covered up or enclosed until it has been inspected, tested, and accepted by the Engineer and by all other authorities having jurisdiction.

B. Uncovering: Should any of the work of this Section be covered up or enclosed before it has been completely inspected, tested, and approved, do all things necessary to uncover all such work. After the work has been completely inspected, tested, and approved, provide all materials and labor necessary and make all repairs necessary to restore the work to its original and proper condition at no additional cost to the owner.

3.15 BUILDING ACCESS

A. The Contractor shall inform himself fully regarding the peculiarities and limitations of space available for the passage and installation of all equipment and materials under the Contract.

B. Verify and coordinate the removal of existing construction and/or knock-down of equipment to suit conditions. Special attention should be given to equipment installation. Provide all labor and materials to facilitate installation.

3.16 COOPERATION WITH OTHER TRADES PHASING

A. Cooperate with other trades so that all systems in the work may be installed in the best arrangements.

B. Coordinate as required with all other trades to share space in common areas and to provide maximum access to each system.

C. This Contractor shall submit fully coordinated shop drawings showing all piping, ductwork, and equipment, as well as relevant work of all other trades such as light, conduits, structural, and steel, which may impact the final size or placement of piping, ductwork, equipment, diffusers, and grilles.

D. The work shall be scheduled and phased in accordance with the requirements of the contract and the client. Before the commencement of work, the contractor shall submit a schedule in writing to the Engineer and owner for approval. There shall be no shutdowns of any systems without prior written approval from the owner.

3.17 CLEANING

A. It is the intent of the contract documents that all work, including the inside of equipment, be left in a clean condition. All construction dirt shall be removed from material and equipment.

B. All removed items shall be taken off the premises and discarded in a manner satisfactory to the Owner.

3.18 COMPLETENESS

A. It is the intent of the contract documents to provide complete systems. Completeness shall mean not only that all material and equipment has been installed properly, but that all material and equipment is installed, adjusted, and operating as per the design intent in the opinion of the Engineer and in accordance with generally accepted industry good practice.

3.19 FIRE PREVENTION DURING HOT WORK

A. Before starting operations, the Contractor shall furnish trained personnel to provide fire watches for locations where hot work is to be performed. One fire watcher may observe several locations in a relatively small contiguous area. The contractor shall furnish a suitable type, fully-charged, operable portable fire extinguisher to each fire watcher.

B. The Contractor shall provide fire watchers who know how to operate the fire extinguisher, how to turn on a fire alarm and how to summon the fire department.

C. Before starting operations, take suitable precautions to minimize the hazard of a fire communicating to the opposite side of walls, floors, ceilings, and roofs from the operations.

3.20 SAFETY MEASURES

A. Hot work shall not be done in or near rooms or areas where flammable liquids or explosive vapors are present or thought to be present. A combustible gas indicator (explosimeter) test shall be conducted to ensure that each area is safe. The Contractor is responsible for arranging and paying for each test.

B. Insofar as possible, the Contractor shall remove and keep the area free from all combustibles, including rubbish, paper, and waste within a radius of 25 feet from hot operations.

C. If combustible material cannot be removed, the Contractor shall furnish fireproof blankets to cover such materials. At the direction of the owner floors, walls, and ceilings of combustible material shall be wetted thoroughly with water before, during, and after operations sufficiently to afford adequate protection.

D. Where possible, the Contractor shall furnish and use baffles of metal or gypsum board to prevent the spraying of sparks, hot slag, and other hot particles into surrounding combustible material.

E. The Contractor shall prevent the spread of sparks and particles of hot metal through open windows, doors, and holes and cracks in floors, walls, ceilings, and roofs.

F. Cylinders of gas used in hot work shall be placed at a safe distance from the work. The Contractor shall provide hoses and equipment free of deterioration, malfunction, and leaks. Suitable supports shall be provided to prevent accidental overturning of cylinders. All cylinder control valves shall be shut off while in use, with the gas pressure regulator set at 15 psi or less.

G. When hot work operations are completed or ended for the day, each location of the day's work shall be inspected by the Contractor 30 to 60 minutes after completion of operations to detect hidden or smoldering fires and to ensure that proper housekeeping is maintained. The contractor shall clean up the area of work at the end of each shift or workday.

H. Where sprinkler protection exists, the sprinkler system shall be maintained without interruption while operations are being performed. If operations are performed close to automatic sprinkler heads, gypsum board sheets or damp cloth guards may be used to shield the individual heads temporarily. The heads shall be inspected by the Contractor immediately after hot work operations cease, to ensure all materials have been removed from the heads and that the heads have not been damaged.

I. Suitable type, fully charged, operable portable fire extinguisher shall be available at all times during hot work operations.

J. If any of the above safeguards are not employed or are violated, the Contracting Owner's Representative may, by written notice, stop the work until compliance is obtained. Such stoppage shall not relieve the Contractor from performing his work within the Contract period for the Contract price.

3.21 USE OF OWNERS EQUIPMENT

A. The contractor shall not use any of the owner’s HVAC system or equipment, new or existing, for any purpose. The contractor shall provide temporary HVAC equipment, ductwork, power, and controls for use during construction for ventilation or heating during the construction process. All such equipment, ductwork, power, and controls shall be removed upon completion of work.

END OF SECTION 210500

SECTION 210517 - SLEEVES AND SLEEVE SEALS FOR FIRE-SUPPRESSION 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. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

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

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

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

D. 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, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Advance Products & Systems, Inc.
2. Metraflex Company (The).
3. Proco Products, Inc.

B. Description: Modular sealing-element unit, designed for field assembly, for filling the annular space between piping and sleeve.

1. Sealing Elements: EPDM-rubber or NBR interlocking links shaped to fit the surface of the pipe. Include the type and number required for pipe material and the size of pipe.
2. Pressure Plates: Stainless steel.
3. Connecting Bolts and Nuts: Stainless steel of the length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Advance Products & Systems, Inc.
2. Metraflex Company (The).
3. Proco Products, Inc.

B. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in a concrete slab or wall. Unit has a plastic or rubber water stop collar with a center opening to match piping OD.

2.4 GROUT

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

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

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

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

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

B. For sleeves that will have a sleeve-seal system installed, select sleeves of size large enough to provide a 1-inch annular clear space between piping and concrete slabs and walls.

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

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

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

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

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

4. Sleeves for building service piping shall be one nominal pipe size larger than the service pipe.

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 a 1/4-inch annular clear space between the sleeve and pipe or pipe insulation.
3. Install sleeves in seismic applications to provide adequate clearance according to NFPA 13 recommendations unless otherwise indicated.
4. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for the size, depth, and location of the joint.

E. Fire-Barrier Penetrations: Maintain the indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into the 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 the center of the sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in the annular space between the piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position the water stop flange to be centered in the concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around the outside of sleeve-seal fittings.

3.4 SLEEVE AND SLEEVE-SEAL SCHEDULE

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

1. Exterior Concrete Walls above Grade:

   a. Piping Smaller Than NPS 6: Cast-iron wall sleeves or Galvanized-steel wall sleeves or Galvanized-steel-pipe sleeves or Sleeve-seal fittings.
   b. Piping NPS 6 and Larger: Cast-iron wall sleeves or Galvanized-steel wall sleeves or Galvanized-steel-pipe sleeves.

2. Exterior Concrete Walls below Grade:

   a. Piping All Sizes: Cast-iron wall sleeves with sleeve-seal system, or Galvanized-steel wall sleeves with sleeve-seal system, or Galvanized-steel-pipe sleeves with sleeve-seal system.

      1) Select sleeve size to allow for a 1-inch annular clear space between piping and sleeve for installing the sleeve-seal system.

3. Concrete Slabs-on-Grade:

   a. Piping All Sizes**:** Cast-iron wall sleeves with sleeve-seal system or Galvanized-steel wall sleeves with sleeve-seal system, or Galvanized-steel-pipe sleeves with sleeve-seal system, or Galvanized-steel-pipe sleeves.

      1) Select sleeve size to allow for a 1-inch annular clear space between piping and sleeve for installing the sleeve-seal system.

4. Concrete Slabs above Grade:

    a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves or Stack-sleeve fittings or Sleeve-seal fittings.
    b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves or Stack-sleeve fittings.

5. Interior Partitions:

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

END OF SECTION 210517

SECTION 210518 - ESCUTCHEONS FOR FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Escutcheons.
2. Floor plates.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

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

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

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

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

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

2.2 FLOOR PLATES

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

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

PART 3 - EXECUTION

3.1 INSTALLATION

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

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

1. Escutcheons for New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
b. Chrome-Plated Piping: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
c. Insulated or bare Piping: concealed or exposed in unfinished spaces - one-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.
d. Bare or insulated Piping in Finished Spaces: One-piece, cast-brass or split-casting brass with concealed hinge type with polished chrome-plated finish.

2. Escutcheons for Existing Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
b. Chrome-Plated Piping: cast-brass or split-casting brass type with polished, chrome-plated finish.
c. Insulated or bare Piping: concealed or exposed in unfinished spaces - stamped-steel type or split-plate, stamped-steel type with concealed hinge.
d. Bare or insulated Piping in Finished Spaces: cast-brass or split-casting brass with concealed hinge type 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 the opening.

3.2 FIELD QUALITY CONTROL

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

END OF SECTION 210518

SECTION 210523 - GENERAL-DUTY VALVES FOR FIRE PROTECTION 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. Two-piece ball valves with indicators.
2. Bronze butterfly valves with indicators.
3. Iron butterfly valves with indicators.
4. Check valves.
5. Bronze OS&Y gate valves.
6. Iron OS&Y gate valves.
7. NRS gate valves.
8. Trim and drain valves.

1.3 DEFINITIONS

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

B. NRS: Non-rising stem.

C. OS&Y: Outside screw and yoke.

D. SBR: Styrene-butadiene rubber.

1.4 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 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 a higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use a sling to handle large valves; rig the sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.

D. Protect flanges and specialties from moisture and dirt.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. UL Listed: Valves shall be listed in UL's "Online Certifications Directory" under the headings listed below and shall bear UL mark:

1. Main Level: HAMV - Fire Main Equipment.

a. Level 1: HCBZ - Indicator Posts, Gate Valve.
b. Level 1: HLOT - Valves.

1) Level 3: HLUG - Ball Valves, System Control.
2) Level 3: HLXS - Butterfly Valves.
3) Level 3: HMER - Check Valves.
4) Level 3: HMRZ - Gate Valves.

2. Main Level: VDGT - Sprinkler System & Water Spray System Devices.

a. Level 1: VQGU - Valves, Trim and Drain.

B. FM Global Approved: Valves shall be listed in its "Approval Guide," under the headings listed below:

1. Automated Sprinkler Systems:

a. Indicator posts.
b. Valves.

1) Gate valves.
2) Check valves.

a) Single check valves.

3) Miscellaneous valves.

C. Source Limitations for Valves: Obtain valves for each valve type from single manufacturer.

D. ASME Compliance:

1. ASME B16.1 for flanges on iron valves.
2. ASME B1.20.1 for threads for threaded-end valves.
3. ASME B31.9 for building services piping valves.

E. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

F. NFPA Compliance: Comply with NFPA 24 for valves.

G. Valve Pressure Ratings: Not less than the minimum pressure rating indicated or higher as required by system pressures.

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

I. Valve Actuator Types:

1. Worm-gear actuator with handwheel for quarter-turn valves, except for trim and drain valves.
2. Handwheel: For other than quarter-turn trim and drain valves.
3. Handlever: For quarter-turn trim and drain valves NPS 2 and smaller.

2.2 TWO-PIECE BALL VALVES WITH INDICATORS

A. 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. NIBCO INC.
2. Victaulic Company.

B. Description:

1. UL 1091, except with a ball instead of a disc and FM Global standard for indicating valves (butterfly or ball type), Class Number 1112.
2. Minimum Pressure Rating: 175 psig.
3. Body Design: Two-piece.
4. Body Material: Forged brass or bronze.
5. Port Size: Full or standard.
6. Seats: PTFE.
7. Stem: Bronze or stainless steel.
8. Ball: Chrome-plated brass.
9. Actuator: Worm gear or traveling nut.

10. Supervisory Switch: Internal or external.
11. End Connections for Valves NPS 1 through NPS 2: Threaded ends.
12. End Connections for Valves NPS 2-1/2: Grooved ends.

2.3 BRONZE BUTTERFLY VALVES WITH INDICATORS

A. 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. Fivalco Inc.
2. Globe Fire Sprinkler Corporation.
3. Milwaukee Valve Company.

B. Description:

1. Standard: UL 1091 and FM Global standard for indicating valves (butterfly or ball type), Class Number 1112.
2. Minimum: Pressure rating: 175 psig.
3. Body Material: Bronze.
4. Seat Material: EPDM.
5. Stem Material: Bronze or stainless steel.
6. Disc: Bronze or Stainless steel with EPDM coating.
7. Actuator: Worm gear or traveling nut.
8. Supervisory Switch: Internal or external.
9. Ends Connections for Valves NPS 1 through NPS 2: Threaded ends.
10. Ends Connections for Valves NPS 2-1/2: Grooved ends.

2.4 IRON BUTTERFLY VALVES WITH INDICATORS

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. Anvil International.
2. Globe Fire Sprinkler Corporation.
3. Kennedy Valve Company; a division of McWane, Inc.

B. Description:

1. Standard: UL 1091 and FM Global standard for indicating valves (butterfly or ball type), Class Number 112.
2. Minimum Pressure Rating: 175 psig.
3. Body Material: Cast or ductile iron with nylon, EPDM, epoxy, or polyamide coating.
4. Seat Material: EPDM.
5. Stem: Stainless steel.
6. Disc: Ductile iron, and EPDM or SBR coated.

7. Actuator: Worm gear or traveling nut.
8. Supervisory Switch: Internal or external.
9. Body Design: Lug or wafer or Grooved-end connections.

2.5 CHECK VALVES

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. NIBCO INC.
2. Victaulic Company.

B. Description:

1. Standard: UL 312 and FM Global standard for swing check valves, Class Number 1210.
2. Minimum Pressure Rating: 175 psig.
3. Type: Single swing check.
4. Body Material: Cast iron, ductile iron, or bronze.
5. Clapper: Bronze, ductile iron, or stainless steel with an elastomeric seal.
6. Clapper Seat: Brass, bronze, or stainless steel.
7. Hinge Shaft: Bronze or stainless steel.
8. Hinge Spring: Stainless steel.
9. End Connections: Flanged, grooved, or threaded.

2.6 BRONZE OS&Y GATE VALVES

A. 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. Milwaukee Valve Company.
2. NIBCO INC.
3. United Brass Works, Inc.

B. Description:

1. Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves).
2. Minimum Pressure Rating: 175 psig.
3. Body and Bonnet Material: Bronze or brass.
4. Wedge: One-piece bronze or brass.
5. Wedge Seat: Bronze.
6. Stem: Bronze or brass.
7. Packing: Non-asbestos PTFE.
8. Supervisory Switch: External.

9. End Connections: Threaded.

2.7 IRON OS&Y GATE VALVES

A. 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. NIBCO INC.
2. Victaulic Company.
3. Watts; a Watts Water Technologies company.

B. Description:

1. Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves).
2. Minimum Pressure Rating: 175 psig.
3. Body and Bonnet Material: Cast or ductile iron.
4. Wedge: Cast or ductile iron, or bronze with elastomeric coating.
5. Wedge Seat: Cast or ductile iron, or bronze with elastomeric coating.
6. Stem: Brass or bronze.
7. Packing: Non-asbestos PTFE.
8. Supervisory Switch: External.
9. End Connections: Flanged or Grooved or Threaded.

2.8 NRS GATE VALVES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. American Cast Iron Pipe Company.
2. NIBCO INC.
3. Victaulic Company.

B. Description:

1. Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves).
2. Minimum Pressure Rating: 175 psig.
3. Body and Bonnet Material: Cast or ductile iron.
4. Wedge: Cast or ductile iron with elastomeric coating.
5. Wedge Seat: Cast or ductile iron, or bronze with elastomeric coating.
6. Stem: Brass or bronze.
7. Packing: Non-asbestos PTFE.
8. Supervisory Switch: External.
9. End Connections: Flanged or Grooved or Threaded.

2.9 TRIM AND DRAIN VALVES

A. Ball Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. Apollo Valves; Conbraco Industries, Inc.
b. NIBCO INC.
c. Potter Roemer LLC.

2. Description:

a. Pressure Rating: 175 psig or 300 psig.
b. Body Design: Two piece.
c. Body Material: Forged brass or bronze.
d. Port size: Full or standard.
e. Seats: PTFE.
f. Stem: Bronze or stainless steel.
g. Ball: Chrome-plated brass.
h. Actuator: Handlever.
i. End Connections for Valves NPS 1 through NPS 2-1/2: Threaded ends.
j. End Connections for Valves NPS 1-1/4 and NPS 2-1/2: Grooved ends.

B. Angle Valves:

1. 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. Fire Protection Products, Inc.
b. NIBCO INC.
c. United Brass Works, Inc.

2. Description:

a. Pressure Rating: 175 psig or 300 psig.
b. Body Material: Brass or bronze.
c. Ends: Threaded.
d. Stem: Bronze.
e. Disc: Bronze.
f. Packing: Asbestos free.
g. Handwheel: Malleable iron, bronze, or aluminum.

C. Globe Valves:

1. 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. United Brass Works, Inc.

2. Description:

    a. Pressure Rating: 175 psig or 300 psig.
    b. Body Material: Bronze with integral seat and screw-in bonnet.
    c. Ends: Threaded.
    d. Stem: Bronze.
    e. Disc Holder and Nut: Bronze.
    f. Disc Seat: Nitrile.
    g. Packing: Asbestos free.
    h. Handwheel: Malleable iron, bronze, or aluminum.

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

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

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that the gasket is of the 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 them with new valves.

3.2 GENERAL REQUIREMENTS FOR VALVE INSTALLATION

A. Comply with requirements in the following Sections for specific valve installation requirements and applications:
    1. Section 211313 "Wet-Pipe Sprinkler Systems" for the application of valves in wet-pipe, fire-suppression sprinkler systems.

B. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating the portion of the system controlled by each valve.

C. Install valves having threaded connections with unions at each piece of equipment arranged to allow easy access, service, maintenance, and equipment removal without system shutdown. Provide separate support where necessary.

D. Install valves in horizontal piping with stems at or above the pipe center.

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

F. Install valve tags. Comply with requirements in Section 210553 "Identification for Fire-Suppression Piping and Equipment" for valve tags and schedules and signs on surfaces concealing valves; and the NFPA standard applying to the piping system in which valves are installed. Install permanent identification signs indicating the portion of the system controlled by each valve.

G. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire-department connections.

H. Install a check valve in each water-supply connection. Install backflow preventers instead of check valves in potable water supply sources.

END OF SECTION 210523

SECTION 210529 - HANGERS AND SUPPORTS FOR FIRE SUPPRESSION 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. Fastener systems.
4. Equipment supports.

B. Related Requirements:

1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and 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. 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 fire-suppression 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 the combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting the combined operating weight of supported equipment and connected systems and components.
3. Design seismic-restraint hangers and supports for piping and equipment.

C. NFPA Compliance: Comply with NFPA 13.

D. UL Compliance: Comply with UL 203.

2.2 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: Factory-fabricated components, NFPA approved, UL listed, or FM approved for fire-suppression piping support.
2. Galvanized Metallic Coatings: Pregalvanized or hot-dip galvanized.
3. Hanger Rods: Continuous-thread rod, nuts, and washers made of carbon steel.

B. Copper Pipe and Tube Hangers:

1. Description: Copper-coated-steel, factory-fabricated components, NFPA approved, UL listed, or FM approved for fire-suppression piping support.
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 NFPA-approved, UL-listed, or FM-approved carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.4 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: NFPA-approved, UL-listed, or FM-approved 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: NFPA-approved, UL-listed, or FM-approved, 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, an Eaton business.
    b. Hilti, Inc.
    c. ITW Ramset/Red Head; Illinois Tool Works, Inc.

2. Indoor Applications: Zinc-coated or Stainless steel.
3. Outdoor Applications: Stainless steel.

2.5 EQUIPMENT SUPPORTS

A. Description: NFPA-approved, UL-listed, or FM-approved, welded, shop- or field-fabricated equipment support, made from structural-carbon-steel shapes.

2.6 MATERIALS

A. Aluminum: ASTM B221.

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. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation, for penetrations through fire-rated walls, ceilings, and assemblies.

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 the weight of supported components plus 200 lb.

3.2 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with the installation requirements of approvals and listings. 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 them together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for the 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. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete, after the concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to the powder-actuated tool manufacturer's operating manual. Install in accordance with approvals and listings.
2. Install mechanical-expansion anchors in concrete after the concrete is placed and completely cured. Install fasteners according to the manufacturer's written instructions. Install in accordance with approvals and listings.

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

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

F. 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 the action of expansion joints, expansion loops, expansion bends, and similar units.

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

H. 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 the top of inserts.

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

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

3.3 EQUIPMENT SUPPORTS

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

B. Grouting: Place grout under supports for equipment, and make the 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 the 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 the 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 the pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1” inches.

3.6 PAINTING

A. Touchup: Clean field welds and abraded, shop-painted areas. Paint exposed areas immediately after erecting hangers and supports. Use the 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 the sections specifying piping systems and equipment.

B. Comply with NFPA requirements 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, 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. (This includes all outdoor and garage applications)

G. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.

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

I. Horizontal-Piping Hangers and Supports: Comply with NFPA requirements. 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. Steel Pipe Clamps (MSS Type 4): For suspension of NPS 1/2 to NPS 24 if little or no insulation is required.
3. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
4. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
5. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
6. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
7. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
8. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
9. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.

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: Comply with NFPA requirements.

L. Building Attachments: Comply with NFPA requirements. 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 the concrete ceiling.
2. C-Clamps (MSS Type 23): For structural shapes.
3. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.

M. Saddles and Shields: Comply with NFPA requirements. 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 the manufacturer to prevent crushing insulation.
3. Thermal Hanger-Shield Inserts: For supporting insulated pipe.

N. Comply with NFPA requirements for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

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

P. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 210529

SECTION 210553 - IDENTIFICATION FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

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

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

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

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

D. Valve Schedules: Valve numbering scheme.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Brady Corporation.
b. Craftmark Pipe Markers.
c. Marking Services, Inc.
d. Seton Identification Products.

2. Material and Thickness: Brass or aluminum, 0.032-inch, with predrilled 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 4 inch.
6. Minimum Letter Size: 1 inch.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with the label and with the substrate.

B. Plastic Labels for Equipment:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Brady Corporation.
b. Craftmark Pipe Markers.
c. Marking Services, Inc.
d. Seton Identification Products.

2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8-inch thick, with 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 4 inch.
7. Minimum Letter Size: 1 inch. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with the label and with the substrate.

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

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

2.2 WARNING SIGNS AND LABELS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   a. Brady Corporation.
   b. Craftmark Pipe Markers.
   c. Marking Services Inc.
   d. Seton Identification Products.

2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8-inch thick, with predrilled holes for attachment hardware.
3. Letter Color: As Per NFPA / ANSI
4. Background Color: As Per NFPA / ANSI
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 4 inch.
7. Minimum Letter Size: 1 inch. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with the label and with the substrate.
9. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."

2.3 PIPE LABELS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

   1. Brady Corporation.
   2. Craftmark Pipe Markers.
   3. Marking Sevices Inc.
   4. Seton Identification Products.

B. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service and showing flow direction according to ASME A13.1.

C. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover the 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 the same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions or as a separate unit on each pipe label to indicate flow direction.
2. Lettering Size: Size letters according to ASME A13.1 for piping with at least 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances.

F. Pipe-Label Colors:

1. Background Color: As Per NFPA / ANSI
2. Letter Color: As Per NFPA / ANSI

2.4 STENCILS

A. Stencils for Piping:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

   a. Craft Mark Pipe Markers.
   b. Marking Services Inc.

2. Lettering Size: Size letters according to ASME A13.1 for piping with at least 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances.
3. Stencil Material: Fiberboard or metal.
4. Stencil Paint: Safety Red, exterior, gloss, acrylic enamel. Paint may be in pressurized spray-can form.
5. Identification Paint: White, exterior, acrylic enamel. Paint may be in pressurized spray-can form.

2.5 VALVE TAGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Brady Corporation.
2. Craftmark Pipe Markers.
3. Marking Services Inc.
4. Seton Identification Products.

B. Description: Stamped or engraved with 1/4-inch letters for piping-system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass or aluminum, 0.032-inch thick, with predrilled holes for attachment hardware.
2. Fasteners: Brass wire-link chain, beaded chain, or S-hook.
3. Valve-Tag Color: As Per NFPA / ANSI
4. Letter Color: As Per NFPA / ANSI

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.

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 the bond of identification devices.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Coordinate the installation of identifying devices with the completion of covering and painting of surfaces where devices are to be installed.

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

1. Identification Paint: Use for contrasting background.

2. Stencil Paint: Use for pipe marking.

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

C. Directional Flow Arrows: Arrows shall be used to indicate the direction of flow in pipes, including pipes where flow is allowed in both directions.

3.5 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in fire-suppression piping systems. List tagged valves in a valve-tag schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and with captions similar to those indicated in "Valve-Tag Size and Shape" Subparagraph below:

1. Valve-Tag Size and Shape:

a. Fire-Suppression Standpipe: 1-1/2 inches, round.
b. Wet-Pipe Sprinkler System: 1-1/2 inches, round.
c. Dry-Pipe Sprinkler System: 1-1/2 inches, round.
d. Foam-Water System: 1-1/2 inches, round.
e. Clean-Agent Fire-Extinguishing System: 1-1/2 inches, round.

3.6 WARNING-TAG INSTALLATION

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

END OF SECTION 210553

SECTION 211119 - FIRE-DEPARTMENT CONNECTIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings 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. Exposed-type fire-department connections.
2. Flush-type fire-department connections.
3. Yard-type fire-department connections. (Not Used)

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 each fire-department connection.

PART 2 - PRODUCTS

2.1 EXPOSED-TYPE FIRE-DEPARTMENT CONNECTION

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

1. American Fire Hose & Cabinet.
2. Elkhart Brass Mfg. Co., Inc.
3. Guardian Fire Equipment, Inc.

B. Standard: UL 405.

C. Type: Exposed, projecting, for wall mounting.

D. Pressure Rating: 175 psig minimum.

E. Body Material: Corrosion-resistant metal.

F. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.

G. Caps: Brass, lugged type, with gasket and chain.

H. Escutcheon Plate: Round, brass, wall type. Chrome or polished brass.

I. Outlet: Back, with pipe threads.

J. Number of Inlets: Minimum of Two. Contractor shall provide one inlet for each 250 GPM of system-rated capacity.

K. Escutcheon Plate Marking: Similar to "AUTO SPKR or AUTO SPKR & STANDPIPE or STANDPIPE."

L. Finish: Polished chrome plated or Rough brass or bronze.

M. Outlet Size: NPS 4 unless otherwise indicated.

2.2 FLUSH-TYPE FIRE-DEPARTMENT CONNECTION

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. American Fire Hose & Cabinet.
2. Elkhart Brass Mfg. Co., Inc.
3. Potter Roemer LLC.

B. Standard: UL 405.

C. Type: Flush, for wall mounting.

D. Pressure Rating: 175 psig minimum.

E. Body Material: Corrosion-resistant metal.

F. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.

G. Caps: Brass, lugged type, with gasket and chain.

H. Escutcheon Plate: Rectangular, brass, wall type.

I. Outlet: With pipe threads.

J. Body Style: Horizontal.

K. Number of Inlets: Minimum of Two. Contractor shall provide one inlet for each 250 GPM of system-rated capacity.

L. Outlet Location: Back unless otherwise indicated

M. Escutcheon Plate Marking: Similar to "AUTO SPKR OR AUTO SPKR & STANDPIPE OR STANDPIPE."

N. Finish: Polished chrome plated or Rough brass or bronze.

O. Outlet Size: NPS 4 unless otherwise indicated.

2.3 YARD-TYPE FIRE-DEPARTMENT CONNECTION (NOT USED)

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

1. Elkhart Brass Mfg. Co., Inc.
2. Guardian Fire Equipment, Inc.
3. Potter Roemer LLC.

B. Standard: UL 405.

C. Type: Exposed, freestanding.

D. Pressure Rating: 175 psig minimum 300 psig.

E. Body Material: Corrosion-resistant metal.

F. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.

G. Caps: Brass, lugged type, with gasket and chain.

H. Escutcheon Plate: Round, brass, floor type.

I. Outlet: Bottom, with pipe threads.

J. Number of Inlets: Minimum of Two. Contractor shall provide one inlet for each 250 GPM of system-rated capacity.

K. Sleeve: Brass.

L. Sleeve Height: 18 inches.

M. Escutcheon Plate Marking: Similar to "AUTO SPKR or AUTO SPKR & STANDPIPE or STANDPIPE."

N. Finish, Including Sleeve: Polished chrome plated or Rough brass or bronze.

O. Outlet Size: NPS 4 unless otherwise indicated

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of fire-department connections.

B. Examine roughing-in for the fire-suppression standpipe system to verify the actual locations of piping connections before fire-department connection installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install wall-type fire department connections.

B. Install yard-type fire-department connections in the concrete slab support.

C. Install two pipe bollards around each fire department connection where subject to vehicular damage. Comply with requirements for bollards in Section 055000 "Metal Fabrications."

D. Install an automatic (ball-drip) drain valve at each check valve for a fire department connection.

E. All exposed pipe and fittings (that are not brass or chrome) shall be painted red.

END OF SECTION 211119

SECTION 211313 - 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 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Pipes, fittings, and specialties.
2. Specialty valves.
3. Sprinklers.
4. Alarm devices.
5. Pressure gages.

B. Related Requirements:
1. Section 230523 "General-Duty Valves for Water-Based Fire-Suppression Piping" for ball, butterfly, check, gate, post-indicator, and trim and drain valves.

1.3 DEFINITIONS

A. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at a working pressure of 175-psig maximum.

B. High Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure higher than standard 175-psig but not higher than 300-psig maximum.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For wet-pipe sprinkler systems.

1. Include plans, elevations, sections, and attachment details.
2. Include diagrams for power, signal, and control wiring.

C. DELEGATED-DESIGN SUBMITTAL: For wet-pipe sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by a qualified Licensed Professional Engineer (in the state where work is being performed), responsible for their preparation. This shall include fire hydrant flow test results and data, sprinkler system, and standpipe system hydraulic calculations.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Sprinkler systems, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Domestic water, sanitary, and storm piping.
2. Compressed air and medical gas piping.
3. HVAC ductwork and piping.
4. Items penetrating the finished ceiling include the following:

a. Lighting fixtures and ceiling-mounted controllers.
b. Air outlets and inlets.
c. Fire Alarm initiating and signaling devices.

B. Qualification Data: For a qualified Installer and professional engineer.

C. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations and seismic calculations.

D. Welding certificates.

E. Fire-hydrant flow test report, recent within one (1) year.

F. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping" and fire pump test reports.

G. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wet-pipe sprinkler systems and specialties to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for a minimum of six spare sprinklers plus sprinkler wrench. Include the number of sprinklers required by NFPA 13 and a sprinkler wrench. Include a separate cabinet with sprinklers and a wrench for each type of sprinkler used on Project.

1.8 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on the results of the fire-hydrant flow test.

a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.

B. Welding Qualifications: Qualify procedures and operators according to the 2010 ASME Boiler and Pressure Vessel Code.

1.9 FIELD CONDITIONS

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

1. Notify Architect, Construction Manager, Owner, and Engineer no fewer than two days in advance of proposed interruption of sprinkler service.
2. Do not proceed with interruption of sprinkler service without the Architect's, Construction Manager's, Owner's, and Engineer’s written permission.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:

1. NFPA 13 as amended by Appendix Q (BCNYC).

B. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.

C. High-Pressure Piping System Component: Listed for 300-psig working pressure.

D. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design wet-pipe sprinkler systems.

1. Available fire-hydrant flow test records: Refer to Fire Protection contract drawings.

2. Sprinkler system design shall be approved by authorities having jurisdiction.

a. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
b. Sprinkler Occupancy Hazard Classifications: According to NFPA 13 recommendations, unless otherwise indicated.

3. Minimum Density for Automatic-Sprinkler Piping Design: According to NFPA 13 recommendations, unless otherwise indicated.

4. Maximum Protection Area per Sprinkler: According to UL listing.
5. Maximum Protection Area per Sprinkler: According to NFPA 13 recommendations, unless otherwise noted.

E. Total combined Hose-Stream Demand Requirement: According to NFPA 13, unless otherwise indicated.

F. Seismic Performance: Sprinkler piping shall withstand the effects of earthquake motions determined according to NFPA 13 and ASCE/SEI 7.

2.2 STEEL PIPE AND FITTINGS

A. Standard-Weight, Schedule 40, Black-Steel Pipe: ASTM A 53/A 53M, Type E, Grade B. Pipe ends may be factory or field formed to match joining method.

B. Schedule 10, Black-Steel Pipe: ASTM A 135/A 135M or ASTM A 795/A 795M, Schedule 10 in NPS 5 and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 10, plain end.

C. Black-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with threaded ends.

D. Uncoated-Steel Couplings: ASTM A 865/A 865M, threaded.

E. Uncoated, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.

F. Malleable- or Ductile-Iron Unions: UL 860.

G. Cast-Iron Flanges: ASME 16.1, Class 125.

H. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.

1. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8-inch thick or ASME B16.21, nonmetallic and asbestos free or EPDM rubber gasket.

a. Class 125 and Class 250, Cast-Iron, Flat-Face Flanges: Full-face gaskets.
b. Class 150 and Class 300, Ductile-Iron or -Steel, Raised-Face Flanges: Ring-type gaskets.

2. Metal, Pipe-Flange Bolts and Nuts: Carbon steel unless otherwise indicated.

I. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.

1. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

J. Grooved-Joint, Steel-Pipe Appurtenances:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. Anvil International.
b. Tyco Fire Products LP.
c. Victaulic Company.

2. Pressure Rating: 175-psig minimum or 300-psig where exposed to higher system pressures.

3. Uncoated Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting, with dimensions matching steel pipe.
4. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213 rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

2.3 SPECIALTY VALVES

A. Listed in UL's "Fire Protection Equipment Directory" or FM Global’s "Approval Guide."

B. Pressure Rating:

1. Standard-Pressure Piping Specialty Valves: 175-psig minimum.
2. High-Pressure Piping Specialty Valves: 300-psig.

C. Body Material: Cast or ductile iron.

D. Size: Same as connected piping.

E. End Connections: Flanged or grooved.

F. Automatic (Ball Drip) Drain Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

   a. Reliable Automatic Sprinkler Co., Inc. (The).
   b. Tyco Fire Products LP.

2. Standard: UL 1726.
3. Pressure Rating: 175-psig minimum.
4. Type: Automatic draining, ball check.
5. Size: NPS 3/4.
6. End Connections: Threaded.

2.4 SPRINKLER PIPING SPECIALTIES

A. Branch Outlet 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. Anvil International.
   b. Tyco Fire Products LP.
   c. Victaulic Company.

2. Standard: UL 213.
3. Pressure Rating: 175-psig minimum or 300 psig.
4. Body Material: Ductile-iron housing with EPDM seals, bolts, and nuts.
5. Type: Mechanical-tee and -cross fittings.
6. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
7. Size: Of dimension to fit onto the sprinkler main and with outlet connections as required to match connected branch piping.
8. Branch Outlets: Grooved, plain-end pipe, or threaded.

B. Flow Detection and Test Assemblies:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

    a. Reliable Automatic Sprinkler Co., Inc. (The).
    b. Tyco Fire Products LP.
    c. Victaulic Company.

2. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
3. Pressure Rating: 175-psig minimum or 300 psig.
4. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded or grooved.

C. Branch Line Testers:

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. Elkhart Brass Mfg. Co., Inc.
    b. Fire-End & Croker Corporation.
    c. Potter Roemer LLC.

2. Standard: UL 199.
3. Pressure Rating: 175 psig.
4. Body Material: Brass.
5. Size: Same as connected piping.
6. Inlet: Threaded.
7. Drain Outlet: Threaded and capped.
8. Branch Outlet: Threaded, for sprinkler.

D. Sprinkler Inspector's Test 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. Tyco Fire Products LP.
    b. Victaulic Company.
    c. Viking Corporation.

2. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
3. Pressure Rating: 175-psig minimum or 300 psig.
4. Body Material: Cast- or ductile-iron housing with sight glass.

5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded.

E. Adjustable Drop Nipples:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

   a. CECA, LLC.
   b. Corcoran Piping System Co.
   c. Merit Manufacturing.

2. Standard: UL 1474.
3. Pressure Rating: 250-psig minimum or 300 psig.
4. Body Material: Steel pipe with EPDM-rubber O-ring seals.
5. Size: Same as connected piping.
6. Length: Adjustable.
7. Inlet and Outlet: Threaded.

F. Flexible Sprinkler Hose Fittings: Not permitted in NYC

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

   a. FlexHead Industries, Inc.

2. Standard: UL 1474.
3. Type: Flexible hose for connection to sprinkler, and with a bracket for connection to ceiling grid.
4. Pressure Rating: 175-psig minimum or 300 psig.
5. Size: Same as connected piping, for sprinkler.

2.5 SPRINKLERS

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. Reliable Automatic Sprinkler Co., Inc. (The).
2. Tyco Fire Products LP.
3. Victaulic Company.
4. Viking Corporation.

B. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."

C. Pressure Rating for Residential Sprinklers: 175-psig maximum.

D. Pressure Rating for Automatic Sprinklers: 175-psig minimum.

E. Pressure Rating for High-Pressure Automatic Sprinklers: 300 psig.

F. Automatic Sprinklers with Heat-Responsive Element:

1. Early-Suppression, Fast-Response Applications: UL 1767.
2. Nonresidential Applications: UL 199.
3. Residential Applications: UL 1626.
4. Characteristics: Nominal 1/2-inch orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.

G. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.

1. Ceiling Mounting: Chrome-plated steel, one piece, flat or Chrome-plated steel, two-piece, with 1-inch vertical adjustment.
2. Sidewall Mounting: Chrome-plated steel, one piece, flat.

H. Sprinkler Guards:

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. Reliable Automatic Sprinkler Co., Inc. (The).
b. Tyco Fire Products LP.
c. Victaulic Company.
d. Viking Corporation.

2. Standard: UL 199.
3. Type: Wire cage with fastening device for attaching to sprinkler.

2.6 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

B. Electrically Operated Alarm Bell:

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. Fire-Lite Alarms, Inc.; a Honeywell International company.
b. Notifier.

c. Potter Electric Signal Company, LLC.

2. Standard: UL 464.
3. Type: Vibrating, metal alarm bell.
4. Size: 8-inch minimum diameter.
5. Finish: Red-enamel factory finish, suitable for outdoor use.
6. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Water-Flow Indicators:

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. Potter Electric Signal Company, LLC.
b. System Sensor.
c. Viking Corporation.
d. Watts; a Watts Water Technologies company.

2. Standard: UL 346.
3. Water-Flow Detector: Electrically supervised.
4. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends a signal if removed.
5. Type: Paddle operated.
6. Pressure Rating: 250 psig.
7. Design Installation: Horizontal or vertical.

D. Pressure Switches:

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. Potter Electric Signal Company, LLC.
b. System Sensor.
c. Tyco Fire Products LP.
d. Viking Corporation.

2. Standard: UL 346.
3. Type: Electrically supervised water-flow switch with retard feature.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design Operation: Rising pressure signals water flow.

E. Valve Supervisory Switches:

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. Fire-Lite Alarms, Inc.; a Honeywell International company.
    b. Potter Electric Signal Company, LLC.
    c. System Sensor.

2. Standard: UL 346.
3. Type: Electrically supervised.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design: Signals that the controlled valve is in a position other than fully open.
6. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.7 PRESSURE GAGES

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. AGF Manufacturing Inc.
    2. AMETEK, Inc.
    3. Brecco Corporation.

B. Standard: UL 393.
C. Dial Size: 3-1/2- to 4-1/2-inch diameter.
D. Pressure Gage Range: 0 to 300 psig.
E. Label: Include "WATER" label on dial face.

PART 3 - EXECUTION

3.1 PREPARATION

A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in the "Quality Assurance" Article. The flow test utilized for calculations shall be recent within one (1) year.

B. Report test results promptly and in writing.

3.2 PIPING INSTALLATION

A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated on approved working plans.

1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with the Engineer before deviating from approved working plans.
2. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

B. Piping Standard: Comply with NFPA 13 requirements for installation of sprinkler piping.

C. IInstall seismic restraints on piping. Comply with NFPA 13 requirements for seismic-restraint device materials and installation.

D. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

E. Install unions adjacent to each valve in pipes NPS 2 and smaller.

F. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

G. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.

H. Install sprinkler piping with drains for complete system drainage.

I. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.

J. Install an automatic (ball drip) drain valve at each check valve for a fire-department connection, to drain piping between the fire-department connection and check valve. Install drain piping to and spill over the floor drain or to the outside of the building.

K. Install alarm devices in piping systems.

L. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13. In seismic-rated areas, refer to Section 210548 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment."

M. Install pressure gages on riser or feed main, at each sprinkler test connection, and at the top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with a soft-metal seated globe valve, arranged for a draining pipe between the gauge

and the valve. Install gages to permit removal and install where they are not subject to freezing.

N. Fill sprinkler system piping with water.

O. Install electric heating cables and pipe insulation on sprinkler piping in areas subject to freezing. Comply with requirements for heating cables in Section 210533 "Heat Tracing for Fire-Suppression Piping" and for piping insulation in Section 210700 "Fire-Suppression Systems Insulation."

P. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping." Sleeves for building service shall be one nominal line size greater than the service pipe.

Q. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

R. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 210518 "Escutcheons for Fire-Suppression Piping."

S. Paint all sprinkler piping valves and accessories (that are not brass or chrome) with red enamel.

T. Install sprinkler guards anywhere the heads can be subject to damage, including equipment rooms, garages, and gymnasiums

3.3 JOINT CONSTRUCTION

A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than the system's pressure rating for aboveground applications unless otherwise indicated.

B. Install unions adjacent to each valve in pipes NPS 2 and smaller.

C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.

G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

H. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.

I. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble the coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.

J. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in the end of pipe according to AWWA C606. Assemble the coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

K. Dissimilar-Material Piping Joints: Make joints using adapters compatible with the materials of both piping systems.

3.4 VALVE AND SPECIALTIES INSTALLATION

A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.

B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating the portion of the system controlled by each valve.

C. Install a check valve in each water-supply connection. Install backflow preventers instead of check valves in potable water supply sources.

D. Specialty Valves:

1. Install valves in a vertical position for proper direction of flow, in the main supply to the system.
2. Install alarm valves with a bypass check valve and retarding chamber drain-line connection.
3. Install deluge valves in vertical position, in the proper direction of flow, and in the main supply to the deluge system. Install trim sets for drain, priming level, alarm

connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.

3.5 SPRINKLER INSTALLATION

A. Install sprinklers in suspended ceilings in the center of acoustical ceiling panels.

B. Install dry-type sprinklers with a water supply from the heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.

C. Install sprinklers into flexible sprinkler hose fittings, and install the hose into the bracket on the ceiling grid.

3.6 IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13. Comply with requirements for identification specified in Section 210553 "Identification for Fire-Suppression Piping and Equipment".

B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.7 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
4. Energize circuits to electrical equipment and devices.
5. Coordinate with fire-alarm tests. Operate as required.
6. Coordinate with fire-pump tests. Operate as required.
7. Verify that the equipment hose threads are the same as the local fire department equipment.

B. Sprinkler piping system will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.8 CLEANING

A. Clean dirt and debris from sprinklers.

B. Only sprinklers with their original factory finish are acceptable. Remove and replace any sprinklers that are painted or have any other finish than their original factory finish.

3.9 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain the sprinkler system and components.

3.10 PIPING SCHEDULE

A. Piping between Fire Department Connections and Check Valves: Galvanized, standard-weight steel pipe with threaded ends, cast-iron threaded fittings, and threaded joints or grooved ends, grooved-end fittings, grooved-end-pipe couplings, and grooved joints. Where piping between the fire department connection and check valve is routed below grade, piping and fittings shall also be externally coated and wrapped per AWWA C203 or C105.

B. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.

C. Standard-pressure, wet-pipe sprinkler system, NPS 1-1/2 and smaller, shall be one of the following:

1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
2. Standard-weight, black-steel pipe with plain ends; steel welding fittings; and welded joints.

D. Standard-pressure, wet-pipe sprinkler system, NPS 2 and Larger, shall be one of the following:

1. Standard-weight black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
2. Standard-weight, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
3. Standard-weight, black-steel pipe with plain ends; steel welding fittings; and welded joints.
4. Schedule 10 black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
5. Schedule 10 black-steel pipe with plain ends; welding fittings; and welded joints.

E. High-pressure, wet-pipe sprinkler system, [All Sizes], shall be one of the following:

1. Standard-weight, black-steel pipe with plain ends; steel welding fittings; and welded joints.

3.11 SPRINKLER SCHEDULE

A. Use sprinkler types as indicated on the Fire Protection contract drawings.

END OF SECTION 211313

SECTION 220500 - COMMON WORK RESULTS FOR PLUMBING

PART 1- GENERAL

1.1 SECTION INCLUDES

A. These basic requirements apply to all Division 22000 Sections.

B. The work of this Section consists of providing all materials, labor, and equipment and the like necessary and/or required for the complete execution of all Plumbing and related work for this project, as required by the contract documents.

1.2 RELATED SECTIONS

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

1.3 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER RESPECTIVE SECTIONS OF THIS DIVISION

A. Motor starters shall be furnished under this Division. Refer to Specification Section 220513 “Common Motor Requirements for Plumbing Equipment" for technical information.

1.4 REFERENCES

A. ASPE - American Society of Plumbing Engineers.

B. UL - Underwriters Laboratory.

C. NFPA - National Fire Protection Association.

1.5 REGULATORY REQUIREMENTS

A. All equipment and installation methods shall conform to the applicable standards and/or recommendations set forth in the New York State Building Code, Local Codes as well as all Codes and Standards listed in the General and Supplemental Conditions sections of the specification, as well as the following specific codes

1. NY State Building Code,
2. NY State Mechanical Code
3. NY State Fuel Gas Code
4. NY State Plumbing Code
5. NY State Education Department Planning Standards
6. All Supplemental Codes

B. Maximum fixture flow rates shall conform to the New York State Plumbing Code, Section 604.4, as follows: specified fixture may have lower flow rates.

a. Lavatory, private – 1.5 gpm at 60 psi
b. Lavatory, public – 0.25 gpm per metering cycle
c. Shower head – 2.0 gpm at 80 psi
d. Sink faucet – 2.2 gpm at 60 psi
e. Water Closet – 1.28 gal. per flush

1.6 FEES & PERMITS

A. The Contractor shall be responsible for filing drawings, paying necessary fees, and obtaining all permits related to the scope of work.

1.7 QUALITY ASSURANCE

A. The Contractor shall have the work indicated on the drawings and/or specified in each section performed by vendors or mechanics experienced and skilled in its implementation or by a “Specialist”, “Specialty Contractor” or “Specialty Subcontractor” under contractual agreement with the Contractor. These terms mean an individual or firm of established reputation, or, if newly organized, whose personnel have previously established a reputation in the same field, which is regularly engaged in, and which maintains a regular force of workmen skilled in either manufacturing or fabricating items required by the Contract, installing items required by the Contract, or otherwise performing work required by the Contract.

B. Where the Contract Specifications require installation by a "Specialist," that term shall also be deemed to mean either the manufacturer of the item, an individual or firm licensed by the manufacturer, or an individual or firm who will perform such work under the manufacturer's direct supervision.

1.8 PROJECT/SITE CONDITIONS

A. Install Work in locations shown on Drawings, unless prevented by Project conditions.

B. Prepare drawings showing the proposed arrangement of Work to meet Project conditions, including changes to Work specified in other Sections.

1.9 SCOPE OF WORK

A. This Contractor shall be responsible for coordinating his work with all other trades.

B. The Contractor shall provide all materials, labor, equipment, tools, appliances, services, hoisting, scaffolding, supervision, and overhead for the furnishing and installation of all Plumbing work indicated on the plan and in the specifications and related work, including but not limited to the following:

1. Domestic Water Recirculation Pumps
2. Domestic Hot Water Heaters and Expansion Tanks
3. Plumbing Fixtures
4. Piping, valves, fittings, and specialties
5. Domestic systems
6. Drain, Waste, and Vent
7. Gas
8. Storm
9. Hangers and Supports
10. Backflow Preventers
11. Equipment Insulation
12. Pipe Insulation
13. Identification
14. Coordination
15. Phasing
16. Shop Drawings
17. As-Built Drawings and Maintenance Manuals
18. Warrantees

PART 2 PRODUCTS – NOT USED

PART 3 – EXECUTION

3.1 GENERAL

A. Construct all apparatus of materials and pressure ratings suitable for the conditions encountered during continuous operation.

B. Where corrosion can occur, appropriate corrosion-resistant materials and assembly methods must be used, including isolation of dissimilar metals against galvanic interaction. Resistance to corrosion must be achieved by the use of the appropriate base materials. Coatings shall be restored to only when specifically permitted by the Specification.

C. Construct all equipment in accordance with the requirements of all applicable codes. All pressure vessels and safety devices that fall within the scope of the ASME Code shall conform to the Code and bear the ASME label or stamp.

D. Match and balance all system components to achieve compatibility of equipment or satisfactory operation and performance throughout the entire operating temperature and control ranges. All installations shall be in accordance with the manufacturer's recommendations.

E. Provide all controls, wiring, piping, valves, accessories, and other components necessary to make all systems complete and operable.

F. The contractor shall warrant all work, including labor and materials, and equipment furnished and installed as part of this contract for a minimum period of one year from the date of acceptance by the owner, in writing. Certain equipment, such as underground fuel tanks, may have longer warranties as indicated in the specifications. In such cases, the longer of the two warranties shall prevail.

G. All domestic water pipe valves and fittings shall be lead-free.

3.2 SHOP DRAWINGS AND SUBMITTALS (COORDINATE WITH DIVISION 1)

A. Shop drawings and samples shall be prepared and submitted in accordance with the requirements established in the contract and shall consist of all items listed in the following paragraph.

B. Manufacturer's data or shop drawings giving full information as to dimensions, materials, and all information pertinent to the adequacy of the submitted equipment shall be submitted for review. Shop drawings shall include, but not be limited to, the following:

C. Submit all equipment noted and scheduled on plans, including but not limited to the following:

1. Domestic Water Recirculation Pumps
2. Domestic hot water heaters and expansion tanks
3. Plumbing Fixtures
4. Piping, valves, fittings, and specialties
5. Domestic systems

6. Drain, Waste, and Vent
7. Gas piping valves and fittings
8. Storm
9. Hangers and Supports
10. Backflow Preventers
11. Equipment Insulation
12. Pipe Insulation
13. Hangers and Inserts
14. Roof Drains
15. Floor Drains
16. Insulation
17. Piping Layout (3/8 scale)
18. Controls

D. The contractor shall, upon award, submit a schedule for the engineer's review indicating when each of the above shop drawings shall be submitted. Submittals shall be made in a timely manner as the project progresses in accordance with the Construction Manager's or General Contractor's work schedules. The contractor shall allow sufficient time for the engineers to perform their review. A minimum of 10 business days shall be required. Untimely submittals shall be cause for the owner to make a delay against the contractor.

E. Demolition, purchase, and/or installation shall not begin until shop drawings pertaining to the equipment associated with any related portion of the work have been submitted.

F. Coordination shop drawings shall indicate all new lights, walls, piping, ductwork, structural elements, existing work, etc., and dimension locations of plumbing piping, including elevations in relation to these items.

G. Where shop drawings have been reviewed by the Engineer, such review shall not be considered as a guarantee of measurements or building conditions. Where drawings have been reviewed, said review does not mean that drawings have been checked in detail; said review does not substantiate any quantities and in any way relieve the Contractor from his responsibility nor the necessity of furnishing materials or performing work required by the Contract Drawings and Specifications.

H. Where substitutions are submitted for approval, the review shall be for general performance comparison to the specified product. Products shall not be reviewed for size, clearance, or coordination with other trades. Coordination with other trades shall be the responsibility of the contractor. And changes to existing conditions or changes required to the work of other trades, such as a result of substituted material or equipment approved or not, shall be the responsibility of this contractor.

I. Approval of shop drawings

1. The Contractor shall be specifically responsible for checking equipment dimensions and clearances and confirming that equipment will fit into the designated space and connect properly to adjoining equipment and/or materials.
2. Submittals marked "Make Corrections Noted" give authority to proceed in accordance with the notes. However, if drawings are also marked "Amend and Resubmit", corrected drawings must be resubmitted for final review.
3. Submittals marked "Rejected" do not give authority to proceed with any portion of the work shown thereon. Drawings must be resubmitted.
4. Submittals marked "Rejected" or "Amend and Resubmit" shall include a specific written response to the engineer's comments. Resubmission of a submittal without a written response to the engineer's comments will be considered incomplete and shall be returned unreviewed.
5. Coordination submittals for piping, conduit, and equipment within the building shall be made using 3-D software such as AutoCAD and shall include plan view sections and elevations as necessary to fully illustrate, evaluate, and resolve all structural, piping, major conduit, and equipment conflicts with other trades.

3.3 CHARTS AND TAGS

A. The Contractor shall provide three sets of charts and diagrams of all piping systems, indicating the number and location of valves, etc.

B. All valves and controls shall be designated with brass tags. Refer to section 22 05 23 Identification for Plumbing, Piping, and equipment.

C. General and Supplementary Conditions and Division 01 Specification Sections apply to this Section

3.4 PAINTING

A. All field-erected apparatus, stands, supports, and supplemental steel and hangers shall be painted with one coat of primer and one coat of machinery enamel black or grey, or they shall be galvanized. All finishes shall be cleaned and touched up to repair any damage incurred during construction. All factory-manufactured and assembled apparatus and equipment shall be factory-painted with the manufacturer's standard coating, suitable for the environment in which the equipment will be used.

B. All piping shall be painted in colors conforming to OSHA Standards. And labeled according to specifications.

C. All fasteners, nuts, bolts, hanger rods, and “Kindorf” shall be galvanized steel or nickel-plated.

3.5 RIGGING

A. Furnish all labor, materials, and equipment required to rig equipment and materials.

B. The rigger shall secure any necessary permits and comply with all applicable Federal, State, and local safety regulations. A copy of the permits is to be kept at both the project site and the Engineer's Office.

C. The rigger shall have a minimum of five (5) years of practical experience and hold a master rigger's license if required.

D. The procedure for rigging shall be submitted to the Engineer for review. All possible precautions should be taken to prevent damage to the structure, streets, sidewalks, curbs, lawns, etc.

3.6 CUTTING AND PATCHING

A. All cutting and patching required for piping, etc., passing through walls, floors, and roofs shall be provided by the General Contractor under this contract unless otherwise noted. This Contractor shall be responsible for any damage done to the structure due to his negligence.

B. Patching materials and application shall match existing construction.

C. Where applicable, new holes for piping installation shall be core drilled.

D. Pipe Sleeves & Fire-stopping

1. Provide for all pipes and other elements passing through floors, walls, partitions and structural elements, sleeves as specified. Sleeves shall be of adequate diameter to allow for a minimum of 3/4 inch clear all around the sleeve and pipe.
2. Where pipes penetrate fire-rated assemblies, or where holes or voids are created to extend systems through fire-rated assemblies (walls, floors, ceilings, structure, etc.); sleeves and fire-stopping systems shall be installed.

E. Furnish access doors to the General Contractor for installation where required in finished walls, partitions, and the like for access to junction boxes, controls, valves, etc, concealed behind finished construction.

3.7 PROTECTION-COORDINATE WITH DIVISION 1

A. Recommendations and Provisions of ANSI Bulletin A10.2 and OSHA shall be complied with insofar as applicable to the work.

B. The Contractor shall provide temporary partitions or tarpaulins to protect adjacent spaces and/or equipment. He shall be responsible for any damage or injury to person or property of any character resulting from any act, omission, neglect, or misconduct in his manner or method of executing his work.

C. The Contractor shall restore at his own expense such property to a condition similar or equal to that existing before such damage or injury in an acceptable manner.

D. The Contractor, furthermore, shall conduct his operations in such a manner as to prevent dust and debris from transferring onto adjoining property or into existing spaces.

E. All openings cut in walls, floors, roof or ceilings of the building, for pipe, etc., shall be closed off with box-type temporary protective enclosures of ¼" tempered hardboard, except when mechanics are actually working at the particular opening. Enclosures shall be constructed of a fireproof 2x4 frame, four (4) sides covered and made completely dust and water-tight.

F. All finished floor areas through which the contractor must pass with materials or equipment shall be protected with a layer of ¼" hardboard, "Masonite", or “Ramboard” laid with joints taped together.

G. The roof shall be protected with ½” plywood in all areas of work.

3.8 EQUIPMENT SUPPORTS

A. Provide supplementary steel dunnage, curbs, angle iron stands, etc., to properly set and install all equipment, including supports necessary to properly pitch piping.

3.9 WELDING

A. Welding and equipment shall conform to the American Welding Society’s Code for Welding in Building Construction, latest edition, as well as state and local laws and ordinances.

B. The handling and storage of all welding materials, acetylene and oxygen tanks, burners, and other equipment required for the execution of welding and cutting work shall be subject at all times to the approval of the Owner and/or Architect. All welding materials

and gas tanks shall be promptly removed from the premises upon completion of each day's work or stored in a manner satisfactory to the owner. Welding and equipment shall conform to the American Welding Society's Code for Welding in Building Construction, latest edition, as well as state and local laws and ordinances.

C. Provide all temporary exhaust and ventilation air systems required during welding operations as required by OSHA. At no time shall the owners' new or existing HVAC equipment be used for ventilation during construction.

3.10 AS-BUILT DRAWINGS

A. The Contractor shall provide a complete set of As-Built drawings showing actual installation and locations of all piping and roof drains.

B. As-Built drawings shall be submitted as per contract requirements in accordance with Division 1. Accepted as built drawings shall then be submitted in AutoCAD and PDF electronically on a hard disc.

3.11 CONDITIONS

A. Inspection: Prior to all work of this Section, carefully inspect the installed work of all other trades and verify that all such work is complete to the point where this installation may properly commence. Verify that the work of this Section may be completed in strict accordance with all pertinent codes and regulations, the approved Shop Drawings, and the Manufacturers' recommendations.

B. Discrepancies: In the event of a discrepancy, immediately notify the Engineer. Do not proceed in areas of discrepancy until all such discrepancies have been fully resolved.

3.12 INSTALLATION OF EQUIPMENT

A. Locations: Install all equipment in the locations shown on the approved Shop Drawings except where specifically otherwise approved on the job by the Owner and/or Engineer.

B. Interferences: Avoid interference with structure and with work of other trades, preserving adequate headroom and clearing all doors and passageways to the approval of the Engineer.

C. Inspection: Check each piece of equipment in the system for defects, verifying that all parts are properly furnished and installed, that all items function properly, and that all adjustments have been made.

3.13 CLOSING-IN OF UNINSPECTED WORK

A. General: Do not allow or cause any of the work to be covered up or enclosed until it has been inspected, tested, and accepted by the Engineer and by all other authorities having jurisdiction.

B. Uncovering: Should any of the work of this Section be covered up or enclosed before it has been completely inspected, tested, and approved, do all things necessary to uncover all such work. After the work has been completely inspected, tested, and approved, provide all materials and labor necessary and make all repairs necessary to restore the work to its original and proper condition at no additional cost to the owner.

3.14 BUILDING ACCESS

A. The Contractor shall inform himself fully regarding the peculiarities and limitations of space available for the passage and installation of all equipment and materials under the Contract.

B. Verify and coordinate removal of existing construction to suit conditions. Provide all labor and materials to facilitate installation.

3.15 COOPERATION WITH OTHER TRADES / PHASING

A. Cooperate with other trades in order that all systems in the work may be installed in the best arrangements.

B. Coordinate as required with all other trades to share space in common areas and to provide maximum access to each system.

C. This Contractor shall submit fully coordinated shop drawings showing all piping, ductwork, and equipment, as well as relevant work of all other trades, such as light, conduits, structural, and steel, which may impact the final size or placement of piping, roof drains, etc.

D. The work shall be scheduled and phased in accordance with the requirements of the contract and the client. Prior to the commencement of work, the PLUMBING contractor shall submit a schedule in writing to the Architect and the owner for approval. There shall be no shutdowns of any systems without prior written approval from the owner. The contractor shall include in his bid all costs associated with providing temporary piping, pumps, and hot water heaters to maintain operations outside the area of work while work is being performed. It shall also be noted that piping will have to be extended through

the other areas in order to reach the area(s) under construction as part of this work. The contractor shall include in his bid all provisions to perform such phasing work. This note is typical for phases.

3.16 CLEANING

A. It is the intent of the contract documents that all work, including the inside of equipment, be left in a clean condition. All construction dirt shall be removed from the material and equipment.

B. All removed items shall be taken off the premises and discarded in a manner satisfactory to the Owner.

3.17 COMPLETENESS

A. It is the intent of the contract documents to provide complete systems. Completeness shall mean not only that all material and equipment have been installed properly, but that all material and equipment are installed, adjusted, and operating as per the design intent in the opinion of the Engineer.

3.18 FIRE PREVENTION DURING HOT WORK

A. Before starting operations, the Contractor shall furnish trained personnel to provide fire watches for locations where hot work is to be performed. One fire watcher may observe several locations in a relatively small contiguous area. Contractor shall furnish a suitable type, fully-charged, operable portable fire extinguisher to each fire watcher.

B. The Contractor shall provide fire watchers who know how to operate the fire extinguisher, how to turn on a fire alarm, and how to summon the fire department.

C. Before starting operations, take suitable precautions to minimize the hazard of a fire communicating to the opposite side of walls, floors, ceilings, and roofs from the operations.

3.19 SAFETY MEASURES

A. Hot work shall not be done in or near rooms or areas where flammable liquids or explosive vapors are present or thought to be present. A combustible gas indicator (explosimeter) test shall be conducted to ensure that each area is safe. The Contractor is responsible for arranging and paying for each test.

B. Insofar as possible, the Contractor shall remove and keep the area free from all combustibles, including rubbish, paper, and waste, within a radius of 25 feet from hot operations.

C. If combustible material cannot be removed, the Contractor shall furnish fireproof blankets to cover such materials. At the direction of the owner, floors, walls, and ceilings of combustible material shall be wetted thoroughly with water before, during, and after operations sufficiently to afford adequate protection.

D. Where possible, the Contractor shall furnish and use baffles of metal or gypsum board to prevent the spraying of sparks, hot slag, and other hot particles into surrounding combustible material.

E. The Contractor shall prevent the spread of sparks and particles of hot metal through open windows, doors, and holes and cracks in floors, walls, ceilings, and roofs.

F. Cylinders of gas used in hot work shall be placed at a safe distance from the work. The Contractor shall provide hoses and equipment free of deterioration, malfunction, and leaks. Suitable supports shall be provided to prevent accidental overturning of cylinders. All cylinder control valves shall be shut off while in use, with the gas pressure regulator set at 15 psi or less.

G. When hot work operations are completed or ended for the day, each location of the day's work shall be inspected by the Contractor 30 to 60 minutes after completion of operations to detect hidden or smoldering fires and to ensure that proper housekeeping is maintained. Contractor shall clean up the area of work at the end of each shift or workday.

H. Where sprinkler protection exists, the sprinkler system shall be maintained without interruption while operations are being performed. If operations are performed close to automatic sprinkler heads, gypsum board sheets or damp cloth guards may be used to shield the individual heads temporarily. The heads shall be inspected by the Contractor immediately after hot work operations cease to ensure all materials have been removed from the heads and that the heads have not been damaged.

I. Suitable type, fully-charged, operable portable fire extinguisher shall be available at all times during hot work operations.

J. If any of the above safeguards are not employed, or are violated, the Contracting Owner's Representative may, by written notice, stop the work until compliance is obtained. Such stoppage shall not relieve the Contractor from performing his work within the Contract period for the Contract price.

3.20 USE OF OWNERS EQUIPMENT

A. The contractor shall not use any of the owner's HVAC system or equipment, new or existing, for any purpose. The contractor shall provide temporary HVAC equipment, ductwork, power, and controls for use during construction for the purpose of ventilation or heating during the construction process. All such equipment, ductwork, power, and controls shall be removed upon completion of work.

3.21 CONSTRUCTION PHOTOGRAPHS

A. Maintain a key plan with each set of construction photographs that identifies each photographic location.

B. Preconstruction Photographs: Before commencement of the Work, take photographs of the Project site and surrounding properties, including existing items to remain during construction, from different vantage points, as directed by the Construction Manager.
   1. Flag excavation areas and construction limits before taking construction photographs.
   2. Take 20 photographs of existing buildings, either on or adjoining property, to accurately record physical conditions at the start of construction.

C. Concealed Work Photographs: Before proceeding with installing work that will conceal other work, take photographs sufficient in number, with annotated descriptions, to record the nature and location of concealed work, including, but not limited to, the following:

   1. Underground utilities.
   2. Underground plumbing piping
   3. Under slab services.
   4. Piping.

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

E. Final Completion Construction Photographs: Take 100 photographs after the date of Substantial Completion for submission as Project Record Documents. The engineer and owner will inform the photographer of the desired vantage points.

END OF SECTION 220500

SECTION 220513 - COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Division 24 - Equipment Wiring Systems: Electrical characteristics and wiring connections.

1.2 SUMMARY

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

1.3 COORDINATION

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

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

1.4 REFERENCES

A. AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings.

B. AFBMA 11 - Load Ratings and Fatigue Life for Roller Bearings.

C. NEMA MG 1 - Motors and Generators.

D. NFPA 70 - National Electrical Code.

1.5 REGULATORY REQUIREMENTS

A. Conform to UL Component Recognition for appropriate sizes.

B. Conform to NFPA 70 applicable electrical code, Underwriters Laboratories, Inc., and NEMA

C. Conform to New York State energy code.

1.6 DELIVERY, STORAGE, AND PROTECTION

A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weatherproof covering. For extended outdoor storage, remove motors from equipment and store separately.

1.7 WARRANTY

A. Provide a five-year manufacturer's warranty for all motors larger than ½ horsepower.

PART 2 - PRODUCTS

MANUFACTURERS

A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

1. Gould.
2. Century.
3. General Electric.
4. Square D

2.2 GENERAL MOTOR REQUIREMENTS

A. Comply with NEMA MG 1 unless otherwise indicated.

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

C. All electric motors of sizes and types as specified for driving mechanical equipment shall be provided under this section.

D. Electrical Service: All motors shall be 60 Hertz unless otherwise noted. Refer to Electrical Specifications for required electrical characteristics.

E. Motors: Design for continuous operation in a 40 °C environment and for temperature rise in accordance with ANSI/NEMA MG limits for insulation class, Service Factor, and motor enclosure type. Motors shall be of sufficient size for the duty to be performed.

F. Visible Nameplate: Indicating manufacturer's name and model number, motor horsepower, RPM, frame size, voltage, phase, cycles, full load amps, insulation system class, service factor, maximum ambient temperature, temperature rise at rated horsepower, minimum efficiency, and power factor.

G. Electrical Connection: Conduit connection boxes, threaded for conduit. For fractional horsepower motors where connection is made directly, provide a screwed conduit connection in the end frame. Size motor boxes to receive motor feeders and ground cable, as indicated on electrical drawing schedules.

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

I. 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 MOTOR EFFICIENCY

A. Electric motors shall meet the minimum efficiency requirement of the following tables in accordance with the International Energy Conservation Code when tested in accordance with DOE CFR 431. Performance data shall be certified by an approved testing agency.

B. Subtype I motors – NEMA premium efficiency as per table NEMA MG 1 table 12-12 and International Energy Conservation code table 405.8(1). This shall apply to general-purpose, T-frame, single-speed, squirrel cage, induction-type, 230/460-V, NEMA Designs A or B, continuous-rated, 60 Hz, from 1 to 200 hp, 2-, 4- and 6-pole (3600-, 1800- and 1200-rpm), open and enclosed. Subtype I motors 250 hp to 500 hp motor efficiency shall be able NEMA MG 1 table 12-11 and International Energy Conservation Code table 405.8(1).

C. Subtype II motors – NEMA efficiency as per table NEMA MG 1 table 12-11 and International Energy Conservation Code table 405.8(2). This shall apply to general-purpose motors but can be configured as U-frame motors; NEMA Design C motors; close-coupled pump motors; footless motors; vertical solid shaft normal thrust motors (as tested in a horizontal position); eight-pole (900 rpm) motors, and polyphase motors with a voltage of not more than 600 V (other than 230 or 460 V).

D. Minimum average full load efficiency of polyphase small electric motors up to 3 hp shall be in accordance with Table C405.8(3) of the International Energy Conservation Code

E. Minimum average full load efficiency for capacitor-start, capacitor-run and capacitor-start induction-run small electric motors up to 3 hp shall be in accordance with Table C405.8(4) of the International Energy Conservation Code.

2.4 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Service Factor: 1.15.

C. Multispeed Motors: Variable torque.

1. For motors with 2:1 speed ratio, consequent pole, single winding.
2. For motors with a speed ratio other than 2:1, separate windings for each speed.

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. Grease lubricated anti-friction ball bearings with housings equipped with a plugged provision for relubrication, rated for minimum AFBMA 9, L-10 life of 200,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at the end of NEMA standard shaft extension. Stamp bearing sizes on the nameplate.

G. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors embedded in motor windings and an epoxy-encapsulated solid-state control relay with wiring to the terminal box.

H. Sound Power Levels: To NEMA MG 1.

I. Temperature Rise: Match insulation rating.

J. Insulation: Class B or better.

K. 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.

L. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.5 ADDITIONAL REQUIREMENTS FOR POLYPHASE MOTORS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for the controller with required motor leads. Provide terminals in the motor terminal box, suited to the control method.

B. Use part winding Start above 254T Frame Size: Use part of winding to reduce locked-rotor starting current to approximately 60 percent of full winding locked-rotor current while providing approximately 50 percent of full winding locked-rotor torque.

C. Motors Used with Variable-Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by the 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.

D. Severe-Duty Motors: Comply with IEEE 841, with a 1.15 minimum service factor.

2.6 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 the power supply circuit to the motor when winding temperature exceeds a safe value calibrated to the temperature rating of motor insulation. The thermal-protection device shall automatically reset when motor temperature returns to the normal range.

F. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, pre-lubricated sleeve ball bearings.

2.7 POWER FACTOR CORRECTION

A. Provide a capacitor for each three-phase, single-speed motor rated 3 HP or larger shall be provided to correct the full load power factor to 95%. The capacitor shall be mounted on the motor for connection across the motor terminals by the Electrical Contractor

B. Capacitors;
1. Capacitors shall be totally enclosed, fused, and have discharge resistors.
2. Capacitors based on nominal motor RPM shall be provided in accordance with the following table to correct the power factor to 95% and verify sizes with the motor manufacturer.

Motor HP	Capacitor KVAR 3600 RPM Motor	Capacitor KVAR 1800 RPM Motor
3	1.5	1.5
5	2	2
7.5	2.5	2.5
10	3	3
15	4	4
20	5	5
25	6	6
30	7	7
40	9	9
50	12	12
60	14	14

2.8 STARTERS

A. GENERAL

1. See specification Section 16485 and Division 1 for additional information.
2. Starters for motors operating at 120 volts shall be manual starters unless otherwise indicated. Starters for motors operating at other than 120 volts shall be magnetic starters.
3. All starters shall be enclosed. Enclosures shall be surface-mounted NEMA 1 unless otherwise indicated.
4. Where weatherproof starters are required, the enclosure shall be NEMA 4.
5. It shall be verified that the correct overload heaters have been installed in the starter before energizing any motor. Sizing shall be based on the motor nameplate current and taking into account any reduction in current due to power factor correction.
6. Alternate Manufacturers –
   a. Allen-Bradley
   b. Crouse-Hinds Co.

c. Cutler-Hammer, Inc.
d. General Electric Co.
e. Square D Co.
f. Westinghouse Electric Corp.

B. MANUAL STARTERS

1. Two-pole, toggle-operated, thermal overload device in each phase leg, handle guard for padlocking toggle handle, and with indicated control and signal devices.

2. Where a motor is controlled automatically by an interlock or pilot device, a “HAND-OFF-AUTO” switch shall be provided in the starter cover. Where the rating of the interlock or pilot device is inadequate to control the motor currents directly, a properly rated contactor shall be provided between the controlling device and the motor.

3. An “ON” pilot light shall be provided in the starter cover.

C. MAGNETIC STARTERS

1. Starters shall be sized in accordance with NEMA standards and the following table, except that starters shall not be smaller than NEMA size 0. Starters shall be provided with one N.O. electrical holding interlock, under-voltage protection, and two additional auxiliary contacts within the same enclosure. NEMA-size starters shall be provided as follows

STARTER SIZE	MAX HP AT 460 VOLTS
0	5
1	10
2	25

2. All starters shall be combination type with the starter and disconnect in the same enclosure. All starters shall be Type 2 coordination-protected. Fuses shall be Bussman “Low Peak” type or equal-sized at 125% of the motor nameplate rating. Verify and coordinate requirements for fused disconnect switches with the Electrical Contractor prior to ordering starters.

3. Provide S.S.P.B. or H-O-A switches and pilot light in covers as required to facilitate control operation sequences.

PART 3 - EXECUTION

A. Suitable starting and controlling equipment and devices shall be furnished and installed as specified hereinafter and as shown on the Drawings. The starting equipment shall be arranged, generally, in control groups or, in certain cases, as isolated combination starters as specified or indicated. The Sequences of Operation, drawings, and specifications shall be referred to for the manner of control, operation, and monitoring of motors and the electrically operated equipment.

B. A starter and disconnect switch or combination motor starter disconnect shall be provided for every motor and each and every electrically operated piece of equipment by this contractor, except where complete starters and controls are furnished by the manufacturer of the motor or piece of equipment. Starters shall be internally wired to provide the required control operation and monitoring. All control devices, such as push buttons, break-glass stations, alternators, relays, pilot lights, etc., shall be provided as required for the operation of PLUMBING equipment. All remotely located equipment shall have remote starters as located on the plan and shall have local disconnect switches. All equipment located in equipment rooms can use combination starters/disconnects located within the line of sight of controlled equipment. All starters and disconnect switches shall be in enclosures suitable for the environment in which they are installed. Starters and disconnect switches located in machine rooms shall use NEMA 1. Starters and disconnect switches located outdoors shall use NEMA 4x. Starters and disconnect switches located in machine rooms, which are subject to potential water damage, shall use NEMA 2

C. Starting equipment and devices specified in this section (and section 22 29 13 Variable Frequency Controllers) shall be furnished by the PLUMBING subcontractor and shall be installed by the Electrical subcontractor. In general, the PLUMBING subcontractor shall furnish all motor starters and disconnect switches except where they are an integral part of a motor control center; in this case, starters and disconnects shall be provided (furnished and installed) by the electrical contractor. The Electrical subcontractor shall also provide all wiring necessary to supply power to the electric motors specified under this section, including connections from the starters to the motors. Starters and disconnects shall also include variable frequency drives.

D. The PLUMBING Contractor shall furnish and install all wiring between control devices and controlled equipment furnished under this Section, including interlock control wiring between motor starters and all automatic temperature control wiring. All wiring shall be installed in conformance with applicable codes and the requirements of the Electrical Division of the Specifications.

E. The Electrical Contractor shall furnish a 120-volt power source to control panels and equipment requiring a separate 120-volt control power source. Power for control circuits for all devices connecting to motor starters shall be obtained from 120-volt control transformers provided in each starter operating at other than 120 volts. Provide transformers for all low-voltage control systems as required.

F. Furnish detailed composite wiring diagrams and such other information necessary to assure the proper connection, operation, and control of motorized equipment, including interlocks, automatic controls, safety controls, and all auxiliary circuits.

G. All control units shall be furnished with a nameplate indicating which device or equipment controls the voltage. Additional nameplates on each push button, selector switch, and pilot light indicating their functions shall be provided. Nameplates shall be laminated phenolic with white letters on a black background, minimum 2” high.

H. All motors supplied either with equipment or installed separately that are to be used in conjunction with a variable frequency drive shall be inverter duty motors.

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.

1.3 SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

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

B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 80, with plain ends and welded steel collar; zinc-coated.

C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 80, zinc coated, with plain ends.

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

2.2 STACK-SLEEVE FITTINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

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

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

1. Underdeck Clamp: Clamping ring with setscrews.

2.3 SLEEVE-SEAL SYSTEMS

A. Description:

1. Modular sealing-element unit, designed for field assembly, for filling the annular space between piping and sleeve.
2. Designed to form a hydrostatic seal of 20 psig minimum.
3. Sealing Elements: EPDM-rubber or Nitrile (Buna N) interlocking links shaped to fit the surface of the pipe. Include the type and number required for the pipe material and the size of pipe.
4. Pressure Plates: Carbon steel, Stainless steel, Stainless steel, Type 316.
5. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, ASTM B 63,3 Stainless steel, Stainless steel, Type 316 of length required to secure pressure plates to sealing elements.

2.4 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, water stop assembly made for embedding in a concrete slab or wall.

B. Rubber waterstop collar with center opening to match piping OD.

2.5 GROUT

A. Description: Nonshrink, for interior and exterior sealing of openings in non-fire-rated walls or floors.

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

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

D. Packaging: Premixed and factory packaged.

2.6 GROUT

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

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

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

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls. Sleeves for building service piping shall be two nominal line size larger than the service pipe.

B. For sleeves that will have a sleeve-seal system installed, select sleeves of a 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 and concrete walls as new slabs and walls are constructed.
1. Cut sleeves to length for mounting flush with both surfaces.

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

2. Using grout, seal the space outside of sleeves in slabs and walls without a 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 a 1/4-inch annular clear space between the sleeve and pipe or pipe insulation.

3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for the size, depth, and location of the joint. Comply with requirements for sealants specified in Division 07 Section "Joint Sealants."

E. Fire-Barrier Penetrations: Maintain the indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 Section "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 a 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Division 07 Section "Sheet Metal Flashing and Trim."
3. Install a section of cast-iron soil pipe to extend the sleeve to 2 inches above finished floor level.
4. Extend cast-iron sleeve fittings below the floor slab as required to secure the clamping ring if the ring is specified.
5. Using grout, seal the space around outside of the stack-sleeve fittings.

B. Fire-Barrier Penetrations: Maintain the indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 Section "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 the 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 the center of the sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in the 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 the waterstop flange to be centered in the concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Use grout to seal the space around the 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: Steel pipe sleeves, sleeve-seal fittings.
b. Piping NPS 6 and Larger: Cast-iron pipe sleeves, or Steel pipe sleeves with 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 minimum annular clear space between piping and sleeve for installing the sleeve-seal system.

b. Piping NPS 6 and Larger: Cast-iron pipe sleeves with sleeve-seal system or Steel pipe sleeves with sleeve-seal system.

1) Select sleeve size to allow for 1-inch minimum annular clear space between piping and sleeve for installing the 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 minim annular clear space between piping and sleeve for installing sleeve-seal system.

b. Piping NPS 6 and Larger: Cast-iron pipe sleeves with sleeve-seal system or Steel pipe sleeves with sleeve-seal system.

1) Select sleeve size to allow for 1-inch minimum annular clear space between piping and sleeve for installing the sleeve-seal system.

4. Concrete Slabs above Grade:

a. Piping Smaller Than NPS 6: Steel pipe sleeves or Stack-sleeve fittings.
b. Piping NPS 6 and Larger: Steel pipe sleeves or 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 SUBMITTALS

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

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

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

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

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

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

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

2.2 FLOOR PLATES

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

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

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors that are exposed to view in any finished space. New and existing piping

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

1. Escutcheons for New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
b. Chrome-Plated Piping: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
c. Insulated Piping: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.
d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
f. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge.
g. Bare Piping in Equipment Rooms: not required. .

2. Escutcheons for Existing Piping:

a. Chrome-Plated Piping: Split-casting brass type with polished, chrome-plated finish.
b. Insulated Piping: Split-plate, stamped-steel type with concealed hinge.
c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
e. Bare Piping in Unfinished Service Spaces: Split-plate, stamped-steel type with concealed hinge.
f. Bare Piping in Equipment Rooms: Not required.

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 the opening.

1. New Piping: One-piece or Split casing floor-plate type.
2. Existing Piping: Split-casting, floor-plate type.

3.2 FIELD QUALITY CONTROL

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

END OF SECTION 220518

SECTION 220519 - METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Bimetallic-actuated thermometers.
2. Liquid-in-glass thermometers.
3. Thermowells.
4. Dial-type pressure gages.
5. Gage attachments.
6. Test plugs.
7. Test-plug kits.
8. Sight flow indicators.

B. Related Requirements:
1. Section 221119 "Domestic Water Piping Specialties" for water meters.
2. Section 221513 "General-Service Compressed-Air Piping" for compressed air gages.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of meter and gauge.

1.5 CLOSEOUT SUBMITTALS

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

PART 2 - PRODUCTS

2.1 MANUFACTURES

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

1. Trerice, H. O. Co.
2. WATTS.
3. Weiss Instruments, Inc.
4. Weksler Glass Thermometer Corp.

2.2 BIMETALLIC-ACTUATED THERMOMETERS

A. Standard: ASME B40.200.

B. Case: Liquid-filled and sealed type(s); stainless steel with 5-inch nominal diameter.

C. Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg F and deg C.

D. Connector Type(s): Union joint, adjustable angle, with unified-inch screw threads.

E. Connector Size: 1/2 inch, with ASME B1.1 screw threads.

F. Stem: 0.25 or 0.375 inch in diameter; stainless steel.

G. Window: Plain glass.

H. Ring: Stainless steel.

I. Element: Bimetal coil.

J. Pointer: Dark-colored metal.

K. Accuracy: Plus or minus 1 percent of scale range.

2.3 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Compact-Style, Liquid-in-Glass Thermometers:

1. Standard: ASME B40.200.
2. Case: Cast aluminum; 6-inch nominal size.
3. Case Form: Back angle unless otherwise indicated.

4. Tube: Glass with a magnifying lens and blue or red organic liquid.
5. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C.
6. Window: Glass or plastic.
7. Stem: Aluminum or brass, and of length to suit installation.

    a. Design for Thermowell Installation: Bare stem.

8. Connector: 3/4 inch, with ASME B1.1 screw threads.
9. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

B. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:
1. Standard: ASME B40.200.
2. Case: Cast aluminum; 9-inch nominal size unless otherwise indicated.
3. Case Form: Adjustable angle unless otherwise indicated.
4. Tube: Glass with magnifying lens and blue or red organic liquid.
5. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C.
6. Window: Glass.
7. Stem: Aluminum and of length to suit installation.

    a. Design for Thermowell Installation: Bare stem.

8. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
9. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.4 THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into a piping tee fitting.
3. Material for Use with Copper Tubing: CNR or CUNI.
4. Material for Use with Steel Piping: CRES CSA.
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 the size of the thermowell's internal screw thread to the size of thermometer connection.

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

2.5 PRESSURE GAGES

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

2.6 GAGE ATTACHMENTS

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

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

2.7 TEST PLUGS

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

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

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

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

E. Core Inserts: Chlorosulfonated polyethylene synthetic and EPDM self-sealing rubber.

2.8 TEST-PLUG KITS

A. Furnish one test-plug kit(s) containing one thermometer(s), one pressure gauge and adapter, and a carrying case. Thermometer sensing elements, pressure gauge, and adapter probes shall be of a diameter to fit test plugs and of a length to project into piping.

B. Low-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch- diameter dial and tapered-end sensing element. Dial range shall be at least 25 to 125 deg F.

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.

2.9 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. Ernst Flow Industries.
4. John C. Ernst Co., Inc.

B. Description: Piping inline installation device for visual verification of flow.

C. Construction: Bronze or stainless-steel body, with sight glass and ball, flapper, or paddle wheel indicator, and threaded or flanged ends.

D. Minimum Pressure Rating: 150 psig.

E. Minimum Temperature Rating: 200 deg F.

F. End Connections for NPS 2 and Smaller: Threaded.

G. End Connections for NPS 2-1/2 and Larger: Flanged.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermowells with a socket extending one-third of the pipe diameter and in a 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 direct-mounted pressure gages in piping tees with the pressure gage located on the pipe at the most readable position.

H. Install remote-mounted pressure gages on the panel.

I. Install valve and snubber in piping for each pressure gauge for fluids.

J. Install test plugs in piping tees.

K. 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.

L. Install pressure gages in the following locations:

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

3.2 CONNECTIONS

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

3.3 ADJUSTING

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

3.4 PRESSURE GAGE AND THERMOMETER SCHEDULE

A. Install large-sized thermometers wherever space is available. Where space is limited, use a compact style.

B. Install all pressure gages locally unless space does not permit or the location is not readily visible. Then use a remote reading pressure gauge and install it in a location accessible and readily visible, as close to the point of reading as possible.
   1. Test plug with EPDM self-sealing rubber inserts.

C. The thermometer stems shall be of a length to match the thermowell insertion length.

3.5 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Domestic Cold-Water Piping: 0 to 100 deg F.

B. Scale Range for Domestic Hot-Water Piping: 50 to 150 deg F.

3.6 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Water Service Piping: 0 to 150 psi.

B. Scale Range for Domestic Water Pumps: 0 to 175 psi.

C. Scale Range for Domestic Water Piping: 0 to 300 psi.

END OF SECTION 220519

SECTION 220529 - GENERAL-DUTY VALVES OR 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. Brass ball valves.
2. Iron, single-flange butterfly valves.
3. Iron, grooved-end butterfly valves.
4. Bronze lift check valves.
5. Bronze swing check valves.
6. Bronze gate valves.
7. Iron gate valves.
8. Bronze globe valves.
9. Iron globe valves.
10. Lubricated plug valves.

B. Related Sections:

1. Division 22 plumbing piping Sections for specialty valves applicable to those Sections only.
2. Division 22 Section "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

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

D. NRS: Non-rising stem.

E. OS&Y: Outside screw and yoke.

F. RS: Rising stem.

1.4 SUBMITTALS

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

1.5 QUALITY ASSURANCE

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

B. ASME Compliance:

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

C. NSF Compliance: NSF 61 for valve materials for potable water service, piping, and equipment.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set gate valves closed to prevent rattling.
4. Set ball valves open to minimize exposure of functional surfaces.
5. Set butterfly valves closed or slightly open.
6. Block check valves in either the closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at a higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use a sling to handle large valves; rig the sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

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

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

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

D. Valve Actuator Types:
   1. Handwheel: For valves other than quarter-turn types.
   2. Handlever: For quarter-turn valves NPS 6 and smaller.

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

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

F. Valve-End Connections:

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

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

H. All materials shall comply with NSF/ANSI Standard 732 for lead-free.

I. Pressure reducing valves shall conform to ASSE 1003 or CSA B356. The valves shall have an integral or separate strainer. The valve shall be designed to fail open.

2.2 BRASS BALL VALVES

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

   1. Description:

      a. Standard: MSS SP-110.
      b. SWP Rating: 150 psig.
      c. CWP Rating: 600 psig.
      d. Body Design: Two piece.
      e. Body Material: Forged brass.
      f. Seats: PTFE or TFE.
      g. Stem: Brass.
      h. Ball: Chrome-plated brass.
      i. Port: Full.

B. Two-Piece, Regular-Port, Brass Ball Valves with Brass Trim:

1. Description:

a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Two piece.
e. Body Material: Forged brass.
f. Seats: PTFE or TFE.
g. Stem: Brass.
h. Ball: Chrome-plated brass.
i. Port: Regular.

2.3 IRON, SINGLE-FLANGE BUTTERFLY VALVES

A. Iron, Single-Flange Butterfly Valves with EPDM or NBR Seat and Aluminum-Bronze Disc:

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. Crane Co.; Crane Valve Group; Jenkins Valves.
   b. Crane Co.; Crane Valve Group; Stockham Division.
   c. NIBCO INC.
   d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-67, Type I.
b. CWP Rating: 250 psig.
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
e. Seat: EPDM or NBR.
f. Stem: One- or two-piece stainless steel.
g. Disc: Aluminum bronze.

2.4 IRON, GROOVED-END BUTTERFLY VALVES

A. Iron, Grooved-End Butterfly Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

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

2. Description:

a. Standard: MSS SP-67, Type I.
b. CWP Rating, NPS 8 and Smaller: 300 psig.
c. CWP Rating, NPS 10 and Larger: 200 psig.
d. Body Material: Coated, ductile iron.
e. Stem: Two-piece stainless steel.
f. Disc: Coated, ductile iron.
g. Seal: EPDM.

2.5 BRONZE LIFT CHECK VALVES

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

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. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Crane Co.; Crane Valve Group; Stockham Division.

2. Description:

a. Standard: MSS SP-80, Type 2.
b. CWP Rating: 200 psig.
c. Body Design: Vertical flow.
d. Body Material: ASTM B 61 or ASTM B 62, bronze.
e. Disc: Bronze.

2.6 BRONZE SWING CHECK VALVES

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

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. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Crane Co.; Crane Valve Group; Stockham Division.
d. Milwaukee Valve Company.

e. NIBCO INC.
f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-80, Type 3.
b. CWP Rating: 200 psig.
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Disc: Bronze.

2.7 BRONZE GATE VALVES

A. Class 125, NRS Bronze Gate Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Crane Co.; Crane Valve Group; Stockham Division.
d. Milwaukee Valve Company.
e. NIBCO INC.
f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-80, Type 1.
b. CWP Rating: 200 psig.
c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
d. Ends: Threaded or solder joint.
e. Stem: Bronze.
f. Disc: Solid wedge; bronze.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron, bronze, or aluminum.

B. Class 125, NRS Bronze Gate Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Crane Co.; Crane Valve Group; Stockham Division.
d. Hammond Valve.
e. Milwaukee Valve Company.
f. NIBCO INC.

g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-80, Type 2.
b. CWP Rating: 300 psig.
c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
d. Ends: Threaded or solder joint
e. Stem: Bronze.
f. Disc: Solid wedge; bronze.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron, bronze, or aluminum.

2.8 IRON GATE VALVES

A. Class 150, OS&Y, Iron Gate Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Crane Co.; Crane Valve Group; Stockham Division.
d. Milwaukee Valve Company.
e. NIBCO INC.
f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

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

B. Class 250, OS&Y, Iron Gate Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Stockham Division.
c. Milwaukee Valve Company.

d. NIBCO INC.
e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-70, Type I.
b. CWP Rating: 500 psig.
c. Body Material: ASTM A 126, gray iron with bolted bonnet.
d. Ends: Flanged.
e. Trim: Bronze.
f. Disc: Solid wedge.
g. Packing and Gasket: Asbestos free.

2.9 BRONZE GLOBE VALVES

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

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

a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Stockham Division.
c. Milwaukee Valve Company.
d. NIBCO INC.
e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

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

2.10 IRON GLOBE VALVES

A. Class 125, Iron Globe Valves:

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

a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.

c. Crane Co.; Crane Valve Group; Stockham Division.
d. Milwaukee Valve Company.
e. NIBCO INC.
f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

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

2.11 LUBRICATED PLUG VALVES

A. Plug valves are specified in the Specification section 221114 Natural gas piping

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 the 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 them 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 the stem at or above the center of the pipe.

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

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

1. Swing Check Valves: In horizontal position with hinge pin level.
2. Lift Check Valves: With stem upright and plumb.

F. All valves used in any system shall have a pressure class that exceeds the pressure of the system it is installed in.

G. All valves located at an elevation greater than 8’ above the finished floor and over 3” in size shall have chain operators that extend to the floor.

H. Provide pressure-reducing valves for all domestic water services where the static pressure is 80 psi static pressure or greater.

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 on the plan, use the following:

1. Shutoff Service: Ball, butterfly, or gate valves.
2. Butterfly Valve Dead-End Service: Single-flange (lug) type.
3. Throttling Service: Globe or ball valves.
4. Pump-Discharge Check Valves.
5. Pump inlet and outlet - globe, gate, or ball valve for positive shutoff.

    a. NPS 2 and Smaller: Bronze swing check valves with bronze or nonmetallic disc.
    b. 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 SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

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

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where the solder-joint valve-end option is indicated in valve schedules below.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.

3. For Steel Piping, NPS 2 and Smaller: Threaded ends.
4. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where the threaded valve-end option is indicated in valve schedules below.
5. For Grooved-End Copper Tubing and Steel Piping: Valve ends may be grooved.

3.5 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Brass Valves: May be provided with lead-free solder-joint ends instead of threaded ends.
2. Ball Valves: Two-piece, full-port, brass with brass trim. Class 150
3. Bronze Swing Check Valves: Class 150, bronze disc.
4. Bronze Gate Valves: Class 150.

B. Pipe NPS 2-1/2 and Larger:

1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
2. Iron, Single-Flange Butterfly Valves: 200 CWP, EPDM, NBR seat, aluminum-bronze disc.
3. Iron, Grooved-End Butterfly Valves: 175 CWP.
4. Iron Gate Valves: Class 150.

3.6 SANITARY WASTE AND STORM-DRAINAGE VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Bronze Swing Check Valves: Class 150, nonmetallic disc.
3. Bronze Gate Valves: Class 150.

B. Pipe NPS 2-1/2 and Larger:

1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
2. Iron Gate Valves: Class 150.
3. Iron Swing Check Valves: Class 150.
4. Iron Globe Valves: Class 150.

END OF SECTION 220523

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. Thermal-hanger shield inserts.
4. Fastener systems.
5. Pipe stands.
6. Pipe positioning systems.
7. Vibration Isolation

B. Related Sections:

1. Division 05 Section "Metal Fabrications" for structural steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Division 21 fire-suppression piping: Sections for pipe hangers for fire-suppression piping.

1.3 DEFINITIONS

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

1.4 PERFORMANCE REQUIREMENTS

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

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

1. Design supports for multiple pipes, including pipe stands, capable of supporting the combined weight of supported systems, system contents, and test water.

1.5 SUBMITTALS

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

B. Shop Drawings: Show fabrication and installation details and include calculations for the following: include Product Data for components:

1. Trapeze pipe hangers.
2. Metal framing systems.
3. Fiberglass strut systems.
4. Pipe stands.

C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of trapeze hangers.
2. Design Calculations: Calculate requirements for designing trapeze hangers.

D. Welding certificates.

1.6 QUALITY ASSURANCE

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

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

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

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

B. Copper Pipe Hangers:

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

2.2 TRAPEZE PIPE HANGERS

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

2.3 THERMAL-HANGER SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. National Pipe Hanger Corporation.
2. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
3. Rilco Manufacturing Co., Inc.
4. Other manufacturers offering equivalent products.

B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.

C. Insulation-Insert Material for Hot Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.

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

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

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

2.4 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened Portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

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

2.5 PIPE STANDS

A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

C. Low-Type, Single-Pipe Stand: One-piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.

D. High-Type, Single-Pipe Stand:

1. Description: Assembly of base, vertical and horizontal members, and pipe support for roof installation without membrane penetration.
2. Base: Stainless steel.
3. Vertical Members: Two or more cadmium-plated steel or stainless-steel, continuous-thread rods.
4. Horizontal Member: Cadmium-plated steel or stainless-steel rod with plastic or stainless-steel roller-type pipe support.

E. High-Type, Multiple-Pipe Stand:

1. Description: Assembly of bases, vertical and horizontal members, and pipe supports for roof installation without membrane penetration.
2. Bases: One or more; plastic.
3. Vertical Members: Two or more protective-coated-steel channels.
4. Horizontal Member: Protective-coated-steel channel.
5. Pipe Supports: Galvanized steel, clevis-type pipe hangers.

2.6 PIPE POSITIONING SYSTEMS

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

2.7 MISCELLANEOUS MATERIALS

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

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

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

2.8 VIBRATION ISOLATION HANGERS

A. Vibration isolation pipe hangers; pre-compressed and locked at the rated deflection by means of a resilient up-stop to keep the piping or equipment at a fixed elevation during installation. The hangers shall be designed with a release mechanism to free the spring after the installation is complete and the hanger is subjected to its full load. Deflection shall be clearly indicated by means of a scale. Submittals shall include a drawing of the hanger showing the 30° capability. Hangers shall be type PC30N as manufactured by Mason Industries, Inc

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

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

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for the 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 trapezoids for the smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Thermal-Hanger Shield Installation: Install in a pipe hanger or shield for insulated piping.

D. 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 the powder-actuated tool manufacturer. Install fasteners according to the 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 the manufacturer's written instructions.

E. Pipe Stand Installation:

1. Pipe Stand: Assemble components and mount on a smooth roof surface. Do not penetrate the roof membrane.

F. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture. See Division 22 plumbing fixture Sections for requirements for pipe positioning systems for plumbing fixtures.

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

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, 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 the 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 a thermal-hanger shield insert with a clamp sized to match the OD of the 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 a vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

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

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

    a. Option: Thermal-hanger shield inserts may be used. Include a steel weight-distribution plate for pipe NPS 4 and larger if the 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 the protective shield.
6. Thermal-Hanger Shields: Install with insulation of the same thickness as piping insulation.
7. Install vibration isolation hangers on all piping connected to motor-driven equipment for a distance of 20’ or the first two hangers.

3.2 METAL FABRICATIONS

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

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 the 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.

3.3 ADJUSTING

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

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

3.4 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use the 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. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.

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

3.5 HANGER AND SUPPORT SCHEDULE

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

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

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

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

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

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

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

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

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

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. 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 not necessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

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

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

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

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

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

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from a concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to the top flange of the structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to the bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to the center of the bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to the 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 the top of beams, if a hanger rod is required tangent to the flange edge.
8. Side-Beam Clamps (MSS Type 27): For the bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to the bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to the 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 a 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 the 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 the 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 hangers 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 the piping system from the 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 the piping system from the 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 the piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

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

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

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

Q. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION 220529

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. Stencils.
   5. Valve tags.
   6. Warning tags.

1.3 SUBMITTALS

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

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

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

D. Valve numbering scheme.

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

1.4 COORDINATION

A. Coordinate the installation of identifying devices with the completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate the installation of identifying devices with the locations of access panels and doors.

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

PART 2 - PRODUCTS

2.1 NAMEPLATES, TAGS, MARKERS, ETC

A. Manufacturer: W.H. Brady Co., Signmark Div

B. Acceptable manufacturers offering equivalent products

1. Atlantic Engraving Company.
2. Seton Name Plate Co.
3. MSI Services
4. Substitutions as per Contract Requirements.

C. Description: Nameplates should be as specified in Division 1.

2.2 EQUIPMENT LABELS

A. Metal Labels for Equipment:
1. Material and Thickness: Brass 0.032-inch, stainless steel 0.025-inch, aluminum, 0.032-inch or anodized aluminum, 0.032-inch minimum thickness, with predrilled holes.
2. Letter Color: Black
3. Background Color: White
4. Minimum Label Size: Length and width vary for required label content, but not less than 3”x3”
5. Minimum Letter Size: 1” inch for equipment mounted on the floor or on a stand. 2” for hanging equipment.
6. Fasteners: Stainless steel rivets or self-tapping screws.
7. Adhesive: not allowed.

B. Plastic Labels for Equipment:
1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, with predrilled holes.
2. Letter Color: Black
3. Background Color: White
4. Minimum Label Size: Length and width vary for required label content, but not less than 3”x3”
5. Minimum Letter Size: 1” inch for equipment mounted on the floor or on stands. 2” for hanging equipment.
6. Fasteners: Stainless steel rivets or self-tapping screws.
7. Adhesive: Contact-type permanent adhesive, compatible with the label and with the substrate.

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

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

2.3 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: As per ANSI.

C. Background Color: As per ANSI

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 5”x2”.

F. Minimum Letter Size: 1 inch.

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

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

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

2.4 PIPE LABELS

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

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to fully cover the circumference of the pipe and or insulation and to attach to the pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing. Fully cover the circumference of the pipe

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

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

2.5 STENCILS

A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.
   1. Stencil Paint: Exterior, gloss, black unless otherwise indicated. Paint may be in pressurized spray-can form.
   2. Identification Paint: Exterior, enamel in colors according to ASME A13.1 unless otherwise indicated.

2.6 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

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

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

   1. Valve-tag schedule shall be included in operation and maintenance data. 81/2 x 11” fully framed behind glass

2.7 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags of plasticized card stock with matte finish suitable for writing.

   1. Size: 3 by 5-1/4 inches minimum.
   2. Fasteners: Brass grommet and wire.
   3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
   4. Color: Yellow background with black lettering.

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 PIPE LABEL INSTALLATION

A. Piping Color-Coding: Painting of piping is specified in Division 09 Section "Interior Painting."

B. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at the installer's option on uninsulated pipes only. Install stenciled pipe labels with painted, color-coded bands or rectangles on each piping system.

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

C. 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 the flow pattern is not obvious, mark each pipe at the branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit a view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 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.

D. Directional Flow Arrows: Arrows shall be used to indicate the direction of flow in pipes, including pipes where flow is allowed in both directions.

E. Pipe Label Color Schedule: AS per ANSI – submit or review and approval

3.3 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-Tags
   a. Size: shall 1 ½”
   b. Shape: round
   c. Color: as per ANSI
   d. Lettering as per ANSI
   e. Submit for review and approval.

3.4 WARNING-TAG INSTALLATION

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

END OF SECTION 220553

SECTION 220719 - PLUMBING PIPING INSULATION AND JACKETS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings 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. Sanitary waste piping exposed to freezing conditions.
5. Storm-water piping exposed to freezing conditions.
6. Roof drains and rainwater leaders.
7. Supplies and drains for handicap-accessible lavatories and sinks.
8. Protective Shields and Guards

B. Related Sections:

1. Section 221116 "Domestic Water Piping."

1.3 ACTION SUBMITTALS

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

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 pipe expansion joints for each type of insulation.
3. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
4. Detail removable insulation at piping specialties, equipment connections, and access panels.
5. Detail application of field-applied jackets.

C. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing the product and its 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 a 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 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.

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 the manufacturer with appropriate ASTM standard designation, type, and grade, and maximum use temperature.

1.7 COORDINATION

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

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

1.8 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

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

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in the "Factory-Applied Jackets" Article.

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. Pittsburgh Corning Corporation; Foam glass.

2. Block Insulation: ASTM C 552, Type I.
3. Special-Shaped Insulation: ASTM C 552, Type III.
4. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
5. Preformed Pipe Insulation with Factory-Applied ASJ: Comply with ASTM C 552, Type II, Class 2.
6. Factory fabricates shapes according to ASTM C 450 and ASTM C 585.

G. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Aeroflex USA, Inc.; Aerocel.
b. Armacell LLC; AP Armaflex.
c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.

H. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II, and ASTM C 1290, Type I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

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. CertainTeed Corp.; SoftTouch Duct Wrap.
b. Johns Manville; Microlite.
c. Knauf Insulation; Friendly Feel Duct Wrap.
d. Manson Insulation Inc.; Alley Wrap.
e. Owens Corning; SOFTR All-Service Duct Wrap.

I. Mineral-Fiber, Preformed Pipe Insulation:

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. Fibrex Insulations Inc.; Coreplus 1200.
b. Johns Manville; Micro-Lok.
c. Knauf Insulation; 1000-Degree Pipe Insulation.
d. Manson Insulation Inc.; Alley-K.
e. Owens Corning; Fiberglas Pipe Insulation.

2. Type I, 850 Deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in the "Factory-Applied Jackets" Article.

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. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.

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.; Thermokote V.

C. 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. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 81-84.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Aeroflex USA, Inc.; Aeroseal.
b. Armacell LLC; Armaflex 520 Adhesive.

c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
d. K-Flex USA; R-373 Contact Adhesive.

2. For indoor applications, the adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. 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, the adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
b. Eagle Bridges - Marathon Industries; 225.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-20.
d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, the adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

F. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Dow Corning Corporation; 739, Dow Silicone.
b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
c. P.I.C. Plastics, Inc.; Welding Adhesive.
d. Speedline Corporation; Polyco VP Adhesive.

2. For indoor applications, the adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.4 SEALANTS

A. Joint Sealants:

1. Joint Sealants for Cellular-Glass and Phenolic Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
    b. Eagle Bridges - Marathon Industries; 405.
    c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-45.
    d. Mon-Eco Industries, Inc.; 44-05.
    e. Pittsburgh Corning Corporation; Pittseal 444.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Permanently flexible, elastomeric sealant.
4. Service Temperature Range: Minus 100 to plus 300 deg F.
5. Color: White or gray.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
    b. Eagle Bridges - Marathon Industries; 405.
    c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
    d. Mon-Eco Industries, Inc.; 44-05.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.5 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.6 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Johns Manville; Zeston.
b. P.I.C. Plastics, Inc.; FG Series.
c. Proto Corporation; LoSmoke.
d. Speedline Corporation; SmokeSafe.

2. Adhesive: As recommended by jacket material manufacturer.
3. Color: White.
4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

C. Metal Jacket:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.
    b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
    c. RPR Products, Inc.; Insul-Mate.

2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.

    a. Sheet and roll stock ready for shop or field sizing.
    b. Finish and thickness are indicated in field-applied jacket schedules.
    c. Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and kraft paper.
    d. Factory-Fabricated Fitting Covers:

        1) Same material, finish, and thickness as jacket.
        2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
        3) Tee covers.
        4) Flange and union covers.
        5) End caps.
        6) Beveled collars.
        7) Valve covers.
        8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

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. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Pittsburgh Corning Corporation; Pittwrap.
    b. Polyguard Products, Inc.; Insulrap No Torch 125.

E. OUTDOOR PIPING

1. Insulation Type A thickness as scheduled with ASJ vapor barrier jacket (if applicable) - Cover factory interior jacket with Alumaguard Cool Wrap by Polyguard, rubberized bitumen membrane designed specifically to be installed over insulation on exterior piping, tanks, vessels, and equipment. The membrane shall be 'peel and stick', self-healing if punctured, UV stable, and will expand and contract with the mechanical system. All seams shall be sealed water tight. Permeability .0053 perm

2.7 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. ABI, Ideal Tape Division; 428 AWF ASJ.
b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
c. Compac Corporation; 104 and 105.
d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.

2. Width: 3 inches.
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 C 1136.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. ABI, Ideal Tape Division; 491 AWF FSK.
b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
c. Compac Corporation; 110 and 111.
d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.

2. Width: 3 inches.
3. Thickness: 6.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. ABI, Ideal Tape Division; 370 White PVC tape.
b. Compac Corporation; 130.
c. Venture Tape; 1506 CW NS.

2. Width: 2 inches.
3. Thickness: 6 mils.

4. Adhesion: 64 ounces force/inch in width.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. ABI, Ideal Tape Division; 488 AWF.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
   c. Compac Corporation; 120.
   d. Venture Tape; 3520 CW.

2. Width: 2 inches.
3. Thickness: 3.7 mils.
4. Adhesion: 100 ounces force/inch in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

2.8 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. ITW Insulation Systems; Gerrard Strapping and Seals.
   b. RPR Products, Inc.; Insul-Mate Strapping and Seals.

2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with wing seal or closed seal.
3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal or closed seal.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

2.9 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers:

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. Insul-Tect Products Co.; a subsidiary of MVG Molded Products.
   b. McGuire Manufacturing.
   c. Truebro; a brand of IPS Corporation.

d. Zurn Industries, LLC; Tubular Brass Plumbing Products Operation.

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; a brand of IPS Corporation.
b. Zurn Industries, LLC; Tubular Brass Plumbing Products Operation.

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 the 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 the insulation application.

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at the top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.

I. Install insulation with the least number of joints practical.

J. Apply adhesives, mastics, and sealants at the manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:

1. Draw the jacket tight and smooth.
2. Cover circumferential joints with 3-inch-wide strips of the same material as the 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 the bottom of the pipe. Clean and dry the surface to receive the self-sealing lap. Staple laps with outward clinching staples along the edge at 4 inches OC.

    a. For below-ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to the insulation material manufacturer's written instructions, to maintain a vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying the same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

O. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. 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 the roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation. Seal the joint with joint sealant.
3. Extend the jacket of outdoor insulation outside the roof flashing at least 2 inches below the top of the roof flashing.
4. Seal the jacket to the 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 the 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 the joint with joint sealant.
3. Extend the jacket of outdoor insulation outside the wall flashing and overlap the wall flashing at least 2 inches.
4. Seal the jacket to the 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, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from the same material and density as adjacent pipe insulation. Each piece shall be butted tightly against the adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of the same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with a tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of the same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of the same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so the 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 a vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric, install a fitted PVC cover over elbows, tees, strainers, valves, flanges,

and unions. Terminate ends with PVC end caps. Tape PVC covers adjoining insulation facing using PVC tape.

9. Stencil or label the outside insulation jacket of each union with the word "union." Match the size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

3.6 INSTALLATION OF CELLULAR-GLASS INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to the pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward clinched staples at 6 inches OC
4. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by the insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to the outer diameter of the pipe flange.
2. Make the width of the insulation section the same as the overall width of the flange and bolts, plus twice the thickness of the pipe insulation.
3. Fill voids between the inner circumference of flange insulation and the outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of the same thickness as pipe insulation.
4. Install jacket material with the 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 the same material as straight segments of pipe insulation when available. Secure according to the manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass insulation to the valve body.

2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.7 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with the manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to the surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to the outer diameter of the pipe flange.
2. Make the width of insulation section the same as the overall width of the flange and bolts, plus twice the thickness of the pipe insulation.
3. Fill voids between the inner circumference of flange insulation and the outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of the same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with the manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to the 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 the manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to the surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of the same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to the 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 the manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to the surface being insulated.

3.8 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to the 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 OC.
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 the insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to the outer diameter of the pipe flange.
2. Make the width of insulation section the same as the overall width of the flange and bolts, plus twice the thickness of the pipe insulation.
3. Fill voids between the inner circumference of flange insulation and the outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with the 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 the same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of the same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to the 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.

3.9 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 the surface with a 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 the jacket material smoothly and tightly.
2. Install lap or joint strips with the same material as the 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 a 1-inch overlap at longitudinal seams and end joints. Seal with the manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along the seam and joint edge.

2. Jacket all plumbing piping that is insulated in the MER and adjacent spaces with PVC Jackets for a distance of 10’ above the finished floor to the floor. This shall include new and existing piping.

D. Where metal jackets are indicated, install with a 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by the insulation manufacturer. Secure jacket with stainless-steel bands 12 inches OC and at the end joints.

E. Interior Applications:
1. Insulation Type A - Factory applied, white, flame retardant, all service (ASJ) vapor barrier jacket of .001" aluminum foil laminated to Kraft paper with a flame retardant snuffer type adhesive reinforced with glass fibers and having a self-sealing lap. Provide 2" longitudinal lap and 4" circumferential sealing strips. Permeability .02 perm.

F. Exterior Applications:
1. Insulation Type A thickness as scheduled with ASJ vapor barrier jacket (if applicable) - Cover factory interior jacket with Alumaguard Cool Wrap by Polyguard, rubberized bitumen membrane designed specifically to be installed over insulation on exterior piping, tanks, vessels, and equipment. The membrane shall be 'peel and stick', self-healing if punctured, UV stable, and will expand and contract with the mechanical system. All seams shall be sealed water-tight. Permeability .0053 perm

G. Piping exposed in Mechanical Rooms or any space:
1. All exposed piping and fittings shall be completely covered with white Zeston 2000 PVC insulated piping and fitting covers. Apply as per the manufacturer with perma-weld adhesive.

3.10 FINISHES

A. Color: Final color as selected by the Engineer. Vary the first and second coats to allow visual inspection of the completed Work.

B. Do not field paint aluminum or stainless-steel jackets.

3.11 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Inspect pipe, fittings, strainers, and valves, randomly selected by the Engineer by removing field-applied jacket and insulation in layers in reverse order of their installation. The extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.12 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 the materials listed is the 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.

3.13 PIPING INSULATION SCHEDULE

A. Domestic Cold Water:

1. Piping less than NPS 1”

a. Cellular Glass: ½ inches thick.
b. Flexible Elastomeric: ½” inch thick.
c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

2. Piping NPS 1“ to 1 ½”

a. Cellular Glass: 1 inch thick.

b. Flexible Elastomeric: 1 inch thick.
c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

3. Piping NPS 1 ½" to 4"

a. Cellular Glass: 11/2 inch thick.
b. Flexible Elastomeric: 11/2 inch thick.
c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 11/2 inch thick.

4. Piping over 4" to 8"

a. Cellular Glass: 2-inch thick.
b. Flexible Elastomeric: 2-inch thick.
c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2-inch thick.

B. Domestic Hot and Recirculated Hot Water: (T ≤ 140° F)

1. Piping less than NPS 1 ½":

a. Cellular Glass: 1 inch thick.
b. Flexible Elastomeric: 1 inch thick.
c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

2. Piping NPS 1 ½" and larger

a. Cellular Glass: 1-1/2 inches thick.
b. Flexible Elastomeric: 1-1/2 inches thick.
c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1-1/2 inches thick.

C. Domestic Hot and Recirculated Hot Water: (T 141°F to 200° F)

1. Piping less than NPS 1 ½": Insulation shall be one of the following:

a. Cellular Glass: 11/2" inch thick.
b. Flexible Elastomeric: 1 ½" inch thick.
c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 11/2" inch thick.

2. Piping NPS 1 ½" and Larger: Insulation shall be one of the following:

a. Cellular Glass: 2 inches thick.
b. Flexible Elastomeric: 2 inches thick.
c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.

D. Roof Drain Bodies and storm piping and PVC sanitary waste piping inside the building:

1. All Pipe Sizes: Insulation shall be one of the following:

a. Cellular Glass: 1 inch thick.
b. Flexible Elastomeric: 1 inch thick.
c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

E. All Sanitary waste, storm, and domestic piping in garages or areas not heated:

1. All Pipe Sizes: Insulation shall be one of the following:

a. Cellular Glass: 2 inches thick.
b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2-inch thick.

F. Domestic Chilled Water (Potable):

1. All Pipe Sizes: Insulation shall be one of the following:

a. Cellular Glass: 1.0 inches thick.
b. Flexible Elastomeric: 1 inch thick.
c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch

G. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:

1. All Pipe Sizes: Insulation shall be one of the following:

a. Flexible Elastomeric: 1/2 inch thick cold water and drain, 1” hot water
b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick old water and drain, 1” hot water
c. Jacket with protective shielding guards. Refer to section 2.9

END OF SECTION 220719

SECTION 221114 - NATURAL GAS PIPING AND 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. Pipes, tubes, and fittings.
2. Piping specialties.
3. Piping and tubing joining materials.
4. Valves.
5. Pressure regulators.
6. Concrete bases.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

1.4 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:

1. Piping and Valves: 100 psig minimum unless otherwise indicated.
2. Service Regulators: 100 psig minimum unless otherwise indicated.

B. Natural-Gas System Pressure within Buildings: 0.5 psig or less.

1.5 SUBMITTALS

A. Product Data: For each type of the following:

1. Piping valves and 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 the location of anchors, alignment guides, and expansion joints and loops.

1. Shop Drawing Scale: 3/8 inch per foot.
2. Detail mounting, supports, and valve arrangements for pressure regulator assembly.

C. Site Survey: Plans, drawn to scale, on which natural-gas piping is shown and coordinated with other services and utilities.

D. Qualification Data: For a qualified professional engineer.

E. Welding certificates.

F. Field quality-control reports.

G. Operation and Maintenance Data: For pressure regulators to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

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

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

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.

B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating and protect from direct sunlight.

1.8 PROJECT CONDITIONS

A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.

B. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide purging and startup of natural-gas supply according to requirements indicated:

1. Notify Construction Manager and Owner no fewer than one week in advance of proposed interruption of natural-gas service.
2. Do not proceed with interruption of natural gas service without the Construction Manager's and Owner's written permission.

1.9 COORDINATION

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

B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Division 08 Section "Access Doors and Frames."

C. Part 2 specifies general descriptions and minimum standards for pipe valves and fittings. All pipes, valves, fittings, and specialties shall meet the requirements of the local utility and shall be listed and approved for use by the local utility.

1.10 REGULATORY REQUIREMENTS

A. All work shall be performed in accordance with the New York State Fuel Gas Code, prevailing edition, and Utility company standards.

B. All materials and equipment shall meet the requirements of the NY State gas code, prevailing edition, and Utility company standards.

C. NY State gas code prevailing edition and Utility company standards supersede and provisions in this specification. If there is any conflict between this specification and the above listed, the standards shall prevail

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.

1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

    a. Material Group: 1.1.
    b. End Connections: Threaded or butt welding to match pipe.
    c. Lapped Face: Not permitted underground.
    d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
    e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.

5. Mechanical Couplings:

    a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

        1) Dresser Piping Specialties; Division of Dresser, Inc.
        2) Smith-Blair, Inc.
        3) Other manufacturers offering similar products.

    b. Steel flanges and tube with epoxy finish.
    c. Buna-nitrile seals.
    d. Steel bolts, washers, and nuts.
    e. Coupling shall be capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
    f. Steel body couplings installed underground on plastic pipe shall be factory equipped with anode.

B. HDPE Pipe: ASTM D 2513, SDR 11. (Underground piping only)

1. HDPE Fittings: ASTM D 2683, socket-fusion type or ASTM D 3261, butt-fusion type with dimensions matching PE pipe.
2. HDPE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D 2513, SDR 11; and steel pipe complying with ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
3. All “joiners” or “welders” must be qualified in accordance with NYCRR Title 16, Part 255.
4. Anodeless Service-Line Risers: Factory-fabricated and leak-tested.

    a. Underground Portion: HDPE pipe complying with ASTM D 2513, SDR 11 inlet.
    b. Casing: Steel pipe complying with ASTM A 53/A 53M, Schedule 40, black steel, Type E or S, Grade B, with corrosion-protective coating covering.
    c. Aboveground Portion: PE transition fitting.
    d. Outlet shall be threaded or flanged or suitable for welded connection.
    e. Tracer wire connection.
    f. Ultraviolet shield.
    g. Stake supports with factory finish to match steel pipe casing or carrier pipe.

5. Transition Service-Line Risers: Factory-fabricated and leak tested.

    a. Underground Portion: HDPE pipe complying with ASTM D 2513, SDR 11 inlet connected to steel pipe complying with ASTM A 53/A 53M, Schedule 40, Type E or S, Grade B, with corrosion-protective coating for aboveground outlet.
    b. Outlet shall be threaded, flanged, or suitable for welded connection.
    c. Bridging sleeve over mechanical coupling.
    d. Factory-connected anode.
    e. Tracer wire connection.
    f. Ultraviolet shield.
    g. Stake supports with factory finish to match steel pipe casing or carrier pipe.

6. Plastic Mechanical Couplings, NPS 1-1/2 and Smaller: Capable of joining PE pipe to PE pipe.

    a. Manufacturers: Subject to approval of the utility and in compliance with requirements, provide products by one of the following:

        1) Lyall, R. W. & Company, Inc.
        2) Mueller Co.
        3) Perfection Corporation.

    b. PE body with molded-in, stainless-steel support ring.
    c. Buna-nitrile seals.
    d. Acetal collets.
    e. Electro-zinc-plated steel stiffener.

7. Plastic Mechanical Couplings, NPS 2 and Larger: Capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.

    a. Manufacturers: Subject to approval by the utility and in compliance with utility requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

        1) Lyall, R. W. & Company, Inc.
        2) Mueller Co.
        3) Perfection Corporation.

    b. Fiber-reinforced plastic body.
    c. PE body tube.
    d. Buna-nitrile seals.
    e. Acetal collets.
    f. Stainless-steel bolts, nuts, and washers.

8. Steel Mechanical Couplings: Capable of joining plain-end PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.

    a. Manufacturers: Subject to approval by the utility and in compliance with utility requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following
        1) Dresser Piping Specialties.
        2) Smith-Blair, Inc.

    b. Stainless-steel flanges and tube with epoxy finish.
    c. Buna-nitrile seals.
    d. Stainless-steel bolts, washers, and nuts.
    e. Factory-installed anode for steel-body couplings installed underground.

C. Prohibited Pipe and fittings.
    1. Copper of any type
    2. Plastic pipe of any type is prohibited for indoor use.
    3. Cast iron pipe of any type.
    4. Corrugated stainless steel (CSST) – only where permitted by utility company

2.2 PROTECTIVE COATING FOR UNDERGROUND STEEL PIPING: [Not Used This Project]

A. All buried steel piping shall be catholically protected as per the following:

1. All buried steel pipe requires factory applied coating in accordance with gas specification g- 8062 titled “extruded polyolefin coating on steel gas pipe”.
2. Field installed joints and fittings will be coated in accordance with gas specification g-8209 titled “field coating of steel gas pipe and fittings installed underground and in subsurface structures”.
3. The new steel service pipe must have an insulating joint (ij) installed when a connection to existing steel or copper tubing is required.
4. An insulating joint (ij) will be installed under the following conditions:
5. Low pressure service - after the service head valve (shv) but before the gas meter.
6. Elevated pressure - after the gas regulator but before the gas meter.
7. Electrical continuity of all steel underground service pipes must be provided. Bonding must be installed across all compression couplings and fittings installed on buried service pipes as per gas drawing specification eo-4718 titled “bonding of compression couplings and valves on steel mains and services”.
8. Magnesium anodes are required on all new direct buried steel service pipes. Utility Company will furnish and install the required anodes on its portion of gas steel gas service pipe with the customer and/or his contractor responsible for the anode installation on the customer's portion of service pipe. All anode wires shall be a-fixed to the steel service pipe using the thermit welding process or by using an approved connector as per gas drawing specification eo-14134 titled “thermit weld process for attaching wire to pipe or fitting”.

PIPE SIZES	PIPE LENGTH	ANODE SIZE	QUANTITY
2"-4"	EVERY 100' OR LESS	32LB	1
6"-12"	EVERY 100' OR LESS	32LB	2

Refer To Utility Company Standards Book For The Complete Table.

9. When a steel gas service is installed that supplies more than one building, the anodes shall be installed after Utility Company personnel have tested the pipe to determine the acceptability of the pipe coating.
10. Utility company will test the cathodic protection on all new gas service installations. Proper catholic protection must exist before the final tie-in by the utility company. Test stations shall be installed along with anodes on all buried steel service pipes greater than 100 lf or more in length. Anode test stations are to consist of #10 copper wire leads (white), thermit-welded to the steel service pipe, along with anode leads (black) routed into a 4” x 4” box, flush to grade. Utility company's gas corrosion personnel will make the final splice.

B. Mechanical Couplings:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Dresser Piping Specialties; Division of Dresser, Inc.
   b. Smith-Blair, Inc.
   c. Other manufacturers offering similar products.
2. Steel flanges and tube with epoxy finish.
   a. Buna-nitrile seals.
   b. Steel bolts, washers, and nuts.
   c. Coupling shall be capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
   d. Steel body couplings installed underground on plastic pipe shall be factory equipped with anode.

2.3 PIPING SPECIALTIES

A. Appliance Flexible Connectors:

1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
2. Corrugated stainless-steel tubing with polymer coating.
3. Operating-Pressure Rating: 0.5 psig.
4. End Fittings: Zinc-coated steel.
5. Threaded Ends: Comply with ASME B1.20.1.
6. Maximum Length: 72 inches.
7. Corrugated Stainless-Steel Piping (CSST) installation is not permitted.

B. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: 40-mesh startup strainer and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

C. Basket Strainers:

1. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: 60-mesh startup strainer and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

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

2.4 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, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Ballomax
b. kerotest.
c. McDonald, A. Y. Mfg. Co
2. Body: Bronze, complying with ASTM B 584.
3. Ball: Chrome-plated bronze.
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE; blowout proof.

6. Packing: Threaded-body packnut design with adjustable-stem packing.
7. Ends: Threaded, flared, or socket as indicated in "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. Bronze Plug Valves: MSS SP-78.

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. Ballomax
    b. kerotest.
    c. McDonald, A. Y. Mfg. Co
2. Body: Bronze, complying with ASTM B 584.
3. Plug: Bronze.
4. Ends: Threaded, socket, or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
5. Operator: Square head or lug type with tamperproof feature where indicated.
6. Pressure Class: 125 psig.
7. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
8. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

F. Cast-Iron, Nonlubricated Plug Valves: MSS SP-78.

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. Ballomax
    b. kerotest.
    c. McDonald, A. Y. Mfg. Co

2. Body: Cast iron, complying with ASTM A 126, Class B.
3. Plug: Bronze or nickel-plated cast iron.
4. Seat: Coated with thermoplastic.
5. Stem Seal: Compatible with natural gas.
6. Ends: Threaded or flanged as indicated in "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.

2.6 AUTOMATIC GAS SHUTOFF VALVES

A. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33 and UL-listed guide #YRPV2.

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 where indicated. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
5. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on the valve body.
6. Body; Aluminum
7. Seals and disc; NBR
8. Core tube; 305 stainless steel
9. Core and plugnut; 430F stainless
10. Springs; 302 stainless
11. Valves shall be normally closed, cable-operated, and held open. Coordinate the operating mechanism with the fire protection contractor and equipment. The mechanism shall be designed to close the valve when the cable is pulled or released as required

B. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38 and UL-listed guide #YRPV2.

1. CWP Rating: 125 psig.
2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
3. Tamperproof Feature: Locking feature for valves where indicated.
4. Service Mark: Initials "WOG" shall be permanently marked on valve body.
5. Body; Aluminum
6. Seals and disc; NBR
7. Core tube; 305 stainless steel
8. Core and plugnut; 430F stainless
9. Springs; 302 stainless
10. Valves shall be normally closed, cable-operated, and held open. Coordinate the operating mechanism with the fire protection contractor and equipment. The mechanism shall be designed to close the valve when the cable is pulled or released as required.

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.

5. All appliance regulators shall be “lock-up” type

B. Service Pressure Regulators: Comply with ANSI Z21.80.

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
   a. American Meter Company.
   b. Fisher Control Valves and Regulators; Division of Emerson Process Management.

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 the 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.

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, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Capitol Manufacturing Company.
   b. Central Plastics Company.
   c. Hart Industries International, Inc.
   d. McDonald, A. Y. Mfg. Co.
   e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   f. Wilkins; a Zurn company.

2. Description:

   a. Standard: ASSE 1079.
   b. Pressure Rating: 125 psig minimum at 180 deg F.
   c. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Capitol Manufacturing Company.
    b. Central Plastics Company.
    c. Matco-Norca, Inc.
    d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
    e. Wilkins; a Zurn company.

2. Description:

    a. Standard: ASSE 1079.
    b. Factory-fabricated, bolted, companion-flange assembly.
    c. 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, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Advance Products & Systems, Inc.
    b. Calpico, Inc.
    c. Central Plastics Company.
    d. Pipeline Seal and Insulator, Inc.

2. Description:

    a. Nonconducting materials for field assembly of companion flanges.
    b. Pressure Rating: 150 psig.
    c. Gasket: Neoprene or phenolic.
    d. Bolt Sleeves: Phenolic or polyethylene.
    e. Washers: Phenolic with steel backing washers.

2.9 LABELING AND IDENTIFYING

A. In accordance with ASME and Local utility requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for the 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 New York State Fuel Gas Code to determine that natural-gas utilization devices are turned off in piping section affected.

C. Comply with NFPA 54 and the New York State Fuel Gas Code requirements for prevention of accidental ignition.

3.3 OUTDOOR PIPING INSTALLATION

A. Comply with NFPA 54 and Utility Company requirements for installation and purging of natural-gas piping.

B. Install underground, natural-gas piping buried at least 36 inches below finished grade. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

1. If natural-gas piping is installed less than 36 inches below finished grade, install it in a containment conduit.

C. Install fittings for changes in direction and branch connections.

D. Install pressure gage upstream and downstream from each service regulator. Pressure gages are specified in Division 23 Section "Meters and Gages for HVAC Piping."

E. Paint all pipe valves and fittings grey, with machine enamel.

3.4 INDOOR PIPING INSTALLATION

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

B. Drawing plans, schematics, and diagrams indicates the 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 the 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 piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Verify final equipment locations for roughing-in.

K. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

L. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-regulator 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 a tee fitting with the bottom outlet plugged or capped. Use nipple with a minimum length of 3 pipe diameters, but not less than 3 inches long, and the same size as the connected pipe. Install with space below the bottom of the drip to remove the plug or cap.

M. Extend relief vent connections for service regulators to outdoors and terminate with a weatherproof vent cap.

N. 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.

O. 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 the containment conduit to outdoors and terminate with a weatherproof vent cap.

1. 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.

2. 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 or air shafts.
b. Do not install natural-gas piping in solid walls or partitions.

P. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with the level side down.

Q. Connect branch piping from the top or side of the horizontal piping.

R. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at the final connection to each piece of equipment. Unions are not required at flanged connections.

S. Do not use natural-gas piping as a grounding electrode.

T. Install a strainer on the inlet of each line-pressure regulator and automatic or electrically operated valve.

U. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 23 Section "Sleeves and Sleeve Seals for HVAC Piping."

V. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 23 Section "Sleeves and Sleeve Seals for HVAC Piping."

W. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 23 Section "Escutcheons for HVAC Piping."

X. Paint all indoor piping yellow with machine enamel. Label in accordance with ASME standards and section 220553 Identification for Plumbing Piping.

3.5 VALVE INSTALLATION

A. Install a 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 the full inside diameter of the pipe.
4. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints:

1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
2. Bevel plain ends of steel pipe.
3. Patch factory-applied protective coating as recommended by the manufacturer at field welds and where damage to the coating occurs during construction.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

F. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install the gasket concentrically positioned.

G. Flared Joints: Cut tubing with a roll cutting tool. Flare tube ends with a tool to result in flare dimensions complying with SAE J513. Tighten the finger tight, then use the wrench. Do not overtighten.

3.7 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hangers and supports specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.
5. NPS 4 and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.

3.8 CONNECTIONS

A. Install natural-gas piping, electrically continuous and bonded to the gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.

B. Install piping adjacent to appliances to allow service and maintenance of appliances.

C. Connect piping to appliances using manual gas shutoff valves and unions. Install a valve within 72 inches of each gas-fired appliance and equipment. Install a union between the valve and appliances or equipment.

D. Sediment Traps: Install a tee fitting with a capped nipple in the bottom to form a 6” drip leg, as close as practical to the inlet of each appliance.

3.9 LABELING AND IDENTIFYING

A. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment" for piping and valve identification.

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

3.10 PAINTING

A. Comply with requirements in Division 09 painting Sections for painting interior and exterior natural-gas piping.

B. Paint exposed, interior and exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.

1. Alkyd System: MPI EXT 5.1D.

a. Prime Coat: Alkyd anticorrosive metal primer.
b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
c. Topcoat: Exterior alkyd enamel (flat).
d. Color: yellow.

C. Paint exposed, interior metal piping, valves, service regulators, and piping specialties, except components, with factory-applied paint or protective coating.

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

3.11 CONCRETE BASES

A. Concrete Bases: Anchor equipment to a concrete base.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than the supported unit.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Use 3000-psig, 28-day, compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete."

3.12 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 New York Fuel Gas Code and authorities having jurisdiction.

C. Natural-gas piping will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. 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.

F. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

3.13 PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 0.5 PSIG

A. PIPE SIZE AND PRESSURE LIMITATION FOR GAS PIPING

PSIG	Gas Pipe Installation

In Excess of ½ psig - 5	Gas distribution pipe operating size 4-inch or larger must be weld-
In Excess of 5 psig	All gas distribution pipes operating above 5 psig must be weld-
All welding of gas distribution pipe shall be subject to DOB special inspection (NYCFGC Sec-	
All piping 4-Inch or larger operating in excess of 5 psig must be butt-welded, Subject to DOB special inspection and radiographed	
Threaded piping may be used up to 4 inches at a pressure no greater than ½ psig.	

B. Aboveground, branch piping smaller than 4" NPS and less than ½ psi shall be the following:

1. Steel pipe with malleable-iron fittings and threaded joints.

C. All welded distribution piping shall be one of the following:

1. Steel pipe with wrought-steel fittings and welded joints.

D. Underground piping shall be one of the following: (NOT Used)

1. Steel pipe with wrought-steel fittings and welded joints.
2. High-Density Polyethylene (HDPE) pipe and Fittings with fusion-welded joints ASTM D2513

E. All piping buried under buildings shall be in containment piping.

1. Containment Conduit for gas pipe: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.
2. Containment Conduit for gas vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat the underground pipe and fittings with protective coating for steel piping.

3.14 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Valves for pipe sizes NPS 2 and smaller at the regulator shall be one of the following:

1. One-piece, bronze ball valve with bronze trim.
2. Two-piece, full-port, bronze ball valves with bronze trim.
3. Bronze plug valve.

B. Valves for pipe sizes NPS 2-1/2 and larger at the service regulator shall be one of the following:

1. Two-piece, full-port, bronze ball valves with bronze trim.
2. Bronze plug valve.
3. Cast-iron, nonlubricated plug valve.

C. Distribution piping valves for pipe sizes NPS 2 and smaller shall be one of the following:

1. One-piece, bronze ball valve with bronze trim.
2. Two-piece, full-port, bronze ball valves with bronze trim.
3. Bronze plug valve.

D. Distribution piping valves for pipe sizes NPS 2-1/2 and larger shall be one of the following:

1. Two-piece, full-port, bronze ball valves with bronze trim.
2. Bronze plug valve.
3. Cast-iron, nonlubricated plug valve.

E. Valves in branch piping for single appliance shall be one of the following:

1. One-piece, bronze ball valve with bronze trim.
2. Two-piece, full-port, bronze ball valves with bronze trim.
3. Bronze plug valve.

3.15 UNDERGROUND GAS PIPING

A. The contractor shall field verify the exact size, location, depth, and invert of all existing utilities within the limits of work prior to commencing his operations and report any discrepancies to the engineer for resolution.

B. The contractor shall notify all utility companies 72 hours prior to the start of his operations and shall comply with the latest industrial code rule 53 regulations.

C. Install all high-pressure and low-pressure piping in accordance with Utility Company requirements. Provide minimum cover over the top of the service pipe of 24” in accordance with Utility Company requirements. Use only Utility Company-approved backfill material, yellow sand, clean of all stones and debris.

D. Plastic and steel pipe shall be installed to allow thermal expansion and contraction. Joints shall be made under the Utility Company

E. guidelines. Install tracer wire along the lengths of the pipe in accordance with Utility Company guidelines. Plastic and steel pipe installation is subject to inspection by the utility.

F. All buried piping shall have plastic warning tape installed 1’-0” above the pipe as per utility requirements

G. All buried plastic pipe shall be installed with a #14 gage, red, insulated tracer wire from 1’ above grade, taped to the meter riser, and along the entire continuous length of the service pipe to a point 1’ beyond the installation. The tracer must not be electrically connected to any metallic pipe.

H. Provide all pressure tests in accordance with Utility Company requirements and NFPA 54. The contractor is responsible for all required paperwork and filing.

I. Provide appropriate plugs and caps on open-ended pipes.

J. When steel service pipe is required, the service pipe will be installed as follows:
1. Buried steel service pipe is to be joined with non-insulating compression-type couplings or by welding. Buried threaded joints or flanged joints are not permitted.

2. Compression couplings may be used to join exposed meter piping as depicted on gas meter piping drawings. Refer to applicable drawings in the reference section. All meter piping must be properly supported and affixed to the building wall, floor, or ceiling.
3. Care should be taken in the use and application of pipe joint compound or Teflon tape. The compound shall only be applied to the male threaded end of the fitting. Teflon™ tape may not be used on pipe joints on the inlet side of a gas rotary meter.
4. Lamp wick or cloth thread intended for use as a seal in the root of threaded joints is not permitted.
5. Changes in the direction of the gas service pipe may be made through the use of factory bends only.

K. Install piping in 12” of yellow sand bedding, refer to Utility Company, pipe trench standard detail.

3.16 BELOW GROUND PIPING: LEAKAGE TESTING:

A. All of the customer’s service piping and meter piping shall be tested in accordance with the following requirements:

B. All buried piping, before the building wall, shall be pressure tested per the requirements of Gas Specification G-8204, “Pressure Testing Requirements for Gas Mains and Services”.

C. All buried piping shall be blocked, supported, and held in place with sandbags for the leakage test and coating inspection.

D. The test medium shall be either air or inert gas for testing pressures up to 150 psig. Water may be used for test pressures exceeding 150 psig.

E. The pressure source shall be isolated from the piping prior to the start of the test.

F. All joints, fittings, valves, or other potential leak sources shall be checked for leakage during the pressure test using a leak detection solution (soap water).

G. Test duration times are to be measured after the test medium has stabilized.

H. Pressure readings shall be performed using a calibrated pressure gauge.

I. Prior to tie-in, Utility Company will pressure test the buried pipe to the head of service/riser valve

3.17 REQUIREMENTS FOR BUILDINGS IN FLOOD ZONES:

A. For buildings in flood zones with industrial meter sets or elevated pressure gas regulators, vent lines should be elevated so the terminus is 3’ above the FEMA base flood elevation (BFE). If this is not feasible, a Vent Line Protector (VLP) shall be installed on the vent line to prevent water intrusion.

B. Refer to Gas Specification G-8217, “Flood-Prone Areas for the Installation of Gas Service Regulator Vent Line Protectors (VLP’s)” for location listings (by M&S Plate) where water intrusion protection devices shall be installed on vent lines of elevated-pressure gas services in Category 3 hurricane flood-prone areas.

C. For those areas not listed in Gas Specification G-8217 where there is a potential for exposure to severe water or flooding, a water intrusion protection device should be considered for installation to prevent blocking of the service regulator vent line at the Utility Company discretion.

D. All outside regulators and the outside terminus for inside service regulators shall have an approved vent line cap (peck vent) or water intrusion protection device, aka vent line protector (VLP).

E. Each Water Intrusion Protection Device shall:

1. Terminate outdoors with VLP facing downward.
2. Be weather and insect-resistant.
3. Not be covered or obstructed in any way that would prevent or interfere with the operation of the gas regulator.
4. Have a minimum clearance of eighteen inches (18”) from the final outdoor grade to the lower end of the protection device.

F. Refer to Gas Specification G-699, “Installation and Inspection of Gas Service Regulator Vent Line Protectors (VLPs)” for proper sizing of the device and properly matched 90 deg. elbow and pipe strap.

3.18 PROHIBITED LOCATIONS FOR SERVICE AND METERING EQUIPMENT OUTDOORS AND INDOORS:

1. Service head valves, meters, pressure regulators, and associated equipment shall not be located:
2. In a designated boiler or fire pump room of a multi-family or commercial building.
3. Gas meters shall not be installed within three feet (3 ft.) of sources of ignition, including burners, electric panel boxes, or machinery.
4. Where they could become a hindrance, obstruction, or be exposed to mechanical damage.
5. In sleeping quarters, toilets, bathrooms, washrooms, unventilated closets, stairways, and stair landings.
6. Indoors on walls of elevator or dumbwaiter shafts, over doorways.
7. Under water pipes or other pipes that may be subject to sweating.
8. In any recess or enclosure unless its design and location have been approved by the Utility Company
9. Gas piping shall not be installed within six inches of electric meter equipment.

3.19 SPECIAL CONSIDERATIONS FOR SCHOOLS.

A. All gas piping and appliances shall be provided in accordance with [New York State Education Department Manual of Planning Standards.] Pipe materials, testing

requirements and pressure limitation as stated in the SED Manual of Planning Standards shall supersede any other requirements of local utility or state or local codes. Including but not limited to the following.

B. GAS FACILITIES

1. See S409; Part IV, Site and Utilities.
2. Outside shut-off valves to shut off the supply of gas shall be installed and located for ready accessibility in case of emergency.
3. All gas equipment shall comply with AGA Listing or Approved Requirements and shall bear the listing or approval seal of a recognized testing agency such as the American Gas Association Laboratories, Inc., or Underwriter's Laboratories, Inc. Installation of gas equipment and piping shall be in accordance with the applicable American National Standards Institute (ANSI) Code and the rules and regulations of the local gas utility.
4. All gas appliances shall be provided with suitable pressure regulation by an approved individual regulator. It is not required that individual Bunsen burner outlets be provided with pressure regulators.
5. Gas piping shall not be buried in slabs or under buildings unless there is no other reasonable location available. In such cases, the gas pipe shall be encased in a gas-tight casing which shall be vented to the atmosphere. Gas pipes shall not be run in or through heating ducts and shall not be installed in plenums where air is being returned to air handling systems for recirculation. Gas piping shall be in accordance with ANSI Z21.30 or Z83.1 (where applicable) and in accordance with the Public Service Commission Regulations NYCRR, Part 255, and the Federal Department of Transportation, Part 192.
6. Gas Piping Tests
   a. Gas piping with a working pressure up to 12" W.C. must be welded for pipe sizes 3" and over. The completed line is to be pressure tested with air or inert gas for a minimum of one hour at 15 psig.
   b. Gas piping with a working pressure above 12" W.C. must be welded for pipe sizes 3" and over. The completed line is to be pressure tested with air or inert gas for a minimum of one hour at 1/2 times the working pressure or a minimum of 50 psig.
   c. Coated or wrapped pipe must be tested at 100 psig for a time period of 1 hour to ensure the gas-tightness of the pipe.
   d. The source of test pressure shall be isolated before the pressure tests are made. Tests shall be made in the presence of the architect, engineer, or their representative in conjunction with the local gas utility requirements.
7. Utility gas admitted into school buildings shall also be adequately odorized to render it detectable as prescribed by the Public Service Commission. Liquefied petroleum gases shall be odorized as prescribed by NFPA Standard No. 58.
8. Whenever liquefied petroleum is used, special pipe joint compound resistant to liquefied petroleum gas shall be used.

9. Gas piping entering a building shall be sleeved and sealed as stated in S403d.

C. BUILDING GAS PRESSURES

1. The allowable gas pressures within areas of the school building, other than the Boiler Room, (after the meter and/or regulators) will be the normal 1/2 psig or less service.

2. The allowable gas pressures within the Boiler Room, after the meter and/or regulators, may be up to 2 psig. Normally, above 1/2 psig is only required for use in the Boiler Room. It will not be ordinary that gas pressure above 2 psig will be required, and requests for utilization of gas pressures above 2 psig will only be considered for approval upon formal presentation for such a request by the consulting engineer of technical reasons to the Office of Facilities Planning.

3. Pressure switches, pressure regulators, and other equipment requiring atmospheric pressure to balance a diaphragm shall be suitably vented to function properly. Over-pressure relief valves, normally open vent solenoids, and other similar equipment shall be suitably vented to function properly and operate safely.

4. Gas pressure regulators designed and equipped with vent limiting devices need not be vented to the outdoors. Other gas pressure regulators shall be vented directly to the outdoors.

5. Relief valves and normally open vent valves shall be vented directly to the outdoors.

6. Vent line size

   a. Vent lines for gas pressure regulators and other devices requiring venting that do not normally discharge gas through the vent shall be vented to the outdoors through a rigid pipe at least 3/4" in size. Consideration shall be given to increasing the size of the vent lines longer than 20 feet. Manifolding of these vents is allowed, provided the cross-sectional area of a common vent line is equal to the sum of the cross-sectional areas of the manifolded vent lines.

   b. Vent lines for relief valves and normally open vent valves shall be piped directly to the outdoors. (They shall not be vented commonly with devices requiring atmospheric air pressure to balance a diaphragm.) The size of these lines shall be calculated to provide full relief capacity under the conditions of design. The size of such lines shall never be less than the size of the connection at the device. Manifolding of these vent lines is allowed, provided the cross-sectional area of a common vent line is not less than the cross-sectional area of the largest individual line plus 50% of the total cross-sectional area of all other connecting lines.

7. Vent termination - All vent lines shall terminate outdoors in a safe place and not less than 18" from any opening or overhang. Adequate means shall be employed to prevent water from entering the vent pipe, and also to prevent stoppage of it by insects or foreign matter.

D. AREAS OF USE OF GAS DISTRIBUTION

1. Science classrooms - gas outlets at fixed spacing (usually 5 feet) at work counters.

2. Homemaking classrooms - outlets to gas burner-type kitchen equipment.
3. Art classrooms - gas outlets at work counters (usually every 30 inches).
4. Gas-fired kilns - whenever used, a control valve shall be provided.
5. Kitchens - as required by equipment.
6. Soldering and Annealing - with compressed air if a compressed air torch is to be used.
7. A master control valve shall be provided for the instructor's control in any space having 3 or more gas outlets. This valve may be either a manual or an electrically operated solenoid valve.
8. If gas outlets are in close proximity to water or air outlets, the gas supply pipe shall be equipped with a gas check valve.

END OF SECTION 221114

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. Ductile iron pipe and fittings
3. Pipe joining materials
4. Specialty valves
5. Transition fittings
6. Dielectric fittings.

B. Related Section:

1. Division 22 Section "Facility Water Distribution Piping" for water-service piping and water meters outside the building from the source to the point where water-service piping enters the building.

1.3 SUBMITTALS

A. Product Data: For the following products:

1. Specialty valves.
2. Transition fittings.
3. Dielectric fittings.
4. Flexible connectors.

B. Water Samples: Specified in "Cleaning" Article.

C. Coordination Drawings: For piping in equipment rooms and other congested areas, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:

1. Fire-suppression-water piping.
2. Domestic water piping, storm water piping and sanitary piping.
3. HVAC hydronic piping and Ductwork.
4. Electrical conduits.

D. Field quality-control reports.

1.4 QUALITY ASSURANCE

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

B. Comply with NSF 61 for potable domestic water piping and components.

1.5 PROJECT 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 the Construction Manager and the Owner no fewer than two days in advance of a proposed interruption of water service.
2. Do not proceed with interruption of water service without the Construction Manager's and Owner's written permission.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

B. Potable-water piping and components shall comply with NSF 14 and NSF 61 Annex G. Plastic piping components shall be marked with "NSF-pw."

C. All materials shall comply with NSF/ANSI Standard 732 for lead-free.

2.2 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.

1. Cast-Copper Solder-Joint Fittings: ASME B16.18, pressure fittings.
2. Wrought-Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
3. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
4. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

B. Copper Unions:

1. MSS SP-123.
2. Cast-copper-alloy, hexagonal-stock body.
3. Ball-and-socket, metal-to-metal seating surfaces.
4. Solder-joint or threaded ends.

C. Copper, Brass, or Bronze Pressure-Seal-Joint Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
   a. Apollo Valves; Conbraco Industries, Inc.
   b. Elkhart Products Corporation.
   c. Mueller Industries, Inc.
   d. NIBCO INC.
2. Fittings: Cast-brass, cast-bronze or wrought-copper with EPDM O-ring seal in each end. Sizes NPS 2-1/2 and larger with stainless steel grip ring and EPDM O-ring seal.
3. Minimum 200-psig working-pressure rating at 250 deg F.

D. Copper-Tube, Extruded-Tee Connections:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
   a. Apollo Valves; Conbraco Industries, Inc.
   b. Elkhart Products Corporation.
   c. Mueller Industries, Inc.
   d. NIBCO INC.
2. Description: Tee formed in a copper tube according to ASTM F 2014.

E. Appurtenances for Grooved-End Copper Tubing:
1. Bronze Fittings for Grooved-End, Copper Tubing: ASTM B75/B75M copper tube or ASTM B584 bronze castings.
2. Mechanical Couplings for Grooved-End Copper Tubing:
   a. Copper-tube dimensions and design similar to AWWA C606.
   b. Ferrous housing sections.
   c. EPDM-rubber gaskets suitable for hot and cold water.
   d. Bolts and nuts.
   e. Minimum Pressure Rating: 300 psig.

2.3 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe:
1. AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Standard-Pattern, Mechanical-Joint Fittings:
   1. AWWA C110/A21.10, ductile or gray iron.
   2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

C. Compact-Pattern, Mechanical-Joint Fittings:
   1. AWWA C153/A21.53, ductile iron.
   2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

D. Plain-End, Ductile-Iron Pipe: AWWA C151/A21.51.

E. Appurtenances for Grooved-End, Ductile-Iron Pipe:
   1. Fittings for Grooved-End, Ductile-Iron Pipe: ASTM A47/A47M, malleable-iron castings or ASTM A536, ductile-iron castings with dimensions that match pipe.
   2. Mechanical Couplings for Grooved-End, Ductile-Iron-Piping:
      a. AWWA C606 for ductile-iron-pipe dimensions.
      b. Ferrous housing sections.
      c. EPDM-rubber gaskets suitable for hot and cold water.
      d. Bolts and nuts.
      e. Minimum Pressure Rating:
         1) NPS 14 to NPS 18: 250 psig.

F. NPS 20 to NPS 46: 150 psig

2.4 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos-free, unless otherwise indicated; full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813. Lead-free.

D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.5 SPECIALTY VALVES

A. Comply with requirements in Division 22, Section "General-Duty Valves for Plumbing Piping" for general-duty metal valves.

B. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for balancing valves, drain valves, backflow preventers, and vacuum breakers.

2.6 TRANSITION FITTINGS

A. General Requirements:

1. Same size as pipes to be joined.
2. Pressure rating at least equal to that of the pipes to be joined.
3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

2.7 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.

B. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Capitol Manufacturing Company.
b. Central Plastics Company.
c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
d. Zurn Plumbing Products Group; Wilkins Water Control Products.

2. Description:

a. Pressure Rating: 150 psig at 180 deg F.
b. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Capitol Manufacturing Company.
b. Central Plastics Company.
c. EPCO Sales, Inc.
d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Factory-fabricated, bolted, companion-flange assembly.
b. Pressure Rating: 150 psig.

c. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Kits:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Central Plastics Company.
d. Pipeline Seal and Insulator, Inc.

2. Description:

a. Nonconducting materials for field assembly of companion flanges.
b. Pressure Rating: 150 psig.
c. Gasket: Neoprene or phenolic.
d. Bolt Sleeves: Phenolic or polyethylene.
e. Washers: Phenolic with steel backing washers.

E. Dielectric Couplings:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Calpico, Inc.
b. Lochinvar Corporation.

2. Description:

a. Galvanized steel coupling.
b. Pressure Rating: 300 psig at 225 deg F.
c. End Connections: Female threaded.
d. Lining: Inert and noncorrosive, thermoplastic.

F. Dielectric Nipples:
1. Standard: IAPMO PS 66.
2. Electroplated steel nipple complying with ASTM F1545.
3. Pressure Rating and Temperature: 300 psig at 225 deg F.
4. End Connections: Male threaded or grooved.
5. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 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. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.

D. Under-building-slab, domestic water, building-service piping, NPS 3 and smaller, shall be one of the following:
   1. Soft copper tube, ASTM B 88, Type K, ASTM B 88 Type L; wrought-copper, solder-joint fittings; and brazed, copper pressure-seal fittings; and pressure-sealed joints.

E. Under-building-slab, domestic water, building-service piping, NPS 4 to NPS 8 and larger, shall be one of the following:
   1. Soft copper tube, ASTM B 88, Type K, ASTM B 88, Type L; wrought-copper, solder-joint fittings; and brazed joints.
   2. Mechanical-joint, ductile-iron pipe; standard-pattern, mechanical-joint fittings; and mechanical joints.

F. Under-building-slab, combined domestic water, building-service, and fire-service-main piping, NPS 6 to NPS 12, shall be the following:
   1. Mechanical-joint, ductile-iron pipe; standard-pattern, mechanical-joint fittings; and mechanical joints.
   2. Push-on-joint, ductile-iron pipe; standard-pattern, push-on-joint fittings; and gasketed joints.

G. Under-building-slab, domestic water distribution piping, NPS 3 and smaller, shall be the following:
   1. Hard copper pipe type L, ASTM B42 or soft copper tube type L, ASTM B88. wrought-copper, solder-joint fittings, and brazed joints.

H. Aboveground domestic water distribution piping, NPS 2 and smaller, shall be one of the following:
   1. Hard copper tube, ASTM B 88, Type L; copper, solder-joint fittings; and joints.
   2. (Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.)

I. Aboveground domestic water piping, NPS 2-1/2 to NPS 4, shall be one of the following:

   1. Hard copper tube, ASTM B 88, Type L; cast- or wrought-copper, solder-joint fittings; and brazed soldered joints.

2. Hard copper tube, ASTM B 88, Type L or copper pressure-seal-joint fittings; and pressure-sealed joints.
3. Hard copper tube, ASTM B 88, Type L or grooved-joint copper-tube appurtenances and grooved joints.

J. Aboveground domestic water piping, NPS 5 to NPS 8, shall be one of the following:
1. Hard copper tube, ASTM B 88, Type L; cast- or wrought-copper, solder-joint fittings; and brazed soldered joints.
2. Hard copper tube, ASTM B 88, Type L or grooved-joint copper-tube appurtenances; and grooved joints.

K. Aboveground, combined domestic water-service and fire-service-main piping, NPS 6 to NPS 12, shall be one of the following:
1. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.

3.2 EARTHWORK

A. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

3.3 INSTALLATION OF PIPING

A. Drawing plans, schematics, and diagrams indicate the 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 the layout are approved on the Coordination Drawings.

B. Install copper tubing under the building slab according to CDA's "Copper Tube Handbook."

C. Install ductile-iron piping under the building slab with restrained joints according to AWWA C600 and AWWA M41.

D. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water service entrance. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for drain valves and strainers.

E. Install shutoff valve immediately upstream of each dielectric fitting.

F. Install domestic water piping level without pitch and plumb.

G. Rough-in domestic water piping for water-meter installation according to the utility company's requirements.

H. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.

I. 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.

J. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.

K. Install piping adjacent to equipment and specialties to allow service and maintenance.

L. Install piping to permit valve servicing.

M. 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.

N. Install piping free of sags and bends.

O. Install fittings for changes in direction and branch connections.

P. Install unions in copper tubing at the final connection to each piece of equipment, machine, and specialty.

Q. Install pressure gages on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gages in Section 220519 "Meters and Gages for Plumbing Piping."

R. Install thermostats in hot-water circulation piping. Comply with requirements for thermostats in Section 221123 "Domestic Water Pumps."

S. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements for thermometers in Section 220519 "Meters and Gages for Plumbing Piping."

T. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."

U. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."

V. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 Section "Escutcheons for Plumbing Piping."

W. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.4 JOINT CONSTRUCTION

A. Ream the ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.

E. Soldered Joints: Apply ASTM B 813, water-flushable flux to the end of the tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

F. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools and procedure recommended by the pressure-seal-fitting manufacturer. Leave insertion marks on pipe after assembly

G. Copper-Tubing Grooved Joints: Roll groove end of tube. Assemble the coupling with housing, gasket, lubricant, and bolts. Join copper tube and grooved-end fittings according to AWWA C606 for roll-grooved joints.

H. Joint Construction for Grooved-End, Ductile-Iron Piping: Make joints according to AWWA C606. Cut round-bottom grooves in ends of pipe at gasket-seat dimension required for specified (flexible or rigid) joint. Lubricate and install a gasket over the ends of pipes or the pipe and fitting. Install coupling housing sections over the gasket with keys seated in piping grooves. Install and tighten housing bolts

I. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with a gasket and bolts according to ASME B31.9.

J. Dissimilar-Material Piping Joints: Make joints using adapters compatible with the materials of both piping systems.

3.5 INSTALLATION OF TRANSITION FITTINGS

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping:
   1. Fittings for NPS 1-1/2 and Smaller: Fitting-type coupling.
   2. Fittings for NPS 2 and Larger: Sleeve-type coupling.

C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition fittings or unions.

3.6 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 couplings, nipples or unions.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges or nipples.

D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.7 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 hangers, supports, and anchor devices in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

C. Install hangers for copper, ductile iron, galvanized steel, and stainless steel tubing and piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

D. Install vinyl-coated hangers for CPVC and PVC piping, with maximum horizontal spacing and minimum rod diameters, to comply with the manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

E. Install vinyl-coated hangers for PEX tubing, with maximum horizontal spacing and minimum rod diameters, to comply with the manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

F. Support horizontal piping within 12 inches of each fitting.

G. Support vertical runs of copper ductile iron, galvanized steel, and stainless steel tubing and piping to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

H. Support vertical runs of CPVC, PVC, and piping to comply with the manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

I. Support vertical runs of PEX tubing to comply with the manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.8 CONNECTIONS

A. Drawings indicate the general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment and machines to allow service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with a 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 the 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 a shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.9 IDENTIFICATION

A. Identify system components. Comply with requirements in Division 22, Section "Identification for Plumbing Piping and Equipment" for identification materials and installation.

B. Label pressure piping with the system operating pressure.

3.10 ADJUSTING

A. Perform the following adjustments before operation:
   1. Close drain valves, hydrants, and hose bibs.
   2. Open shutoff valves to the fully open position.
   3. Open throttling valves to the 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 the application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.11 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Piping Inspections:

1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
2. During installation, notify authorities having jurisdiction at least one day before inspection is made. Perform tests specified below in the presence of authorities having jurisdiction:

   a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
   b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

3. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

C. Piping Tests:

1. Fill domestic water piping. Check components to determine that they are not air-bound and that piping is full of water.
2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with a diagram of the portion of piping tested.
3. 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.
4. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding the pressure rating of piping system materials. Isolate

the test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.

5. Repair leaks and defects with new materials and retest piping or the portion thereof until satisfactory results are obtained.
6. Prepare reports for tests and for corrective action required.

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

E. Prepare test and inspection reports. Submit for the engineer's review and approval.

3.12 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 the piping system with clean, potable water until dirty water does not appear at outlets.
   b. Fill and isolate the system according to either of the following:
      1) Fill the 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 the system or part thereof with a water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
   c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
   d. Repeat procedures if biological examination shows contamination.
   e. Submit water samples in sterile bottles to authorities having jurisdiction.

B. Clean non-potable domestic water piping as follows:
1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:
   a. Flush the piping system with clean, potable water until dirty water does not appear at outlets.
   b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if the biological examination shows contamination.

C. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

D. Clean the interior of the domestic water piping system. Remove dirt and debris as work progresses.

3.13 VALVE INSTALLATION

A. General-Duty Valves: Comply with requirements in Section 220523 "General-Duty Valves for Plumbing Piping" for valve installations.

B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball or gate valves for piping NPS 2 and smaller. Use butterfly or gate valves for piping NPS 2-1/2and larger.

C. Install drain valves for equipment at the base of each water riser, at low points in horizontal piping, and where required to drain water piping. Drain valves are specified in Section "Domestic 221119 Water Piping Specialties."

1. Hose-End Drain Valves: At low points in water mains, risers, and branches.
2. Stop-and-Waste Drain Valves: Instead of hose-end drain valves, where indicated.

D. Install RPZ backflow preventer (BFP) in the cold water make-up to all mechanical equipment, including boilers, water heaters, chiller water system, heat exchanger, and steam humidifiers. Provide a funnel drain under each BFP. Pipe drain to indirect discharge at nearest floor drain or to the outdoors.

E. Install a pressure-reducing valve with isolation valves and a valved bypass in the cold-water make-up to the chilled water and hot water system.

F. Install shut-off valves at the supply to each fixture and all equipment.

G. Provide a pressure-reducing valve and strainer on new domestic water services with static pressure greater than 80 psi. Pressure-reducing valves shall conform to ASSE 1003 or CSA B356. The valve shall be designed to fail open.

3.14 VALVE SCHEDULE

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Shutoff Duty: Use ball or gate valves for piping NPS 2and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2and larger.
2. Throttling Duty: Use ball or globe valves for piping NPS 2 and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 and larger.
3. Hot-Water Circulation Piping, Balancing Duty: Memory-stop balancing valves.
4. Drain Duty: Hose-end drain valves.

B. Use check valves to maintain the correct direction of domestic water flow to and from equipment.

C. Iron grooved-end valves may be used with grooved-end piping.

END OF SECTION 221116

SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following domestic water piping specialties:

1. Vacuum breakers.
2. Backflow preventers.
3. Water pressure-reducing valves
4. Balancing valves.
5. Temperature-actuated water mixing valves.
6. Electronic mixing valves
7. Strainers.
8. Outlet boxes
9. Hose bibs.
10. Wall hydrants.
11. Drain valves.
12. Water hammer arresters.
13. Air vents.
14. Trap-seal primer valves.
15. Trap seal primer systems
16. Flexible connections

B. Related Sections include the following:

1. Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers, pressure gages, and flow meters in domestic water piping.
2. Division 22 Section "Domestic Water Piping".

1.3 PERFORMANCE REQUIREMENTS

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

1.4 SUBMITTALS

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

B. Field quality-control test reports.

C. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. NSF Compliance:

1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components.
2. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

A. Potable-water piping and components shall comply with NSF 61 Annex G and NSF 14.

2.2 PERFORMANCE REQUIREMENTS

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

2.3 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. FEBCO
b. Zurn Industries, LLC

c. Watts
d. Ames Co.

2. Standard: ASSE 1001.
3. Size: NPS 1/4 to NPS 3, as required to match connected piping.
4. Body: Bronze.
5. Inlet and Outlet Connections: Threaded.
6. Finish: Chrome-plated.

B. Hose-Connection Vacuum Breakers:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. FEBCO
b. Zurn Industries, LLC
c. Watts
d. Ames Co.

2.
3. Standard: ASSE 1011.
4. Body: Bronze, nonremovable, with manual drain.
5. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
6. Finish: Chrome or nickel-plated.

C. Laboratory-Faucet Vacuum Breakers:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. FEBCO
b. Zurn Industries, LLC
c. Watts
d. Ames Co.

2.
3. Standard: ASSE 1035.
4. Size: NPS 1/4 or NPS 3/8 matching faucet size.
5. Body: Bronze.
6. End Connections: Threaded.
7. Finish: Chrome plated.

2.4 BACKFLOW PREVENTERS

A. Double-Detector Check Backflow-Prevention Assemblies:
1. Basis of design Watts Industries. Provide the basis of design as indicated on drawings or a comparable product by one of the following, subject to review and approval by the engineer: FEBCO; SPX Valves & Controls.
a. Zurn Plumbing Products Group; Wilkins Div.

b. Watts Industries
c. Ames Co

2. Standard: ASSE 1015.
3. Operation: Continuous-pressure applications, unless otherwise indicated.
4. Pressure Loss: 5 psig maximum, through the middle 1/3 of the flow range.
5. Size, Design Flow Rate: as indicated on drawings.
6. Body: stainless steel.
7. End Connections: Flanged.
8. Configuration: Designed for horizontal, straight-through flow.
9. Body: Bronze for NPS 2 and smaller; ductile or cast iron with interior lining that complies with AWWA C550 or that is FDA-approved for NPS 2-1/2 and larger.
10. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
11. Accessories:

    a. Valves NPS 2 and Smaller: Ball type with threaded ends on inlet and outlet.
    b. Valves NPS 2-1/2 and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.

B. Reduced-Pressure-Principle Backflow Preventers:
1. Basis of design Watts Industries. Provide the basis of design as indicated on drawings or a comparable product by one of the following, subject to review and approval by the engineer, Watts Industries.
    a. Ames Co.
    b. Conbraco Industries, Inc.
    c. FEBCO; SPX Valves & Controls.

2. Standard: ASSE 1013.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 12 psig maximum, through the middle 1/3 of the flow range.
5. Size; as per plan
6. Pressure loss at design flow rate 15 psi max
7. Body: Bronze for NPS 2 and smaller.
8. End Connections: Threaded for NPS 2 and smaller.
9. Body: Bronze or for NPS 2 and smaller; ductile or cast iron with interior lining that complies with AWWA C550 or that is FDA approved for NPS 2-1/2 (DN 65) and larger.
10. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
11. Configuration: Designed for horizontal, straight-through flow
12. Configuration: Designed for horizontal, straight-through flow.
13. Accessories:

    a. Valves NPS 2 and Smaller: Ball type with threaded ends on inlet and outlet.
    b. Valves NPS 2-1/2 and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
    c. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

C. Beverage-Dispensing-Equipment Backflow Preventers:
1. Ames Co. or a comparable product by one of the following as indicated on Drawings:

a. FEBCO; SPX Valves & Controls.
b. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1022.
3. Operation: Continuous-pressure applications.
4. Size: NPS 1/4 or NPS 3/8
5. Body: Stainless steel.
6. End Connections: Threaded.

D. Dual-Check-Valve Backflow Preventers:
1. Ames Co. or a comparable product by one of the following as indicated on Drawings:

a. FEBCO; SPX Valves & Controls.
b. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1024.
3. Operation: Continuous-pressure applications.
4. Size: as per plan
5. Body: Bronze with union inlet.

E. Carbonated-Beverage-Dispenser, Dual-Check-Valve Backflow Preventers:
1. Ames Co. or a comparable product by one of the following as indicated on Drawings:

a. FEBCO; SPX Valves & Controls.
b. Zurn Plumbing Products Group; Wilkins Div.

2.
3. Standard: ASSE 1032.
4. Operation: Continuous-pressure applications.
5. Size: NPS 1/4 or NPS 3/4
6. Body: Stainless steel.
7. End Connections: Threaded.

F. Backflow-Preventer Test Kits:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. FEBCO; SPX Valves & Controls.
b. Watts Industries, Inc.; Water Products Div.
c. Zurn Plumbing Products Group; Wilkins Div.

2. Description: Factory calibrated, with gages, fittings, hoses, and a carrying case with test-procedure instructions.

2.5 WATER PRESSURE-REDUCING VALVES

A. Water Regulators Pressure Reducing Valves
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Zurn
   b. Watts
   c. Josam.
2. Standard: ASSE 1003.
3. Pressure Rating: Initial working pressure of 150 psig.
4. Size – as per plan
5. Design flow rate – as per plan
6. Design inlet pressure – as peer plans
7. Design outlet pressure setting 80 psi max or as per plan
8. Body:
   a. 2 ½" and smaller – Bronze – chrome plated for appliance connections or in finished spaces
   b. Over 2 ½" -cast iron with interior lining that complies with AWWA C550 or that is FDA approved for NPS 2-1/2 and NPS 3.
9. Valves for Booster Heater Water Supply: Include integral bypass.
10. End Connections:
    a. Threaded for NPS 2 ½" and smaller.
    b. Flanged for over 2 ½"
11. House or service pressure-reducing valves shall conform to ASSE 1003 or CSA B356 with a strainer.

B. Water-Control Valves:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. FEBCO
   b. Zurn Industries, LLC
   c. Watts
   d. Ames Co.
2. Description: Pilot-operated, diaphragm-type, single-seated, main water-control valve.
3. Pressure Rating: Initial working pressure of 150 psig minimum with AWWA C550 or FDA-approved, interior epoxy coating. Include small pilot-control valve, restrictor device, specialty fittings, and sensor piping.
4. Main Valve Body: Cast- or ductile-iron body with AWWA C550 or FDA-approved interior epoxy coating; or stainless-steel body.

a. Pattern: Angle or Globe-valve design.
b. Trim: Stainless steel.

5. Design Flow: as per plan
6. Design Inlet Pressure: as per plan
7. Design Outlet Pressure Setting: as per plan
8. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.

2.6 BALANCING VALVES

A. Memory-Stop Balancing Valves:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Conbraco Industries, Inc.
b. Crane Co.; Crane Valve Group
c. Milwaukee Valve Company.
d. NIBCO INC.

2. Standard: MSS SP-110 for two-piece, copper-alloy ball valves.
3. Pressure Rating: 400-psig minimum CWP.
4. Size: NPS 2 or smaller.
5. Body: Copper alloy.
6. Port: Standard or full port.
7. Ball: Chrome-plated brass.
8. Seats and Seals: Replaceable.
9. End Connections: Solder joint or threaded.
10. Handle: Vinyl-covered steel with memory-setting device.

2.7 TEMPERATURE-ACTUATED WATER MIXING VALVES

A. Individual-Fixture, Water Tempering Valves:

1. Lawler Company Model 911, or a comparable product by one of the following:

a. Armstrong International, Inc.
b. Leonard Valve Company.
c. Powers; a Watts Industries Co.
d. Symmons Industries, Inc.

2. Standard: ASSE 1016, thermostatically controlled water tempering valve.
3. Pressure Rating: 125 psigminimum, unless otherwise indicated.
4. Body: Bronze body with corrosion-resistant interior components.

5. Temperature Control: Adjustable.
6. Inlets and Outlets: Threaded.
7. Finish: Rough or chrome-plated bronze.
8. Tempered-Water Setting: 80˚F

B. Primary Thermostatic, Water Mixing Valves:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Holby Valve Co., Inc.
    b. Lawler Manufacturing Company, Inc.
    c. Leonard Valve Company.
    d. Powers; a Watts Industries Co.
    e. Symmons Industries, Inc.

2. Standard: ASSE 1017.
3. Pressure Rating: 125 psig.
4. Type: Exposed-mounting, 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.
8. Valve Pressure Rating: 125 psig minimum, unless otherwise indicated.
9. Tempered-Water Setting: 120˚F
10. Valve Finish: Rough bronze.
11. Piping Finish: Copper

C. Manifold, Thermostatic, Water Mixing-Valve Assemblies:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Holby Valve Co., Inc.
    b. Lawler Manufacturing Company, Inc.
    c. Leonard Valve Company.
    d. Powers; a Watts Industries Co.
    e. Symmons Industries, Inc.
2. Description: Factory-fabricated, cabinet-type, thermostatically controlled, water mixing-valve assembly in two or three-valve parallel arrangement.
3. Large-Flow Parallel: Thermostatic, water mixing valve and downstream-pressure regulator with pressure gages on inlet and outlet.
4. Intermediate-Flow Parallel: Thermostatic, water mixing valve and downstream-pressure regulator with pressure gages on inlet and outlet.
5. Small-Flow Parallel: Thermostatic, water mixing valve.
6. Thermostatic Mixing Valves: Comply with ASSE 1017. Include check stops on hot- and cold-water inlets and shutoff valve on outlet.

7. Water Regulator(s): Comply with ASSE 1003. Include pressure gage on inlet and outlet.
8. Pressure Rating: 125 psig minimum unless otherwise indicated.
9. Cabinet: Factory fabricated, stainless steel, for recessed mounting and with hinged, stainless-steel door.
10. Selected Large-Flow, Tempered-Water Valve Size: .
11. Tempered-Water Setting: .
12. Unit Tempered-Water Design Flow Rate: .
13. Unit Minimum Tempered-Water Design Flow Rate: .
14. Selected Unit Flow Rate at 45-psig Pressure Drop: .
15. Unit Pressure Drop at Design Flow Rate: .
16. Unit Tempered-Water Outlet Size: end connection.
17. Unit Hot- and Cold-Water Inlet Size: end connections.
18. Thermostatic Mixing Valve and Water Regulator Finish: Polished, chrome plated.
19. Piping Finish: Chrome plated.

2.8 ELECTRONIC MIXING VALVES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Heat timer
   b. Powers; a Watts Industries Co.
   c. Symons Industries, Inc.

B. Description; electronic hot water temperature control mixing valve with safeguard. With a digital controller and LED display
   1. Conforms to ASSE 1017, lead-free plumbing codes, ANSI 61.
   2. Combination temperature control with alarm safeguard
   3. Heating or cooling applications
   4. Remote communications
      a. Internet – heat Timer RINET
      b. BACnet IP or MSTP
      c. Modbus
   5. Stainless steel 3- way valve body
      a. Max operating temp 300 deg F
      b. Max operating pressure 225 psi
      c. 640 stainless steel stem
   6. Accuracy: .5 gpm to full flow +- 1 degree
   7. 120v power, 24v actuator
   8. Digital display LED output status lights.
   9. Function selection buttons
   10. Graphic display interface

2.9 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig minimum, unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved epoxy coating for NPS 2-1/2 and larger.
3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
4. Screen: Stainless steel with round perforations, unless otherwise indicated.
5. Perforation Size:

    a. Strainers NPS 2 and Smaller: 0.033 inch.
    b. Strainers NPS 2-1/2 to NPS 4: 0.062 inch.

6. Drain: Factory-installed, hose-end drain valve.

2.10 HOSE BIBBS

A. Interior Mechanical Room Application:

1. Available Manufacturers:
    a. Watts.
    b. Nibco.
    c. Chicago.

2. Standard: ASME A112.18.1 for sediment faucets.
3. Body Material: Bronze.
4. Seat: Bronze, replaceable.
5. Supply Connections: 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, drainable, hose-connection vacuum breaker complying with ASSE 1011.
9. Finish for Equipment Rooms: Rough bronze, chrome or nickel-plated.
10. Operation for Equipment Rooms: Wheel handle or operating key.
11. Include an operating key with each operating-key hose bib.

B. Interior Toilet Room Application:

1. Available Manufacturers:

    a. Woodford Manufacturing.
    b. Chicago Faucet.

2. Body: Bronze or brass with integral mounting flange.
3. Seat: Bronze, replaceable.

4. Supply Connections: NPS 3/4 threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: 125 psig.
7. Vacuum Breaker: Integral, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. Finish: chrome or nickel-plated.
9. Operation: Wheel handle or operating key.
10. Include an operating key with each operating-key hose bibb.

2.11 WALL HYDRANTS

A. Nonfreeze Wall Hydrants:
1. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.
2. Pressure Rating: 125 psig.
3. Operation: Loose key.
4. Casing and Operating Rod: Of the length required to match the wall thickness. Include a wall clamp.
5. Inlet: NPS 3/4 or NPS 1.
6. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
7. Box: Deep, flush-mounted with cover.
8. Box and Cover Finish: Polished nickel bronze or chrome-plated.
9. Outlet: Exposed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
10. Nozzle and Wall-Plate Finish: Polished nickel bronze in public area, Rough bronze in utility rooms.
11. Operating Key (s): One with each wall hydrant.

B. Nonfreeze, Hot- and Cold-Water Wall Hydrants:
1. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.
2. Pressure Rating: 125 psig.
3. Operation: Loose key.
4. Casing and Operating Rods: Of the length required to match the wall thickness. Include wall clamps.
5. Inlet: NPS 3/4 or NPS 1.
6. Outlet: Concealed.
7. Box: Deep, flush-mounted with cover.
8. Box and Cover Finish: Polished nickel bronze in exposed public area, or chrome-plated.
9. Vacuum Breaker:
    a. Nonremovable, manual-drain-type, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
    b. Garden-hose thread complying with ASME B1.20.7 on outlet.
10. Operating Key(s): One with each wall hydrant.

C. Vacuum Breaker Wall Hydrants:

1.
2. Standard: ASSE 1019, Type A or Type B.
3. Type: Freeze-resistant, automatic draining with integral air-inlet valve.
4. Classification: Type A, for automatic draining with hose removed, or Type B, for automatic draining with hose removed or with hose attached and nozzle closed.
5. Pressure Rating: 125 psig.
6. Operation: Loose key or wheel handle.
7. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
8. Inlet: NPS 1/2 or NPS 3/4.
9. Outlet: Exposed with garden-hose thread complying with ASME B1.20.7.

2.12 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig minimum CWP.
3. Size: NPS 3/4.
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

B. Gate-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-80 for gate valves.
2. Pressure Rating: Class 125.
3. Size: NPS 3/4.
4. Body: ASTM B 62 bronze.
5. Inlet: NPS 3/4 threaded or solder joint.
6. Outlet: Garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

C. Gate-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-80 for gate valves.
2. Pressure Rating: Class 125.
3. Size: NPS 3/4.
4. Body: ASTM B 62 bronze.
5. Inlet: NPS 3/4 threaded or solder joint.

6. Outlet: Garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

D. Stop-and-Waste Drain Valves:

1. Standard: MSS SP-110 for ball valves or MSS SP-80 for gate valves.
2. Pressure Rating: 200-psig minimum CWP or Class 125.
3. Size: NPS 3/4.
4. Body: Copper alloy or ASTM B 62 bronze.
5. Drain: NPS 1/8 side outlet with cap.

2.13 WATER HAMMER ARRESTERS

A. Water Hammer Arresters:

1. Available Manufacturers:
   a. AMTROL, Inc.
   b. Josam Company.
   c. PPP Inc.
   d. Watts Drainage Products Inc.
   e. Zurn Plumbing Products Group; Specification Drainage Operation.
   f. Jay R. Smith.

2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: Stainless steel construction with metal bellows, precharged.
4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

2.14 AIR VENTS

A. Bolted-Construction Automatic Air Vents:

1. Body: Bronze.
2. Pressure Rating and Temperature: 125-psig minimum pressure rating at 140 deg F.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: NPS 3/8 minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

B. Welded-Construction Automatic Air Vents:

1. Body: Stainless steel.
2. Pressure Rating: 150-psig minimum pressure rating.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: NPS 3/8 minimum inlet.

6. Inlet and Vent Outlet End Connections: Threaded.

2.15 TRAP-SEAL PRIMER VALVES

A. Supply-Type, Trap-Seal Primer Valves:

1. PPP Inc Model P-2 with Distribution Unit DU-2 or a comparable product by one of the following:

   a. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   b. Watts Industries, Inc.; Water Products Div.

2. Standard: ASSE 1018.
3. Pressure Rating: 125 psig minimum.
4. Body: Bronze.
5. Inlet and Outlet Connections: NPS 1/2 threaded, union, or solder joint.
6. Gravity Drain Outlet Connection: NPS 1/2 threaded or solder joint.
7. Finish: Chrome-plated or rough bronze for units used with pipe or tube that is not chrome-finished.

2.16 TRAP-SEAL PRIMER SYSTEMS

A. Trap-Seal Primer Systems:
1. Standard: ASSE 1044.
2. Piping: NPS 3/4, ASTM B 88, Type L; copper, water tubing.
3. Cabinet: Recessed-mounted steel box with stainless-steel cover.
4. Electric Controls: 24-hour timer, solenoid valve, and manual switch for 120-V ac power.

   a. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

5. Vacuum Breaker: ASSE 1001.
6. Number of Outlets: Four.
7. Size Outlets: NPS 1/2.

2.17 FLEXIBLE CONNECTORS

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

1. Flex Pression Ltd.
2. Flex-Hose Co., Inc.
3. Metraflex Company (The).

4. Universal Metal Hose.

B. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.

1. Working-Pressure Rating: Minimum 200 psig.
2. End Connections NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.
3. End Connections NPS 2-1/2 and Larger: Flanged copper alloy.

C. Stainless-Steel-Hose Flexible Connectors: Corrugated stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.

1. Working-Pressure Rating: Minimum 200 psig.
2. End Connections NPS 2 and Smaller: Threaded steel-pipe nipple.
3. End Connections NPS 2-1/2 and Larger: Flanged steel nipple.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Section 22 05 00 "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

B. Install balancing valves in locations where they can easily be adjusted.

C. Install temperature-actuated water mixing valves with check stops or shutoff valves on inlets and with a shutoff valve on the outlet.

1. Install thermometers and water regulators if specified.

D. Install Y-pattern strainers for water on the supply side of each control valve, solenoid valve, and pump, and where indicated on Drawings.

E. Install water hammer arresters in water piping according to PDI-WH 201.

F. Install air vents at high points of water piping.

G. Install supply-type, trap-seal primer valves with outlet piping pitched down toward the drain trap a minimum of 1 percent, and connect to the floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.

H. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.

1. Locate backflow preventers in the same room as connected equipment or system.
2. Install a 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 the air-gap device attached to or under the backflow preventer. Simple air brakes are not acceptable for this application.
3. Do not install bypass piping around backflow preventers.

I. All valves, fittings, and specialties shall have a pressure class rating that exceeds the pressure of the system it is installed in.

J. Install pressure-reducing valves where water pressure within a building exceeds 80 psi static pressure. An approved pressure-reducing valve conforming to ASSE 1003 or CSA B356 with a strainer shall be installed to reduce pressure in the distribution piping to 80 psi max.
   a. Exception is service risers and mains where pressure is reduced at individual fixtures 80 PSI or less.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate the general arrangement of piping and specialties.

B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

C. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:

1. Pressure vacuum breakers.
2. Intermediate atmospheric-vent backflow preventers.
3. Reduced-pressure-principle backflow preventers.
4. Double-check, backflow-prevention assemblies.
5. Carbonated-beverage-machine backflow preventers.
6. Dual-check-valve backflow preventers.
7. Reduced-pressure-detector, fire-protection, backflow-preventer assemblies.
8. Double-check, detector-assembly backflow preventers.
9. Water pressure-reducing valves.
10. Calibrated balancing valves.
11. Primary, thermostatic, water mixing valves.
12. Manifold, thermostatic, water mixing-valve assemblies.

13. Photographic-process, thermostatic, water mixing-valve assemblies.
14. Primary water tempering valves.
15. Outlet boxes.
16. Hose stations.
17. Supply-type, trap-seal primer valves.
18. Trap-seal primer systems.

B. Distinguish among multiple units, inform the operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying the unit. Nameplates and signs are specified in Division 22, Section "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and prepare test reports:

1. Test each pressure vacuum breaker, reduced-pressure-principle backflow preventer double-check, backflow-prevention assembly and double-check, detector-assembly backflow preventer backflow preventer according to authorities having jurisdiction and the device's reference standard.

B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

3.5 ADJUSTING

A. Set field-adjustable pressure set points of water pressure-reducing valves.

B. Set field-adjustable temperature set points of temperature-actuated water mixing valves.

END OF SECTION 221119

SECTION 221123.21 - INLINE, DOMESTIC-WATER PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. In-line, sealless centrifugal pumps.
2. Horizontally mounted, in-line, separately coupled centrifugal pumps.
3. Horizontally mounted, in-line, close-coupled centrifugal pumps.
4. Vertically mounted, in-line, close-coupled centrifugal pumps.

B. Related Requirements:

1. Section 221116 "Domestic-Water Piping"
2. Section 331119 Domestic Water Piping Specialties "

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include construction materials, rated capacities, certified performance curves with operating points plotted on curves, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Detail pumps and adjacent equipment. 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 pumps will be attached.
2. Size and location of initial access modules for acoustical tile.

B. Seismic Qualification Data: Certificates, for inline, domestic-water pumps, accessories, and components, from the manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For inline, domestic water pumps to include in operation and maintenance manuals.

1.6 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 instructions for handling.

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. UL Compliance: UL 778 for motor-operated water pumps.

C. Drinking Water System Components - Health Effects and Drinking Water System Components - Lead Content Compliance: NSF 61 and NSF 372.

2.2 IN-LINE, SEALLESS CENTRIFUGAL PUMPS

A. Description: Factory-assembled and -tested, in-line, close-coupled, canned-motor, sealless, overhung-impeller centrifugal pumps.

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

1. Armstrong
2. Bell and Gosset
3. Grundfos Pumps Corp.
4. TACO Comfort Solutions, Inc.

C. Capacities and Characteristics:

1. Capacity: Refer to plans and schedules

D. Pump Construction:

1. Pump and Motor Assembly: Hermetically sealed, replaceable-cartridge type with motor and impeller on a common shaft and designed for installation with the pump and motor shaft horizontal.
2. Minimum Working Pressure: 125 psig.
3. Maximum Continuous Operating Temperature: 220 deg F.
4. Casing: Bronze or Stainless steel, with threaded or companion-flange connections.
5. Impeller: composite or stainless steel.
6. Motor: Single

2.3 HORIZONTALLY MOUNTED, IN-LINE, SEPARATELY COUPLED CENTRIFUGAL PUMPS

A. Description: Factory-assembled and -tested, in-line, single-stage, separately coupled, overhung-impeller centrifugal pumps designed for installation with pump and motor shafts mounted horizontally.

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

1. Bell & Gossett; a Xylem brand.
2. TACO Comfort Solutions, Inc.
3. Thrush Co. Inc.
4. Armstrong

C. Capacities and Characteristics:

1. Capacity: Refer to plans and schedules.

D. Pump Construction:

1. Casing:

a. Radially split bronze or stainless steel with threaded companion-flange connections for pumps with NPS 2 pipe connections and flanged connections for pumps with NPS 2-1/2 pipe connections.
b. Built to permit servicing of pump internals without disturbing the casing or the suction and discharge piping.
c. Gauge port tappings at suction and discharge nozzles.

2. Impeller: Bronze or stainless steel, statically and dynamically balanced, closed, and keyed to the shaft.
3. Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve.
4. Shaft Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.
5. Seal: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and rubber bellows and gasket.
6. Bearings: Grease-lubricated or permanently lubricated ball type.
7. Minimum Working Pressure: 125 psig.
8. Continuous Operating Temperature: 200 deg F.

E. Motor: Single speed, with permanently lubricated ball bearings, and resiliently or rigidly mounted to the pump casing.

2.4 HORIZONTALLY MOUNTED, IN-LINE, CLOSE-COUPLED CENTRIFUGAL PUMPS

A. Description: Factory-assembled and -tested, in-line, single-stage, close-coupled, overhung-impeller centrifugal pumps designed for installation with the pump and motor shaft mounted horizontally.

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

1. Bell & Gossett; a Xylem brand.
2. TACO Comfort Solutions, Inc.
3. Thrush Co. Inc.
4. Armstrong

C. Capacities and Characteristics:

1. Capacity: Refer to plans and schedules

D. Pump Construction:

1. Casing:

a. Radially split bronze or brass with threaded companion-flange connections for pumps with NPS 2 pipe connections and flanged connections for pumps with NPS 2-1/2 pipe connections.

b. Built to permit servicing of pump internals without disturbing the casing or the suction and discharge piping.
c. Gauge port tappings at suction and discharge nozzles.

2. Impeller: Bronze or brass, statically and dynamically balanced, closed, and keyed to the shaft.
3. Shaft and Shaft Sleeve: Steel shaft with deflector, with copper-alloy shaft sleeve. Include a water slinger on the shaft between the motor and seal.
4. Shaft Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.
5. Seal: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and rubber bellows and gasket.
6. Bearings: Grease-lubricated or permanently lubricated ball type.
7. Minimum Working Pressure: 175 psig.
8. Continuous Operating Temperature: 225 deg F.

E. Motor: Single speed, with grease-lubricated ball bearings; resiliently or rigidly mounted to pump casing.

2.5 VERTICALLY MOUNTED, IN-LINE, CLOSE-COUPLED CENTRIFUGAL PUMPS

A. Description: Factory-assembled and -tested, in-line, single-stage, close-coupled, overhung-impeller centrifugal pumps designed for installation with the pump and motor shaft mounted vertically.

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

1. Armstrong Pumps, Inc.
2. Bell & Gossett; a Xylem brand.
3. PACO Pumps; Grundfos Pumps Corporation, USA.
4. TACO Comfort Solutions, Inc.

C. Capacities and Characteristics:

1. Capacity: Refer to plans and schedules.

D. Pump Construction:

1. Casing: Radially split bronze, with wear rings and threaded companion-flange connections for pumps with NPS 2 pipe connections and flanged connections for pumps with NPS 2-1/2 pipe connections. Include the pump manufacturer's base attachment for mounting the pump on a concrete base.
2. Impeller: Bronze, brass, or stainless steel, statically and dynamically balanced, closed, and keyed to the shaft.
3. Shaft and Shaft Sleeve: stainless-steel shaft, with copper-alloy shaft sleeve.
4. Shaft Coupling: Flexible or rigid type if the pump is provided with a coupling.

5. Seal: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and rubber bellows and gasket. Include a water slinger on the shaft between the motor and seal.
6. Bearings: Oil-lubricated; bronze-journal or ball type.
7. Minimum Working Pressure: 175 psig.
8. Continuous Operating Temperature: 225 deg F.

E. Motor: Single speed, with grease-lubricated ball bearings; rigidly mounted to pump casing.

2.6 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 220513 "Common Motor Requirements for Plumbing Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough driven load will not require the motor to operate in a service factor range above 1.0.

2.7 CONTROLS

A. Thermostats: Electric; adjustable for control of hot-water circulation pump.

1. Type: Water-immersion temperature sensor, for installation in piping.
2. Range: 65 to 200 deg F.
3. Enclosure: NEMA 12.
4. Operation of Pump: On or off.
5. Transformer: Provide if required.
6. Control Power Requirement: 24 V ac or 120 V ac.
7. Settings: Start pump at 95 deg F and stop pump at 100 deg F. – Building Domestic.
8. Settings: Start pump at 110 deg F and stop pump at 135 deg F. – Kitchen High temp loop
9.

B. Timers: Electric, for control of the hot-water circulation pump.

1. Type: Programmable, seven-day clock with manual on-off switch.
2. Enclosure: NEMA 12 suitable for wall mounting.
3. Operation of Pump: On or off.
4. Transformer: Provide if required.
5. Control Power Requirement: 24 V ac or 120 V ac.
6. Programmable Sequence of Operation: Up to two on-off cycles each day for seven days.

C. Time-Delay Relays: Electric, for control of hot-water circulation pump between water heater and connected hot-water storage tank.

1. Type: Adjustable time-delay relay.
2. Range: Up to five minutes.
3. Setting: Five minutes.
4. Enclosure: NEMA 12
5. Operation of Pump: On or off.
6. Transformer: Provide if required.
7. Control Power Requirement: 24 V ac or 120 V ac.
8. Programmable Sequence of Operation: Limit pump operation to periods of burner operation, plus a maximum of five minutes after the burner stops.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for the domestic water piping system to verify actual locations of piping connections before pump installation.

3.2 PUMP INSTALLATION

A. Comply with HI 1.4.

B. Mount pumps in an orientation that complies with the manufacturer's written instructions.

C. Pump Mounting:

1. Install vertically mounted, in-line, close-coupled centrifugal pumps with cast-iron base mounted on a concrete base using vibration isolation type and deflection as specified in Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.

D. Install continuous-thread hanger rods and vibration isolation of size required to support pump weight.

E. Vibration isolation pipe hangers; pre-compressed and locked at the rated deflection by means of a resilient up-stop to keep the piping or equipment at a fixed elevation during installation. The hangers shall be designed with a release mechanism to free the spring

after the installation is complete and the hanger is subjected to its full load. Deflection shall be clearly indicated by means of a scale. Submittals shall include a drawing of the hanger showing the 30° capability. Hangers shall be type PC30N as manufactured by Mason Industries, Inc

F. Install pressure switches in water-supply piping.

G. Install thermostats in hot-water return piping.

H. Install timers and controllers on the wall in the engineer's office, MER room, where hot water heaters are located, or as directed.

I. Install time-delay relays in piping between water heaters and hot-water storage tanks.

3.3 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate the general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to inline, domestic hot water pumps allows space for service and maintenance.

C. Connect domestic water piping to pumps. Install suction and discharge piping equal to or greater than the size of the pump nozzles.

1. Install flexible connectors adjacent to pumps in suction and discharge piping of the following pumps:

    a. Horizontally mounted, in-line, separately coupled centrifugal pumps.
    b. Horizontally mounted, in-line, close-coupled centrifugal pumps.
    c. Vertically mounted, in-line, close-coupled centrifugal pumps.
    d. Comply with requirements for flexible connectors specified in Section 221116 "Domestic Water Piping."

D. Install shutoff valve and strainer on suction side of each pump, and check, shutoff, and throttling valves on discharge side of each pump. Install valves of the same size as the connected piping. Comply with requirements for strainers specified in Section 221119 "Domestic Water Piping Specialties." Comply with requirements for valves specified in the following:

1. Section 220523. "General Duty Valves for Plumbing Piping."
2. Install a pressure gauge at the suction of each pump and a pressure gauge at the discharge of each pump. Install an integral pressure-gauge tappings where provided or install pressure-gauge connectors in suction and discharge piping around pumps. Comply with requirements for pressure gauges and snubbers specified in Section 220519 "Meters and Gages for Plumbing Piping."

3.4 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring between temperature controllers and devices.

C. Interlock the pump between the water heater and the hot-water storage tank with the water heater burner and time-delay relay.

3.5 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment" for identification of pumps.

3.6 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 the 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.

F. Inline, domestic-water pump will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

3.7 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to the manufacturer's written instructions.
2. Check piping connections for tightness.
3. Clean strainers on suction piping.
4. Set thermostats, timers, and time-delay relays for automatic starting and stopping operation of pumps.
5. Perform the following startup checks for each pump before starting:

    a. Verify bearing lubrication.
    b. Verify that the pump is free to rotate by hand and that the pump for handling hot liquid is free to rotate with the pump hot and cold. If the pump is bound or drags, do not operate until the cause of trouble is determined and corrected.
    c. Verify that the pump is rotating in the correct direction.

6. Prime the pump by opening suction valves and closing drains, and prepare the pump for operation.
7. Start motor.
8. Open discharge valve slowly.
9. Adjust temperature settings on thermostats.
10. Adjust timer settings.

3.8 ADJUSTING

A. Adjust the inline, domestic water pumps to function smoothly, and lubricate as recommended by the manufacturer.

B. Adjust initial temperature set points.

C. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

END OF SECTION 221123.21

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. Pipe, tube, and fittings.
2. Specialty pipe fittings.
3. Encasement for underground metal piping.

B. Related Requirements:

1. Section 221319 "Sanitary Waste Piping Specialties".

1.3 SUBMITTALS

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

B. Field quality-control reports.

1.4 QUALITY ASSURANCE

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

1.5 PROJECT CONDITIONS

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

1. Notify Construction Manager, Owner, no fewer than two days in advance of proposed interruption of sanitary waste service.
2. Do not proceed with interruption of sanitary waste service without the Construction Manager's or Owner's written permission.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:

1. Soil, Waste, and Vent Piping: 300-foot head of water
2. Waste, Force-Main Piping: 100 psig.

2.2 PIPING MATERIALS

A. Piping materials shall bear a label, stamp, or other markings of the 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 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

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

B. Sovent Stack Fittings: ASME B16.45 or ASSE 1043, hubless, cast-iron aerator and deaerator drainage fittings.

C. CISPI, Hubless-Piping Couplings:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. ANACO-Husky.
b. Dallas Specialty & Mfg. Co.
c. MIFAB, Inc.
d. Tyler Pipe.

2. Standards: ASTM C 1277 and CISPI 310.
3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

D. Heavy-Duty, Hubless-Piping Couplings:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. ANACO-Husky.
b. Dallas Specialty & Mfg. Co.
c. MIFAB, Inc.
d. Tyler Pipe.

2. Standards: ASTM C 1277 and ASTM C 1540.
3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

E. Cast-Iron, Hubless-Piping Couplings:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. ANACO-Husky.
b. Dallas Specialty & Mfg. Co.
c. MIFAB, Inc.
d. Tyler Pipe.

2. Standard: ASTM C 1277.
3. Description: Two-piece ASTM A 48/A 48M, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve with integral, center pipe stop.

F. No Hub Fitting Restraints;
1. Basis-of-Design Product: Subject to compliance with requirements, provide Holdrite: 117 Series No Hub Fitting Restraints or comparable

2. Description: CISPI Designation 301-12, large diameter no-hub cast iron fittings, 4” and over in size, shall be provided with supplemental support to minimize the risk of joints separation under high thrust conditions. Auxiliary restraint products used shall be manufactured assemblies with thrust pressure rating adequate for the specific installation. Field devised methods and materials shall not be used to accomplish this application solution.

2.4 DUCTILE-IRON, GRAVITY SEWER PIPE AND FITTINGS

A. Pipe: ASTM A 746, for push-on joints.

B. Standard Fittings: AWWA C110/A21.10, ductile or gray iron, for push-on joints.

C. Compact Fittings: AWWA C153/A21.53, ductile iron, for push-on joints.

D. Gaskets: AWWA C111/A21.11, rubber.

2.5 DUCTILE-IRON, PRESSURE PIPE AND FITTINGS

A. Mechanical-Joint Piping:

1. Pipe: AWWA C151/A21.51, with bolt holes in bell.
2. Standard Fittings: AWWA C110/A21.10, ductile or gray iron, with bolt holes in bell.
3. Compact Fittings: AWWA C153/A21.53, with bolt holes in bells.
4. Glands: Cast or ductile iron; with bolt holes and high-strength, cast-iron or high-strength, low-alloy steel bolts and nuts.
5. Gaskets: AWWA C111/A21.11, rubber, of shape matching pipe, fittings, and glands

2.6 PRESSURE-TYPE PIPE COUPLINGS

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

1. Cascade Waterworks Mfg. Co.
2. Dresser, Inc.
3. Jay R. Smith Mfg. Co.
4. JCM Industries, Inc.
5. Victaulic Company.

B. Tubular-Sleeve Couplings: AWWA C219, with center sleeve, gaskets, end rings, and bolt fasteners.

C. Metal, bolted, sleeve-type, reducing or transition coupling; for joining underground pressure piping. Include 200-psig minimum pressure rating and ends of same sizes as the piping to be joined.

D. Center-Sleeve Material: Stainless steel or Ductile iron.

E. Gasket Material: Natural or synthetic rubber.

F. Metal Component Finish: Corrosion-resistant coating or material

2.7 COPPER TUBE AND FITTINGS

A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.

B. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.

C. Hard Copper Tube: ASTM B 88, Type L and Type M, water tube, drawn temper.

D. Soft Copper Tube: ASTM B 88, Type L, water tube, annealed temper.

E. Copper Pressure Fittings:

1. Copper Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
2. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

F. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.

1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

G. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.

2.8 SPECIALTY PIPE FITTINGS

A. Non-pressure Transition Couplings:

1. General Requirements: A fitting or device for joining piping with small differences in OD's or of different materials. Include end connections that are the same size as and compatible with the pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
3. Unshielded, Nonpressure Transition Couplings:

    a. Standard: ASTM C 1173.
    b. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include a shear ring and corrosion-resistant-metal tension band, and a tightening mechanism on each end.
    c. Sleeve Materials:
        1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
        2) For Concrete Pipes: ASTM C 443, rubber.
        3) For Fiberglass Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
        4) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
        5) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

4. Shielded, Nonpressure Transition Couplings:

    a. Standard: ASTM C 1460.
    b. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Ring-Type, Flexible Couplings:

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

   a. Fernco Inc.
   b. Logan Clay Pipe.
   c. Mission Rubber Company; a division of MCP Industries, Inc.

2. Description: Elastomeric compression seal with dimensions to fit inside the bell of the larger pipe and for the spigot of the smaller pipe to fit inside the ring.

C. Dielectric Fittings:

1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
2. Dielectric Unions:

   a. 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) Capitol Manufacturing Company.
      2) Hart Industries International, Inc.
      3) Watts Regulator Co.; a division of Watts Water Technologies, Inc.
      4) Wilkins; a Zurn company.

   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.

3. Dielectric Nipples:

   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) Grinnell Mechanical Products.
      2) Precision Plumbing Products, Inc.
      3) Victaulic Company.

   b. Description:

      1) Electroplated steel nipple complying with ASTM F 1545.
      2) Pressure Rating: 300 psig at 225 deg F.

3) End Connections: Male threaded or grooved.
4) Lining: Inert and noncorrosive, propylene.

2.9 ENCASEMENT FOR UNDERGROUND METAL PIPING

A. Standard: ASTM A 674 or AWWA C105/A 21.5.

B. Material: high-density, cross-laminated polyethylene film of 0.004-inch minimum thickness.

C. Form: Sheet or tube.

D. Color: Black or natural.

2.10 EXPANSION JOINTS AND DEFLECTION FITTINGS

A. Ductile-Iron, Flexible Expansion Joints:

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

   a. EBAA Iron, Inc.
   b. Romac Industries, Inc.
   c. Star Pipe Products.

2. Description: Compound fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include two gasketed ball-joint sections and one or more gasketed sleeve sections, rated for 250-psig minimum working pressure and for offset and expansion indicated.

B. Ductile-Iron Expansion Joints:

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

   a. Dresser, Inc.
   b. EBAA Iron, Inc.
   c. JCM Industries, Inc.
   d. Smith-Blair, Inc.; a Sensus company.

2. Description: Three-piece assembly of telescoping sleeve with gaskets and restrained-type, ductile-iron, bell-and-spigot end sections complying with AWWA C110 or AWWA C153. Include a rating for 250-psig minimum working pressure and for expansion indicated.

C. Ductile-Iron Deflection Fittings:

1. Description: Compound coupling fitting with ball joint, flexing section, gaskets, and restrained-joint ends complying with AWWA C110/A21.10 or AWWA C153/A21.53. Include rating for 250-psig minimum working pressure and for up to 15 degrees of deflection.

2.11 BACKWATER VALVES

A. Cast-Iron Backwater Valves:

1. Description: ASME A112.14.1, gray-iron body and bolted cover, with bronze seat.

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

   a. Jay R. Smith Mfg. Co.
   b. Josam Company.
   c. Watts; a Watts Water Technologies company.
   d. Zurn Industries, LLC.

3. Horizontal type; with swing check valve and hub-and-spigot ends.
4. Combination horizontal and manual gate-valve type; with swing check valve, integral gate valve, and hub-and-spigot ends.
5. Terminal type; with bronze seat, swing check valve, and hub inlet.

2.12 CLEANOUTS

A. Cast-Iron Cleanouts:

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

   a. Josam Company.
   b. Smith, Jay R. Mfg. Co.
   c. Watts Water Technologies, Inc.
   d. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.

2. Description: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
3. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicates the general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to the layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if the change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch, and 1/8-bend fittings if two fixtures are installed back to back or side by side with a common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change the direction of flow more than 90 degrees. Use the proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing the size of drainage piping in the direction of flow is prohibited.

K. Lay buried building waste piping beginning at the low point of each system.

1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place the hub ends of piping upstream.
2. Install required gaskets according to the 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 drainage and vent piping at the following minimum slopes unless otherwise indicated:

1. Horizontal Sanitary Drainage Piping: 2 percent downward in the direction of flow.
2. Vent Piping: 1 percent down toward the vertical fixture vent or toward the 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 the standards of authorities having jurisdiction.
2. Hubless, Single-Stack Drainage System: Comply with ASME B16.45 and the hubless, single-stack aerator fitting manufacturer's written installation instructions.

3. Reduced-Size Venting: Comply with the standards of authorities having jurisdiction.

P. Install underground, ductile-iron, force-main piping according to AWWA C600.

1. Install buried piping inside the building between wall and floor penetrations and connection to sanitary sewer piping outside the building with restrained joints.
2. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.
3. Install encasement on piping according to ASTM A 674 or AWWA C105/A 21.5.

Q. Install underground, copper, force-main tubing according to CDA's "Copper Tube Handbook."

1. Install encasement on piping according to ASTM A 674 or AWWA C105/A 21.5.

R. Install force mains at elevations indicated

S. Plumbing Specialties:

1. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Install a cleanout fitting with a closure plug inside the building in sanitary drainage force-main piping. Comply with requirements for cleanouts specified in Division 22 Section "Sanitary Waste Piping Specialties."
2. Install drains in sanitary drainage gravity-flow piping. Comply with requirements for drains specified in Division 22 Section "Sanitary Waste Piping Specialties."

3. Install backwater valves in sanitary waste gravity-flow piping.

a. Comply with requirements for backwater valves specified in Section 221319 "Sanitary Waste Piping Specialties."

T. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

U. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."

V. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."

W. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 Section "Escutcheons for Plumbing Piping."

3.2 PIPE JOINT CONSTRUCTION

A. 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.

B. 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.

C. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux, and ASTM B 32, lead-free-alloy solder.

D. Grooved Joints: Cut groove ends of pipe according to AWWA C606. Lubricate and install a gasket over the ends of pipes or pipes and fittings. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.

E. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install the gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in a cross pattern.

F. 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 non-pressure flexible couplings where required to join gravity-flow, non-pressure sewer piping unless otherwise indicated.

    a. Shielded flexible couplings for pipes of the 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 the annular space between the smaller piping's OD and the larger piping's ID permits installation.

2. Use pressure pipe couplings for force-main joints.

G. Install corrosion-protection piping encasement over the following underground metal piping according to ASTM A 674 or AWWA C105/A21.5:
    1. Hubless cast-iron soil pipe and fittings.
    2. Ductile-iron pipe and fittings.
    3. Expansion joints and deflection fittings.

H. Install No Hub Fitting Restraints on all piping 4 inch and over in size, shall be provided with supplemental support to minimize the risk of joints separation under high thrust conditions. Auxiliary restraint products used shall be manufactured assemblies with thrust pressure rating adequate for the specific installation. Field devised methods and materials shall not be used to accomplish this application solution

3.3 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 the direction of flow in the sewer pipe.

    1. Use Light-Duty, top-loading classification cleanouts in earth or unpaved foot-traffic areas.
    2. Use Medium-Duty, top-loading classification cleanouts in paved foot-traffic areas.
    3. Use Heavy-Duty, top-loading classification cleanouts in vehicle-traffic service areas.
    4. Use Extra-Heavy-Duty, top-loading classification cleanouts in roads.

B. Set cleanout frames and covers in earth in cast-in-place-concrete block, 18 by 18 by 12 inches Insert dimensions deep. Set with tops 1 inch above the surrounding grade.

C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

3.4 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in OD's.
2. In Drainage Piping: Shielded, non-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 or unions.
3. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric nipples.
4. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.5 VALVE INSTALLATION

A. Comply with requirements in Section 220523. General-duty valve installation requirements.

B. Shutoff Valves:

1. Install a shutoff valve on each sewage pump discharge.
2. Install a gate or full-port ball valve for piping NPS 2 and smaller.
3. Install gate valve for piping NPS 2-1/2 and larger.

C. Check Valves: Install a swing check valve between the pump and shutoff valve, on each sewage pump discharge.

D. Backwater Valves: Install backwater valves in piping subject to backflow.

1. Horizontal Piping: Horizontal backwater valves. Use normally closed type unless otherwise indicated.
2. Floor Drains: Drain outlet backwater valves unless the drain has an integral backwater valve.
3. Install backwater valves in accessible locations.
4. Comply with requirements for backwater valve specified in Section 221319 "Sanitary Waste Piping Specialties."

3.6 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger and support devices and installation specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.

2. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
3. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
4. Vertical Piping: MSS Type 8 or Type 42, clamps.
5. 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.

6. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on a trapeze hanger.
7. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.

C. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.

D. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
2. NPS 3: 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
5. NPS 10 and NPS 12 60 inches with a 7/8-inch rod.
6. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

E. Install supports for vertical cast-iron soil piping every 15 feet and or at every floor

F. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4: 84 inches with 3/8-inch rod.
2. NPS 1-1/2: 108 inches with 3/8-inch rod.
3. NPS 2: 10 feet with 3/8-inch rod.
4. NPS 2-1/2: 11 feet with 1/2-inch rod.
5. NPS 3: 12 feet with 1/2-inch rod.
6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
7. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
8. NPS 6 and NPS 8: 12 feet with 3/4-inch rod.
9. NPS 10 and NPS 12: 12 feet with 7/8-inchrod

G. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4: 72 inches with 3/8-inch rod.
2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
3. NPS 2-1/2: 108 inches with 1/2-inch rod.
4. NPS 3 and NPS 5: 10 feet with 1/2-inch rod.
5. NPS 6: 10 feet with 5/8-inch rod.
6. NPS 8: 10 feet with 3/4-inch rod

H. Install supports for vertical copper tubing every 10 feet and at every floor

3.7 CONNECTIONS

A. Drawings indicate the 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 the floor and floor cleanouts with covers flush with the floor.
5. Comply with requirements for backwater valves, cleanouts, and drains specified in Section 221319 "Sanitary Waste Piping Specialties."
6. Equipment: Connect waste piping as indicated.

    a. Provide a shutoff valve if indicated and a union for each connection.
    b. Use flanges instead of unions for connections NPS 2-1/2 and larger.

D. Connect force-main piping to the following:

1. Sanitary Sewer: To the exterior force main.
2. Sewage Pump: To the sewage pump discharge.

E. Where installing piping adjacent to equipment, allow space for service and maintenance of the equipment.

F. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at the final connection to each piece of equipment.
2. Install flanges in piping NPS 2-1/2 and larger, adjacent to flanged valves and at the final connection to each piece of equipment.

3.8 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.9 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in the 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 the test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in the absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with a diagram of the portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in the piping system and fill with water to the point of overflow, but not less than a 10-foot head of water. From 15 minutes before inspection starts to the completion of the inspection, the water level must not drop. Inspect joints for leaks.
4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on the roof and building drains where they leave the building. Introduce air into the piping system equal to the pressure of 1-inch wg. Use a U-tube or a manometer inserted in the trap of the water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout the period of inspection. Inspect plumbing fixture connections for gas and water leaks.

5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

E. Test force-main piping according to procedures of authorities having jurisdiction or, in the absence of published procedures, as follows:

1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved.

    a. Expose work that was covered or concealed before it was tested.

2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding the pressure rating of piping system materials.

    a. Isolate the test source and allow it to stand for four hours.
    b. Leaks and loss in test pressure constitute defects that must be repaired.

3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
4. Prepare reports for tests and required corrective action.

3.10 CLEANING AND PROTECTION

A. Clean the interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during the remainder of the construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in the ends of uncompleted piping at the end of the day and when work stops.

3.11 PIPING SCHEDULE

A. Aboveground, soil and waste piping NPS 4 and smaller shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
3. Copper DWV tube, copper drainage fittings, and soldered joints.
4. Dissimilar Pipe-Material Couplings: Shielded, pressure transition couplings.

B. Aboveground, soil and waste piping NPS 5 and larger shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.

2. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
3. Galvanized-steel pipe, drainage fittings, and threaded joints.
4. Dissimilar Pipe-Material Couplings: Shielded, pressure transition couplings.

C. Aboveground, vent piping NPS 4 and smaller shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Copper DWV tube, copper drainage fittings, and soldered joints.

a. Option for Vent Piping, NPS 2-1/2 and NPS 3-1/2: Hard copper tube, Type M; copper pressure fittings; and soldered joints.

3. Dissimilar Pipe-Material Couplings: Shielded, pressure transition couplings.

D. Aboveground, vent piping NPS 5 and larger shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
3. Galvanized-steel pipe, drainage fittings, and threaded joints.
4. Dissimilar Pipe-Material Couplings: Shielded, pressure transition couplings.

E. Underground, soil, waste, and vent piping NPS 4 and smaller shall be any of the following:

1. Extra heavy class, cast-iron soil piping; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
3. Dissimilar Pipe-Material Couplings: Shielded, pressure transition couplings.

F. Underground, soil and waste piping NPS 5 and larger shall be any of the following:

1. Extra heavy class, cast-iron soil piping; gaskets; and gasketed joints.
2. Dissimilar Pipe-Material Couplings: Shielded, pressure transition couplings.

3. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints

G. Aboveground sanitary-sewage force mains NPS 1-1/2 and NPS 2 shall be any of the following:

1. Hard copper tube, Type L; copper pressure fittings; and soldered joints.
2. Galvanized-steel pipe, pressure fittings, and threaded joints.

H. Aboveground sanitary-sewage force mains NPS 2-1/2 to NPS 6 shall be any of the following:

1. Hard copper tube, Type L; copper pressure fittings; and soldered joints.
2. Galvanized-steel pipe, pressure fittings, and threaded joints.

I. Underground sanitary-sewage force mains NPS 4 and smaller shall be any of the following:
   1. Ductile-iron, mechanical-joint piping, and mechanical joints.
   2. Fitting-type transition coupling for piping smaller than NPS 1-1/2 and pressure transition coupling for NPS 1-1/2 and larger if dissimilar pipe materials.

J. Underground sanitary-sewage force mains NPS 5 and larger shall be any of the following:
   1. Ductile-iron, mechanical-joint piping, and mechanical joints.
   2. Pressure transition couplings for dissimilar pipe materials.

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. This Section includes the following sanitary drainage piping specialties:
   1. Backwater valves
   2. Cleanouts.
   3. Air admittance Valves
   4. Floor drains
   5. Pipe Roof flashing assemblies.
   6. Through-penetration firestop assemblies.
   7. Miscellaneous sanitary drainage piping specialties.
   8. Flashing Materials
   9. Solids interceptors.
   10. Clay Interceptor
   11. Protective shielding guards

B. Related Sections include the following:

   1. Division 22 Section "Sanitary Waste and Vent Piping”.

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. HDPE: High-density polyethylene plastic.

C. PE: Polyethylene plastic.

D. PP: Polypropylene plastic.

E. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories for the following:
   1. Grease interceptors.

B. Shop Drawings: Show fabrication and installation details for frost-resistant vent terminals.

   1. Wiring Diagrams: Power, signal, and control wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of the specified testing agency.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic sanitary piping specialty components.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTIONS

A. Sanitary waste piping specialties shall bear a label, stamp, or other markings of the specified testing agency.

B. Comply with NSF 14 for plastic sanitary waste piping specialty components.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing, and marked for intended location and application.

2.2 BACKWATER VALVES

A. Horizontal, Cast-Iron Backwater Valves:

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

    a. Jay R. Smith Mfg. Co.
    b. Josam Company.
    c. MIFAB, Inc.
    d. Watts, a Watts Water Technologies company.
    e. Zurn Industries, LLC.

2. Standard: ASME A112.14.1.

3. Size: Same as connected piping.
4. Body: Cast iron.
5. Cover: Cast iron with bolted or threaded access check valve.
6. End Connections: Hubless.
7. Type Check Valve: Removable, bronze, swing check, factory assembled or field modified to hang open for airflow unless subject to backflow conditions.
8. Extension: ASTM A 74, Service class; full-size, cast-iron, soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.

B. Drain-Outlet Backwater Valves:

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

    a. Jay R. Smith Mfg. Co.
    b. Josam Company.
    c. Watts; a Watts Water Technologies company.
    d. Zurn Industries, LLC.

2. Size: Same as floor drain outlet.

3. Body: Cast iron or bronze made for vertical installation in the bottom outlet of the floor drain.
4. Check Valve: Removable ball float.
5. Inlet: Threaded.
6. Outlet: Threaded or spigot.

2.3 CLEANOUTS

A. Cast Iron Exposed Cleanouts:

1. Available Manufacturers:

    a. Josam Company; Josam Div.
    b. MIFAB, Inc.
    c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.

d. Tyler Pipe; Wade Div.
e. Watts Drainage Products Inc.
f. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
3. Size: Same as connected drainage piping
4. Body Material: cast-iron soil pipe T-branch or Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk or raised-head, brass plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Closure: Stainless-steel plug with seal.

B. Cast Iron Exposed Floor Cleanouts:

1. Available Manufacturers:

a. Josam Company; Josam Div.
b. Watts Drainage Products Inc.
c. Zurn Plumbing Products Group; Light Commercial Operation.
d. Wade
e. Jay R. Smith.

2. Standard: ASME A112.36.2M.
3. Size: Same as connected branch.
4. Type: Threaded, adjustable housing.
5. Body or Ferrule: Cast iron.
6. Clamping Device: Required.
7. Outlet Connection: Threaded.
8. Closure: Brass plug with tapered threads.
9. Adjustable Housing Material: Cast iron.
10. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
11. Frame and Cover Shape: Round.
12. Top Loading Classification: Medium Duty.
13. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.
14. Standard: ASME A112.3.1.
15. Size: Same as connected branch.
16. Housing: Stainless steel.
17. Closure: Stainless steel with seal.
18. Riser: Stainless-steel drainage pipe fitting to cleanout.

C. Cast-Iron Wall Cleanouts:
1. Available Manufacturers:

a. Josam Company; Josam Div.
b. MIFAB, Inc.
c. Watts Drainage Products Inc.
d. Zurn Plumbing Products Group; Specification Drainage Operation.

e. Wade
f. Jay R. Smith

2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: Hub-and-spigot, cast-iron soil pipe T-branch, or Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: cast-iron plug.
6. Closure Plug Size: Same as or not more than one size smaller than the cleanout size.
7. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.
8. Wall Access: Round, nickel-bronze, copper-alloy, or stainless-steel wall-installation frame and cover.

2.4 AIR-ADMITTANCE VALVES

A. Fixture Air-Admittance Valves:

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

a. Ayrlett, LLC.
b. Durgo, Inc.
c. Oatey.
d. ProSet Systems 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. Stack Air-Admittance Valves:

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

a. Ayrlett, LLC.
b. Durgo, Inc.
c. Oatey.
d. ProSet Systems Inc.

2. Standard: ASSE 1050 for vent stacks.
3. Housing: Plastic.
4. Operation: Mechanical sealing diaphragm.
5. Size: Same as connected stack vent or vent stack.

C. Wall Box for Air-Admittance Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Ayrlett, LLC.
b. Durgo, Inc.
c. Oatey.
d. ProSet Systems Inc.

2. Description: White plastic housing with white plastic grille, made for recessed installation. Include the bottom pipe connection and space to contain one air-admittance valve.
3. Size: About 9 inches wide by 8 inches high by 4 inches deep

2.5 FLOOR DRAINS

A. Cast-Iron Floor Drains:
1. Available manufacturers:
a. Josam Company; Josam Div.
b. Tyler Pipe; Wade Div.
c. Watts Drainage Products Inc.
d. Zurn Plumbing Products Group; Light Commercial Operation.
e. Jay R. Smith

2. Standard: ASME A112.6.3.
3. Pattern: Floor drain.
4. Body Material: Gray iron.
5. Anchor Flange: Required.
6. Clamping Device: Required.
7. Sediment Bucket: Not required for finished areas. Required in MER rooms
8. Top or Strainer Material: Nickel bronze. Cast iron in MER rooms
9. Top Shape: Round or square – refer to the schedule on the plan
10. Top Loading Classification: Light Duty for indoor use
11. Trap Material: Cast iron.
12. Trap Pattern: Standard P-trap.

2.6 ROOF FLASHING ASSEMBLIES (all architectural specifications shall supersede this paragraph).

A. Roof Flashing Assemblies:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. Oatley
b. Master flash

c. Portals Plus
d. Elmdor/Stoneman

2. Description: Manufactured assembly flashing collar with skirt extending at least 8 inches from pipe, for multiple or single pipes.
3. Residential;
   a. Rubber collar
   b. 90 degree or angle to match roof pitch
   c. Temperature range to 212 F
   d. 8”x8” aluminum or stainless steel flashing skirt
4. Commercial;
   a. Flashing assemblies are seamless lead flashings that provide for watertight installation using sheet lead complying with ASTM B-29 and Federal Specification QQL-20F, Grade C.
   b. Cast iron counterflashing attaches directly to the roof penetration with set screws. Annular space between flashing and counterflashing skirt is to be field sealed using GE Type II silicone caulk or equal
   c. Provide, on each roof penetration, lead flashing/counter-flashing assembly. Flashing shall be 4 lbs. seamless lead with an 8" skirt and a steel reinforced boot and shall permit installation on roofs with up to a 20 degree pitch. Counterflashing shall be cast iron set screw type and be attached directly to the roof penetration. All flashings shall be installed in accordance with the manufacturer's recommendations and flashed in accordance with the recommendations of the roofing material manufacturer.
   d. Provide vandal-proof vent cap where required.

2.7 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Open Drains:

1. Description: Shop or field fabricated from ASTM A 74, Service class, hub-and-spigot, cast-iron soil-pipe fittings. Include P-trap, hub-and-spigot riser section, and where required, increaser fitting joined with ASTM C 564 rubber gaskets.
2. Size: Same as connected waste piping.

B. Deep-Seal Traps:

1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
2. Size: Same as connected waste piping.

   a. NPS 2: 4-inch minimum water seal.
   b. NPS 2-1/2 and Larger: 5-inch-minimum water seal.

C. Floor-Drain, Trap-Seal Primer Fittings:

1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with NPS 1/2 side inlet.

D. Air-Gap Fittings:

1. Standard: ASME A112.1.2, for fitting designed to ensure a fixed, positive air gap between installed inlet and outlet piping.
2. Body: Bronze or cast iron.
3. Inlet: Opening in the top of the body.
4. Outlet: Larger than inlet.
5. Size: Same as connected waste piping and with an inlet large enough for associated indirect waste piping.

E. Sleeve Flashing Device:

1. Description: Manufactured, cast-iron fitting, with a clamping device that forms a sleeve for pipe floor penetrations of the floor membrane. Include a galvanized-steel pipe extension in top of the fitting that will extend 2 inches above the finished floor and a galvanized-steel pipe extension at the bottom of the fitting that will extend through the floor slab.
2. Size: As required for a close fit to riser or stack piping.

F. Stack Flashing Fittings:

1. Description: Counter-flashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
2. Size: Same as connected stack vent or vent stack.

G. Vent Caps: (not required for this project)

1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include a vented hood and setscrews to secure to the vent pipe.
2. Size: Same as connected stack vent or vent stack.
3. Low-Silhouette Vent Cap: With vandal-proof vent cap.
4. Extended Vent Cap: With a field-installed, vandal-proof vent cap

H. Frost-Resistant Vent Terminals:

1. Description: Manufactured or shop-fabricated assembly constructed of copper, lead-coated copper, or galvanized steel.
2. Design: To provide 1-inch enclosed air space between the outside of the pipe and the inside of the flashing collar extension, with counterflashing.

I. Expansion Joints:

1. Standard: ASME A112.6.4.
2. Body: Cast iron with bronze sleeve, packing, and gland.

3. End Connections: Matching connected piping.
4. Size: Same as connected soil, waste, or vent piping.

J. Automatic Trap Seal Primer Valve:
1. Manufacturers;
   a. J. R. Smith
   b. Sioux Chief
   c. Josum
2. Minimum ½ " outlet size to trap.
3. Cast bronze body
4. Sweat or NPT threaded fittings.

2.8 FLASHING MATERIALS

A. Copper Sheet: ASTM B 152/B 152M, of the following minimum weights and thicknesses, unless otherwise indicated:

1. General Applications: 12 oz./sq. ft. thickness.
2. Vent Pipe Flashing: 8 oz./sq. ft. thickness.

B. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.

C. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.

D. Fasteners: Metal compatible with the material and substrate being fastened.

E. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with the material being installed.

F. Solder: ASTM B 32, lead-free alloy.

G. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

2.9 SOLIDS INTERCEPTORS

A. Solids Interceptors:
1. Jay R. Smith Model 8710 or a comparable product by one of the following:

   a. Josam Company; Josam Div.
   b. Tyler Pipe; Wade Div.
   c. Watts Drainage Products Inc.
   d. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Type: Factory-fabricated interceptor made for removing and retaining sediment from wastewater.
3. Body Material: Cast iron or steel.
4. Interior Separation Device: Screens.
5. Interior Lining: Corrosion-resistant enamel.
6. Mounting: Above floor.

2.10 CLAY INTERCEPTOR

A. Solids Interceptors:
1. Jay R. Smith Model 871 T0150 or a comparable product by one of the following:

a. Josam Company; Josam Div.
b. Tyler Pipe; Wade Div.
c. Watts Drainage Products Inc.
d. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Type: Factory-fabricated interceptor made for removing and retaining sediment from wastewater.
3. Body Material: ABS
4. Interior Separation Device: Screens.
5. 15 gpm
6. 1 ½" inlet/outlet
7. Quick removal latches for top access sediment strainer removal.

2.11 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers:

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. Insul-Tect Products Co.; a subsidiary of MVG Molded Products.
b. McGuire Manufacturing.
c. Truebro; a brand of IPS Corporation.
d. Zurn Industries, LLC; Tubular Brass Plumbing Products Operation.

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; a brand of IPS Corporation.
b. Zurn Industries, LLC; Tubular Brass Plumbing Products Operation.

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 INSTALLATION

A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

B. Install backwater valves in building drain piping if indicated on plan

1. For interior installation, provide a cleanout deck plate flush with the floor and centered over the backwater valve cover, and of adequate size to remove the valve cover for servicing.

C. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless a 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 the base of each vertical soil and waste stack.

D. For cleanouts located in concealed piping, install cleanout wall access covers of the types indicated, with frame and cover flush with finished wall.

E. For floor cleanouts for piping below floors, install cleanout deck plates with the top flush with the finished floor.

F. 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 the elevation of the surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:

a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.

c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.

3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain the integrity of waterproof membranes where penetrated.
4. Install individual traps for floor drains connected to the sanitary building drain, unless otherwise indicated.

G. Install through-penetration firestop assemblies in plastic conductors and stacks at floor penetrations.

H. Install sleeve flashing device with each riser and stack passing through floors with a waterproof membrane.

I. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.

J. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through the roof.

K. Install flashing fittings on sanitary stack vents and vent stacks that extend through the roof.

L. Install floor-drain, trap-seal primer fittings on the inlet to floor drains that require trap-seal primer connection.

1. Exception: Fitting may be omitted if the trap has a trap-seal primer connection.
2. Size: Same as floor drain inlet.

M. Install air-gap fittings on indirect-waste piping discharge into the sanitary drainage system.

N. Install sleeve flashing device with each riser and stack passing through floors with a waterproof membrane.

O. Install vent caps on each vent pipe passing through the roof.

P. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.

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.

S. All valves, fittings, and specialties shall have a pressure class rating that exceeds the pressure of the system it is installed.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate the general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Grease Interceptors: Connect the inlet and outlet to the unit, and connect the flow-control fitting and vent to the unit inlet piping.

D. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

3.3 FLASHING INSTALLATION

A. Fabricate flashing from a single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
   1. Copper Sheets: Solder joints of copper sheets.

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with a waterproof membrane.

   1. Pipe Flashing: Sleeve type, matching pipe size, with a minimum length of 10 inches, and skirt or flange extending at least 8 inches around the pipe.
   2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
   3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around the specialty.

C. Set flashing on floors and roofs in a solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Division 07 Section "Sheet Metal Flashing and Trim."

F. Extend flashing up the vent pipe passing through the roofs and turn down into the pipe, or secure flashing into a cast-iron sleeve having a calking recess.

G. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:

1. Interceptors.

B. Distinguish among multiple units, inform the operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying the unit.

1. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.5 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Leak Test: After installation, charge the system and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.6 PROTECTION

A. Protect drains during the remainder of the construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in the ends of uncompleted piping at the end of each day or when work stops.

END OF SECTION 221319

SECTION 221413 - STORM DRAINAGE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Hubless, cast-iron soil pipe and fittings.
2. Galvanized-steel pipe and fittings.
3. Ductile-iron pipe and fittings.
4. Specialty pipe and fittings.
5. Encasement for underground metal piping.

B. Related Sections:

1. Division 33 Section "Storm Utility Drainage Piping" for storm drainage piping outside the building.

1.3 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:

1. Storm Drainage Piping: 10-foot head of water.

1.4 SUBMITTALS

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

B. Shop Drawings: For controlled-flow roof drainage system. Include calculations, plans, and details.

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

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

B. Comply with NSF/ANSI 14, "Plastics Piping System Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic drain piping and "NSF-sewer" for plastic sewer piping.

1.6 PROJECT CONDITIONS

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

1. Notify Construction Manager, Owner, no fewer than two days in advance of proposed interruption of storm-drainage service.
2. Do not proceed with interruption of storm-drainage service without the Construction Manager's or 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: 300-foot head of water
2. Storm Drainage, Force-Main Piping: 100 psig.

2.2 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.3 HUBLESS, CAST-IRON PIPE AND FITTINGS

A. Pipe and Fittings:

1. Marked with CISPI collective trademark and NSF certification mark.
2. Standard: ASTM A 888 or CISPI 301.

B. CISPI, Hubless-Piping Couplings:

1. 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. Fernco Inc.
b. MIFAB, Inc.
c. Tyler Pipe.

2. Standards: ASTM C 1277 and CISPI 310.
3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

C. Heavy-Duty, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Fernco
   b. ANACO-Husky.
   c. MIFAB, Inc.
   d. Tyler Pipe; a subsidiary of McWane Inc.

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.

D. Cast-Iron, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. MG Piping Products Company.

2. Standard: ASTM C 1277.
3. Description: Two-piece ASTM A 48/A 48M, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve with integral, center pipe stop.

E. No Hub Fitting Restraints;

1. Basis-of-Design Product: Subject to compliance with requirements, provide Holdrite: 117 Series No Hub Fitting Restraints or comparable
2. Description: CISPI Designation 301-12, large diameter no-hub cast iron fittings, 4” and over in size, shall be provided with supplemental support to minimize the risk of joint separation under high thrust conditions. Auxiliary restraint products used shall be manufactured assemblies with a thrust pressure rating adequate for the specific installation. Field devised methods and materials shall not be used to accomplish this application solution.

2.4 GALVANIZED-STEEL PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Tubular USA.
2. U.S. Steel.
3. Wheatland Tube Company.

B. Pipe: ASTM A 53/A 53M, Type E, Standard Weight class. Include square-cut-grooved or threaded ends matching the joining method.

C. Galvanized-Cast-Iron Drainage Fittings: ASME B16.12, threaded.

D. Steel-Pipe Pressure Fittings:

1. Galvanized Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106/A 106M, Schedule 40, seamless steel pipe. Include ends matching the joining method.
2. Malleable-Iron Unions: ASME B16.39; Class 150; hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface; and female threaded ends.
3. Galvanized-Gray-Iron, Threaded Fittings: ASME B16.4, Class 125, standard pattern.

E. Cast-Iron Flanges: ASME B16.1, Class 125.

1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

2.5 DUCTILE-IRON PIPE AND FITTINGS

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

1. American Ductile Iron Pipe.
2. McWane Ductile.
3. U.S. Pipe and Foundry Company.

B. Ductile-Iron, Mechanical-Joint Piping:

1. Ductile-Iron Pipe: AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
2. Ductile-Iron Fittings: AWWA C110/A21.10, mechanical-joint ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
3. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

2.6 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: A fitting or device for joining piping with small differences in ODs or of different materials. Include end connections of the same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified-piping-system fitting.
3. Unshielded, Nonpressure Transition Couplings:

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

        1) Dallas Specialty & Mfg. Co.
        2) Fernco Inc.
        3) Mission Rubber Company, LLC, a division of MCP Industries.
        4) Plastic Oddities.

    b. Standard: ASTM C 1173.

    c. Description: Elastomeric sleeve, reducing or transition pattern. Include a shear ring and a corrosion-resistant-metal tension band and tightening mechanism on each end.
    d. Sleeve Materials:

        1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
        2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
        3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

4. Shielded, Nonpressure Transition Couplings:

    a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

        1) Cascade Waterworks Mfg. Co.
        2) Mission Rubber Company, LLC, a division of MCP Industries.

    b. Standard: ASTM C 1460.

    c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
    d. End Connections: Same size as and compatible with pipes to be joined.

5. Pressure Transition Couplings:

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1) Cascade Waterworks Mfg. Co.
2) EBAA Iron, Inc.
3) Ford Meter Box Company, Inc. (The).
4) JCM Industries, Inc.
5) Romac Industries, Inc.

b. Standard: AWWA C219.

c. Description: Metal, sleeve-type couplings of the same size as pipes to be joined, and with a pressure rating at least equal to and ends compatible with pipes to be joined.
d. Center-Sleeve Material: Carbon steel, Stainless steel, Ductile iron.
e. Gasket Material: Natural or synthetic rubber.
f. Metal Component Finish: Corrosion-resistant coating or material.

B. Dielectric Fittings:

1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
2. Dielectric Unions:

a. 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) Capitol Manufacturing Company.
2) Central Plastics Company.
3) Watts Regulator Co., a division of Watts Water Technologies, Inc.
4) Wilkins; a Zurn company.

b. Description:

1) Standard: ASSE 1079.
2) Pressure Rating: 150 psig at 180 deg F.
3) End Connections: Solder-joint copper alloy and threaded ferrous.

3. Dielectric Flanges:

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) Capitol Manufacturing Company.
2) Central Plastics Company.

3) Watts Regulator Co., a division of Watts Water Technologies, Inc.
4) Wilkins; a Zurn company.

b. Description:

1) Standard: ASSE 1079.
2) Factory-fabricated, bolted, companion-flange assembly.
3) Pressure Rating: 150 psig.
4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

4. Dielectric-Flange Insulating 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) Advance Products & Systems, Inc.
2) Calpico, Inc.
3) Central Plastics Company.
4) Pipeline Seal and Insulator, Inc.

b. Description:

1) Nonconducting materials for field assembly of companion flanges.
2) Pressure Rating: 150 psig.
3) Gasket: Neoprene or phenolic.
4) Bolt Sleeves: Phenolic or polyethylene.
5) Washers: Phenolic with steel-backing washers.

5. Dielectric Nipples:

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

1) Grinnell Mechanical Products.
2) Matco-Norca.
3) Precision Plumbing Products.

b. Description: Electroplated steel nipple.

c. Standard: IAPMO PS 66.
d. Pressure Rating: 300at 225 deg F.
e. End Connections: Male threaded or grooved.
f. Lining: Inert and noncorrosive, propylene.

2.7 ENCASEMENT FOR UNDERGROUND METAL PIPING

A. Standard: ASTM A 674 or AWWA C105/A 21.5.

B. Material: High-density, cross-laminated polyethylene film of 0.004-inch or linear low-density polyethylene film of 0.008-inch minimum thickness.

C. Form: Sheet or tube.

D. Color: Black or natural.

2.8 CLEANOUTS

A. 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. Wade; a subsidiary of McWane Inc.
    d. WATTS.
    e. Zurn Industries, LLC.

2. Standard: ASME A112.36.2M.
3. Size: Same as connected branch.
4. Type: Threaded, adjustable housing.
5. Body or Ferrule: Cast iron.
6. Clamping Device: Required.
7. Outlet Connection: No hub or 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: Nickel-bronze, copper alloy or Polished bronze, Rough bronze for unfinished areas.
11. Frame and Cover Shape: Round.
12. Top Loading Classification: Medium Duty.
13. Riser: ASTM A74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

B. 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: 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 Plug:

    a. Brass.
    b. Countersunk or raised head.
    c. Drilled and threaded for cover attachment screw.
    d. Size: Same as, or not more than, one size smaller than the cleanout size.

6. Wall Access, Cover Plate: Round, deep, chrome-plated bronze, flat, or chrome-plated brass or stainless steel cover plate with screw.
7. Wall Access, Frame and Cover: Round, or Square, nickel-bronze, copper-alloy, or stainless steel, or aluminum wall-installation frame and cover.

2.9 Test Tees:

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. Josam Company.
    b. Smith, Jay R. Mfg. Co.
    c. Watts Water Technologies, Inc.
    d. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M and ASTM A 74, ASTM A 888, or CISPI 301, for cleanout test tees.
3. Size: Same as connected drainage piping.
4. Body Material: Hub-and-spigot, cast-iron soil-pipe T-branch or hubless, cast-iron soil-pipe test tee as required to match connected piping.
5. Closure Plug: Countersunk, brass.
6. Closure Plug Size: Same as or not more than one size smaller than the cleanout size.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicates the general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations from layout are approved on coordination drawings.

B. 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.

C. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

D. Install piping to permit valve servicing.

E. Install piping at indicated slopes.

F. Install piping free of sags and bends.

G. Install fittings for changes in direction and branch connections.

H. Install piping to allow application of insulation.

I. Make changes in direction for storm drainage piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

J. 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.

K. Install storm drainage 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 4and larger.
2. Horizontal Storm-Drainage Piping: 2 percent downward in direction of flow.

L. Install cast-iron storm piping according to CISPI's "Cast Iron Storm Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Storm Pipe and Fittings."

1. Install encasement on underground piping according to ASTM A 674 or AWWA C105.

M. Install engineered controlled-flow drain specialties and storm drainage piping in locations indicated.

N. Install steel piping according to applicable plumbing code.

O. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."

P. Install underground, ductile-iron, force-main piping according to AWWA C600.

1. Install buried piping inside the building between wall and floor penetrations and connection to storm sewer piping outside the building with restrained joints.
2. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.
3. Install encasement on piping according to ASTM A 674 or AWWA C105/A 21.5.

Q. Install underground, copper, force-main tubing according to CDA's "Copper Tube Handbook."

1. Install encasement on piping according to ASTM A 674 or AWWA C105/A 21.5.

R. Install force mains at elevations indicated.

S. 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. Install a cleanout fitting with a closure plug inside the building in storm drainage force-main piping. Comply with requirements for cleanouts specified in Division 22 Section "Storm Drainage Piping Specialties."
2. Install drains in storm drainage gravity-flow piping. Comply with requirements for drains specified in Division 22 Section "Storm Drainage Piping Specialties."

T. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

U. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."

V. Insall sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."

W. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 Section "Escutcheons for Plumbing Piping."

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. Hub-and-Spigot, Cast-Iron Soil Piping Calked Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum calked joints.

C. Hubless, Cast-Iron Soil Piping Coupled Joints: Join according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

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. Grooved Joints: Cut groove ends of pipe according to AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fittings. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.

F. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

G. 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.

H. All no-hub cast iron fittings, 4” and over in size, shall be provided with supplemental support to minimize the risk of joint separation under high thrust conditions. Auxiliary restraint products used shall be manufactured assemblies with a thrust pressure rating adequate for the specific installation. Field devised methods and materials shall not be used to accomplish this application solution

3.3 SPECIALTY PIPE FITTING INSTALLATION

A. 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 or unions.
3. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.

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 unions.
3. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges, flange kits, nipples.
4. Dielectric Fittings for NPS 5and Larger: Use dielectric flange kits.

3.4 VALVE INSTALLATION

A. General valve installation requirements for general-duty valve installations are specified in the following Sections:

1. Section 220523 general duty valves for plumbing."

B. Shutoff Valves:

1. Install a shutoff valve on each sump pump discharge.
2. Install a full-port ball or globe valve for piping NPS 2 and smaller.
3. Install gate valve for piping NPS 2-1/2and larger.

C. Check Valves: Install a swing-check valve between the pump and shutoff valve, on each sump pump discharge.

D. Backwater Valves: Install backwater valves in piping subject to backflow.

1. Horizontal Piping: Horizontal backwater valves. Use normally closed type unless otherwise indicated.
2. Install backwater valves in accessible locations.
3. Comply with requirements for backwater valves specified in Section 221423 "Storm Drainage Piping Specialties."

3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger and support devices and installation specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

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

6. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on a trapeze hanger.
7. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support horizontal piping and tubing within 12 inches of each fitting and coupling.

C. Support vertical piping and tubing at the base and at each floor.

D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.

E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
2. NPS 3: 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.

F. Install supports for vertical cast-iron soil piping every 15 feet and at every floor

G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4: 84 inches with 3/8-inch rod.
2. NPS 1-1/2: 108 inches with 3/8-inch rod.
3. NPS 2: 10 feet with 3/8-inch rod.
4. NPS 2-1/2: 11 feet with 1/2-inch rod.
5. NPS 3: 12 feet with 1/2-inch rod.
6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
7. NPS 6 and NPS 8: 12 feet with 3/4-inch rod.
8. NPS 10 and NPS 12: 12 feet with 7/8-inch rod.

H. Support piping and tubing not listed above according to MSS SP-69 and the manufacturer's written instructions.

I. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4: 72 inches with 3/8-inch rod.
2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
3. NPS 2-1/2: 108 inches with 1/2-inch rod.
4. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
5. NPS 6: 10 feet with 5/8-inch rod.
6. NPS 8: 10 feet with 3/4-inch rod.

J. Install supports for vertical copper tubing every 10 feet.

3.6 CONNECTIONS

A. Drawings indicate the 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 the floor, and floor cleanouts with covers flush with the floor.
2. Comply with requirements for cleanouts specified in Division 22 Section "Storm Drainage Piping Specialties."

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 the final connection to each piece of equipment.
2. Install flanges in piping NPS 2-1/2 and larger, adjacent to flanged valves and at the final connection to each piece of equipment.

F. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2and smaller, adjacent to each valve and at the final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.7 IDENTIFICATION

A. Identify exposed storm drainage piping. Comply with requirements for identification specified in Division 22 Section "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 the 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. Re-inspection: If authorities having jurisdiction find that piping will not pass the test or inspection, make required corrections and arrange for re-inspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test storm drainage piping according to procedures of authorities having jurisdiction or, in the absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with a diagram of the portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Test Procedure: Test storm drainage piping, except outside leaders, on completion of roughing-in. Close openings in the piping system and fill with water to the point of overflow, but not less than a 10-foot head of water. From 15 minutes before inspection starts until completion of inspection, the water level must not drop. Inspect joints for leaks.
4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
5. Prepare reports for tests and required corrective action.

E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved.

    a. Expose work that was covered or concealed before it was tested.

2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding the pressure rating of piping system materials.

    a. Isolate the test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.

3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
4. Prepare reports for tests and required corrective action.

F. Pipe will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

3.9 CLEANING

A. Clean the interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during the remainder of the construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in the ends of uncompleted piping at the end of the day and when work stops.

3.10 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground storm drainage piping NPS 6 and smaller shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; Heavy Duty, hubless-piping couplings; and coupled joints.
3. Galvanized-steel pipe, drainage fittings, and threaded joints.
4. Copper Type DWV tube, copper drainage fittings, and soldered joints.
5. Dissimilar Pipe-Material Couplings: Shielded, pressure transition couplings.

C. Aboveground, storm drainage piping NPS 8 and larger shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; extra heavy-duty, hubless-piping couplings; and coupled joints.
3. Galvanized-steel pipe, drainage fittings, and threaded joints.
4. Copper Type DWV tube, copper drainage fittings, and soldered joints.
5. Dissimilar Pipe-Material Couplings: Shielded, pressure transition couplings.

D. Underground storm drainage piping NPS 6 and smaller shall be any of the following:

1. Extra heavy class, cast-iron soil pipe and fittings; gaskets; heavy-duty, hubless-piping couplings; and coupled joints.

2. Dissimilar Pipe-Material Couplings: Shielded, pressure transition couplings.

E. Underground, storm drainage piping NPS 8 and larger shall be any of the following:

1. Extra heavy class, cast-iron soil pipe and fittings; extra heavy-duty, hubless-piping couplings; and coupled joints.

2. Dissimilar Pipe-Material Couplings: Shielded, pressure transition couplings.

FORCE MAINS

F. Aboveground storm drainage force mains NPS 1-1/2 and NPS 2 shall be any of the following:

1. Hard copper tube, Type L copper pressure fittings, and soldered joints.
2. Galvanized-steel pipe, pressure fittings, and threaded joints.

G. Aboveground storm drainage force mains NPS 2-1/2 to NPS 6 shall be any of the following:

1. Hard copper tube, Type L copper pressure fittings, and soldered joints.
2. Galvanized-steel pipe, pressure fittings, and threaded joints.
3. Fitting-type transition couplings if dissimilar pipe materials.

H. Underground storm drainage force mains NPS 4 and smaller shall be any of the following:

1. Hard copper tube; Type L copper pressure fittings; and soldered joints.
2. Ductile-iron, mechanical-joint piping and mechanical joints.
3. Ductile-iron, push-on-joint piping and push-on joints.
4. Ductile-iron, grooved-joint piping and grooved joints.
5. Fitting-type transition coupling for piping smaller than NPS 1-1/2 and pressure transition coupling for NPS 1-1/2 and larger if dissimilar pipe materials.

I. Underground storm drainage force mains NPS 5 and larger shall be any of the following:

1. Hard copper tube; Type L wrought-copper pressure fittings; and soldered joints.
2. Ductile-iron, mechanical-joint piping and mechanical joints.
3. Pressure transition couplings if dissimilar pipe materials.

END OF SECTION 221413

SECTION 221423 - STORM DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Roof drains – Primary and Secondary.
2. Miscellaneous storm drainage piping specialties
3. Cleanouts.
4. Backwater valves.
5. Trench drains.
6. Channel drainage systems.
7. Through-penetration firestop assemblies.
8. Flashing materials.

1.3 SUBMITTALS

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

1.4 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of the specified testing agency.

PART 2 - PRODUCTS

2.1 METAL ROOF DRAINS

A. Cast-Iron, General-Purpose Roof Drains: Combination Primary Overflow or Primary and Overflow 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. Combination Primary and Secondary (Overflow) Drain: Zurn Z164
4. Standard: ASME A112.6.4, for general-purpose roof drains.
5. Body Material: Cast iron.
6. Dimension of Body;
   a. Small Sump 8”
   b. Medium Sump 8” -12”
   c. Large Sump 14”-16”
7. Combination Flashing Ring and Gravel Stop: Required.
8. Flow control weir; required
9. Outlet: Bottom or Side. Coordinate in the field.
10. Outlet Type: No hub threaded
11. Extension Collars: Required.
12. Underdeck Clamp: Required.
13. Expansion Joint: Required.
14. Sump Receiver Plate: Required.
15. Dome Material: Cast iron.
16. Wire Mesh: Stainless steel or brass over dome.
17. Perforated Gravel Guard: Stainless steel.
18. Vandal-Proof Dome: Required.
19. Water Dam: Not required.

2.2 CLEANOUTS

A. 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. Wade, a subsidiary of McWane Inc.
   d. WATTS.
   e. Zurn Industries, LLC.

2. Standard: ASME A112.36.2M.
3. Size: Same as connected branch.
4. Type: Threaded, adjustable housing.
5. Body or Ferrule: Cast iron.
6. Clamping Device: Required.
7. Outlet Connection: No hub or 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: Nickel-bronze, copper alloy or Polished bronze, Rough bronze for unfinished areas.
11. Frame and Cover Shape: Round.
12. Top Loading Classification: Medium Duty.
13. Riser: ASTM A74, Service class, cast-iron drainage pipe fitting and riser to clean out.

B. 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: 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 Plug:

    a. Brass.
    b. Countersunk or raised head.
    c. Drilled and threaded for cover attachment screw.
    d. Size: Same as, or not more than, one size smaller than the cleanout size.

6. Wall Access, Cover Plate: Round, deep, chrome-plated bronze, flat, or chrome-plated brass or stainless steel cover plate with screw.
7. Wall Access, Frame and Cover: Round, or Square, nickel-bronze, copper-alloy, or stainless steel, or aluminum wall-installation frame and cover.

2.3 Test Tees:

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. Josam Company.
    b. Smith, Jay R. Mfg. Co.
    c. Watts Water Technologies, Inc.
    d. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M and ASTM A 74, ASTM A 888, or CISPI 301, for cleanout test tees.
3. Size: Same as connected drainage piping.

4. Body Material: Hub-and-spigot, cast-iron soil-pipe T-branch or hubless, cast-iron soil-pipe test tee as required to match connected piping.
5. Closure Plug: Countersunk, brass.
6. Closure Plug Size: Same as or not more than one size smaller than the cleanout size.

2.4 BACKWATER VALVES

A. Cast-Iron, Horizontal Backwater Valves:
1. Standard: ASME A112.14.1.
2. Size: Same as connected piping.
3. Body Material: Cast iron.
4. Cover: Cast iron with bolted or threaded access check valve.
5. End Connections: no hub.
6. Check Valve: Removable, bronze, swing check, factory assembled or field modified to hang closed.
7. Extension: ASTM A 74, Service class; full-size, cast-iron soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.

B. Cast-Iron, Drain-Outlet Backwater Valves:
1. Standard: ASME A112.14.1.
2. Size: Same as floor drain outlet.
3. Body Material: Cast iron or bronze made for vertical installation in bottom outlet of floor drain.
4. Check Valve: Removable ball float.
5. Inlet: Threaded.
6. Outlet: Threaded or spigot.

2.5 TRENCH DRAINS

A. Trench Drains:
1. Standard: ASME A112.6.3.
2. Body Material: Cast iron.
3. Flange: Anchor.
4. Clamping Device: Required.
5. Outlet: Bottom, End, or Side coordinate in filed
6. Outlet Type: Inside caulk.
7. Grate Material: Ductile iron cast iron or stainless steel.
8. Grate Finish: brushed stainless steel
9. Dimensions of Frame and Grate: refer to plan and notes.
10. Top-Loading Classification: Extra-Heavy Duty.

2.6 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. ProSet Systems Inc.

2. Standard: ASTM E 814, for through-penetration firestop assemblies.
3. Certification and Listing: Intertek Testing Service NA for through-penetration firestop assemblies.
4. Size: Same as connected pipe.
5. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
6. Stack Fitting: ASTM A 48/A 48M, gray-iron, hubless-pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include a PVC protective cap for the plug.
7. Special Coating: Corrosion-resistant on the interior of fittings.

2.7 FLASHING MATERIALS

A. Copper Sheet: ASTM B 152/B 152M, 12 oz./sq. ft..

B. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.

C. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.

D. Fasteners: Metal compatible with material and substrate being fastened.

E. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

F. Solder: ASTM B 32, lead-free alloy.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions. Roofing materials are specified in Division 07 Sections.

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. Position roof drains for easy access and maintenance.

B. Install cleanouts in aboveground piping and building drain piping according to the following instructions unless otherwise indicated:

1. Use cleanouts the same size as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate cleanouts at each change in direction of piping greater than 45 degrees.
3. Locate cleanouts at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
4. Locate cleanouts at the base of each vertical soil and waste stack.

C. For floor cleanouts for piping below floors, install cleanout deck plates with the top flush with the finished floor.

D. For cleanouts located in concealed piping, install cleanout wall access covers of the types indicated, with frame and cover flush with finished wall.

E. Install test tees in vertical conductors and near the floor.

F. Install wall cleanouts in vertical conductors. Install an access door in the wall if indicated.

G. Install through-penetration firestop assemblies in plastic conductors at concrete floor penetrations.

H. Install sleeve flashing device with each conductor passing through floors with a waterproof membrane.

I. Install through-penetration firestop assemblies for penetrations of fire- and smoke-rated assemblies.

1. Comply with requirements in Section 078413 "Penetration Firestopping."

J. All valves, fittings, and specialties shall have a pressure class rating that exceeds the pressure of the system it is installed.

3.2 CONNECTIONS

A. Comply with requirements for piping specified in Division 22 Sections. Drawings indicate the general arrangement of piping, fittings, and specialties.

3.3 FLASHING INSTALLATION

A. Fabricate flashing from a single piece of metal unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:

1. Lead Sheets: Burn joints of 6.0-lb/sq. ft. lead sheets, 0.0938-inch thickness or thicker. Solder joints of 4.0-lb/sq. ft. lead sheets, 0.0625-inch thickness or thinner.
2. Copper Sheets: Solder joints of copper sheets.

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with a waterproof membrane.

1. Pipe Flashing: Sleeve type, matching the pipe size, with a minimum length of 10 inches and with a skirt or flange extending at least 8 inches around the pipe.
2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around the specialty.

C. Set flashing on roofs in a solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

E. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 PROTECTION

A. Protect drains during the remainder of the construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in the ends of uncompleted piping at the end of each day or when work stops.

END OF SECTION 221423

SECTION 221429 - SUMP PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Submersible sump pumps.
2. Sump-pump basin covers.
3. Elevator Oil Minder Sump Pump.

B. Related Section:

1.3 SUBMITTALS

A. Product Data: For each type of pump, motor, control panel, and basin cover. Include construction details, material descriptions, dimensions of individual components, and profiles. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Wiring Diagrams: For power, signal, and control wiring.

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

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with the pump manufacturer's written rigging instructions for handling.

PART 2 - PRODUCTS

2.1 SUBMERSIBLE SUMP PUMPS

A. Submersible, Fixed-Position, Single-Seal Sump Pumps:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

    a. Federal Pumps
    b. Bell & Gossett Domestic Pump; ITT Corporation.
    c. Goulds Pumps; ITT Corporation.
    d. Grundfos Pumps Corp.
    e. Liberty Pumps.
    f. Stancor, Inc.

2. Description: Factory-assembled and -tested sump-pump unit.
3. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sump pump as defined in HI 1.1-1.2 and HI 1.3.
4. Pump Casing: Cast iron, with a strainer inlet, legs that elevate the pump to permit flow into the impeller, and vertical discharge for piping connection.
5. Seal: Mechanical.
6. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
7. A nameplate showing the serial number, discharge GPM, and Head of each pump shall be attached to the respective pump. The necessary wiring and controlling devices will be furnished and installed completely under the Electrical Division, unless otherwise specified.
8. Controls:

    a. Duplex Sump pump shall be controlled by a pedestal-mounted float switch with built-in alternator, Square D Company Class 9038 type AW-1 in a NEMA Type 4 watertight and dust-tight enclosure that is actuated by a minimum 7" stainless steel ball float and stainless steel rod guided above and below the floor plate of the pump.
    b. Provide a high-water alarm consisting of an auxiliary pedestal-mounted single-pole float switch equipped with a pedestal guide, gas-tight stainless-steel rod, and a minimum 7" stainless steel ball float. Should the high-water alarm be activated, a warning signal shall be delivered to the Indicator Panel. With an electric bell, 120-V ac, with transformer and contacts for a remote alarm bell.

c. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
d. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches.

9. Control-Interface Features:

a. Remote Alarm Contacts: For the remote alarm interface.
b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:

1) On-off status of the pump.
2) Alarm status.

2.2 SUMP PUMP CAPACITIES AND CHARACTERISTICS

1. Refer to Drawing P-001 for unit specifications and capacities.

2.3 SUMP-PUMP BASIN COVERS

A. Angle frame and sump pit cover plate shall be provided and installed by the Plumbing Contractor. The Contractor shall coordinate the sump pit cover with the pump supplier such that it has all required openings for pumps and piping with openings having gaskets, seals, and bushings, such as: 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.

2.4 SUMP PUMP (ELEVATOR PIT)

A. Provide a Stancor pump in the elevator pit. Refer to Drawing P-001 for pump specifications and capacities.

B. Provide a check valve on the pump discharge. Provide 5 ft. extra cable rolled and clamped to allow for the removal of the pump from the pit. Provide a local disconnect switch and pump control panel where indicated on the drawings.

C. Pump Casing: Cast iron, with a strainer inlet, legs that elevate the pump to permit flow into the impeller, and vertical discharge for piping connection.

D. Seal: Mechanical.

E. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.

F. A nameplate showing the serial number, discharge GPM, and Head of each pump shall be attached to the respective pump. The necessary wiring devices will be furnished and installed completely under the Electrical Division, unless otherwise specified.

G. Controls:
1. Simplex sump pump shall be controlled by a pedestal-mounted float switch that is actuated by a minimum 7" stainless steel ball float and stainless steel rod guided above and below the floor plate of the pump. Or a cable-mounted float for on off.
2. Provide a high-water alarm consisting of an auxiliary pedestal-mounted single-pole float switch, equipped with a pedestal guide (or cable-mounted float), a gas-tight stainless steel rod, and a minimum 7" stainless steel ball float. Should the high water alarm be activated, a warning signal shall be delivered to the Indicator Panel. With an electric bell, 120-V ac, with transformer and contacts for a remote alarm bell. The contacts shall be wired to the building BMS. Upon contact closure, an alarm signal shall be initiated on the BMS, which indicates high water and which elevator pit is being served. (i.e.. Main elevator bank or sidewalk elevator)

3. Switch Type: float switch with float rods and rod buttons. Or cable-mounted.
4. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches.
5. Control Panel CB 1000;
   a. Pumps serving non-hydraulic elevators shall have pump control panels that are NEMA 4x suitable for pump control with optional dry remote alarm contacts for high water alarm.
   b. Stanmore model CB 1000. With the pump running, light, high-level alarm, test, and silence the bottom and H-O-A selector switch.
   c. Pumps serving hydraulic elevators shall have a NEMA 4x control panel 4x suitable for pump control with (2) optional dry remote alarm contacts for high water alarm and oil alarm. Provide a stainless-steel discriminating oil detector.
   d. Panel and pump system shall be Stancore oil minder model OM-50SR- ELV , with reset button, silence button, and RMS connector.
   e. Provide a local disconnect switch for all pump systems.

2.5 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 22 Section "Common Motor Requirements for Plumbing Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require the motor to operate in a service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.

B. Motors for submersible pumps shall be hermetically sealed.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavation and filling are specified in Division 31, Section "Earth Moving."

3.2 EXAMINATION

A. Examine roughing-in for plumbing piping to verify actual locations of storm drainage piping connections before sump pump installation.

3.3 INSTALLATION

A. Pump Installation Standards: Comply with HI 1.4 for installation of sump pumps.

B. The Contractor shall have the pump supplier verify the depth of each sump pit so that the proper length of shaft shall be supplied.

3.4 CONNECTIONS

A. Comply with requirements for piping specified in Division 22 Section "Facility Storm Drainage Piping." Drawings indicate the general arrangement of piping, fittings, and specialties.

B. Make all required connections of pumps to the piping systems. Use flexible connectors to connect pumps to piping.

C. Install piping adjacent to equipment to allow service and maintenance.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection.
2. Leak Test: After installation, charge the 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.

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

D. Prepare test and inspection reports.

3.6 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks according to the manufacturer's written instructions.

3.7 ADJUSTING

A. Adjust pumps to function smoothly, and lubricate as recommended by the manufacturer.

B. Adjust control set points.

3.8 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain controls and pumps.

END OF SECTION 221429

SECTION 223400 - FUEL-FIRED, DOMESTIC-WATER HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

1.3 ACTION SUBMITTALS

A. Product Data: For each type and size of domestic water heater indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings:

   1. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of domestic water heater, from the manufacturer.

B. Domestic Water Heater Labeling: Certified and labeled by a testing agency acceptable to authorities having jurisdiction.

C. Source quality-control reports.

D. Field quality-control reports.

E. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

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

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE/IESNA Compliance: Fabricate and label fuel-fired, domestic water heaters to comply with ASHRAE/IESNA 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 Annex G, "Drinking Water System Components - Health Effects."

1.7 COORDINATION

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

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which the manufacturer agrees to repair or replace components of fuel-fired, domestic water heaters that fail in materials or workmanship within the 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 the date of Substantial Completion.

a. Commercial, Gas- and Oil-Fired, Domestic-Water Heaters:

1) Storage Tank: 10 years.
2) Burner: 5 year(s).
3) Controls and Other Components: 5 years.

b. Compression Tanks: Five years.

PART 2 - PRODUCTS

2.1 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. A. O. Smith Corporation.
   b. Bradford White Corporation.
   c. PVI; A WATTS Brand.
   d. Rheem Manufacturing Company.
   e. State Industries.

2. Standard: ANSI Z21.10.3/CSA 4.3.
3. Description: Manufacturer's proprietary design to provide at least 94 percent combustion efficiency at optimum operating conditions.
4. Storage-Tank Construction: ASME-code steel with 150-psig minimum working-pressure rating.

   a. Tappings: Factory-fabricated of materials compatible with the tank. Attach tapings to the tank before testing.

      1) NPS 2 and Smaller: Threaded ends according to ASME B1.20.1.
      2) NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.

   b. Interior Finish: Comply with NSF 61 Annex G barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
   c. Lining: Cement, Glass, Nickel plate, Phenolic coating, Sheet copper. complying with NSF 61 Annex G barrier materials for potable-water tank linings, including extending lining into and through tank fittings and outlets.

5. Factory-Installed Storage-Tank Appurtenances:

   a. Anode Rod: Replaceable magnesium.
   b. Dip Tube: Required unless cold-water inlet is near the bottom of tank.
   c. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
   d. Insulation: Comply with ASHRAE/IESNA 90.1. Surround the 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, direct vent 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-M. Include one or more relief valves with a total relieving capacity at least as great as the heat input, and include a pressure setting less than the domestic-water heater working-pressure rating. Select one relief valve with a sensing element that extends into the storage tank.

B. Capacity and Characteristics: refer to plans and schedules

2.2 DOMESTIC-WATER HEATER ACCESSORIES

A. Domestic-Water Compression Tanks:

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

a. A. O. Smith Corporation.
b. AMTROL, Inc.
c. Honeywell.
d. Pentair Pump Group.
e. State Industries.
f. TACO Comfort Solutions, Inc.

2. Description: Steel, pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air recharge to the minimum system-operating pressure at the tank.

3. Construction:

a. Tappings: Factory-fabricated steel, welded to the tank before testing and labeling. Include ASME B1.20.1 pipe thread.
b. Interior Finish: Comply with NSF 61 Annex G barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
c. Air-Charging Valve: Factory installed.

4. Capacity and Characteristics:

a. Working-Pressure Rating: 150 psig.
b. Capacity Acceptable: as specified on the plan, but not more than 5 gallons.
c. Air Precharge Pressure: 15.

B. Drain Pans: Corrosion-resistant metal with raised edge. Comply with ANSI/CSA LC 3. Include dimensions not less than the base of the domestic water heater, and include a

drain outlet not less than NPS 3/4 with ASME B1.20.1 pipe threads or with ASME B1.20.7 garden-hose threads.

C. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1.

D. Heat-Trap Fittings: ASHRAE 90.2.

E. Manifold Kits: Domestic water heater manufacturer's factory-fabricated inlet and outlet piping for field installation, for multiple domestic water heater installations. Include ball-, butterfly-, or gate-type shutoff valves to isolate each domestic water heater and calibrated or memory-stop balancing valves to provide balanced flow through each domestic water heater.

F. Comply with 220523 General Duty Valves for Plumbing for valve requirements.

G. Comply with requirements for balancing valves specified in Section 221119 "Domestic Water Piping Specialties."

H. Gas Shutoff Valves: ANSI Z21.15/CSA 9.1-M, manually operated. Furnish for installation in piping.

I. Gas Pressure Regulators: ANSI Z21.18/CSA 6.3, appliance type. Include 1/2-psig pressure rating as required to match gas supply.

J. Automatic Gas Valves: ANSI Z21.21/CSA 6.5, appliance, electrically operated, on-off automatic valve.

K. Combination Temperature-and-Pressure Relief Valves: Include relieving capacity at least as great as the heat input and include a pressure setting less than the domestic-water heater working-pressure rating. Select relief valves with a sensing element that extends into the storage tank.

1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4-M.

L. Pressure Relief Valves: Include pressure setting less than the domestic water heater working-pressure rating.

1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4-M.

M. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4-M.

N. Domestic Water Heater Stands: Manufacturer's factory-fabricated steel stand for floor mounting, capable of supporting a domestic water heater and water. Provide a dimension that will support the bottom of the domestic water heater, a minimum of 18 inches above the floor.

O. Domestic-Water Heater Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting a domestic water heater and water.

2.3 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect assembled domestic water heaters and storage tanks specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.

B. Hydrostatically test commercial domestic water heaters and storage tanks to a minimum of one and one-half times the pressure rating before shipment.

C. Domestic water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 014000 "Quality Requirements" for retesting and reinspecting requirements and Section 017300 "Execution" for requirements for correcting the Work.

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 a concrete base. Comply with requirements for concrete base specified in Section 033053 "Miscellaneous Cast-in-Place Concrete."

1. Exception: Omit concrete bases for commercial domestic water heaters if installation on a stand, bracket, suspended platform, or directly on the floor is indicated.
2. Maintain manufacturer's recommended clearances.
3. Arrange units so that controls and devices that require servicing are accessible.
4. Install dowel rods to connect the concrete base to the concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the concrete base.
5. For supported equipment, install epoxy-coated anchor bolts that extend through the concrete base and anchor into the structural concrete floor.
6. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
7. Install anchor bolts to elevations required for proper attachment to supported equipment.
8. Anchor domestic water heaters to the substrate.

B. Install domestic water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff

valves specified in Section 220523 General Duty Valves For Plumbing Piping. Install gas-fired, domestic water heaters according to NFPA 54.

2. Install gas shutoff valves on gas supply piping to gas-fired, domestic water heaters without shutoff valves.
3. 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 the gas pressure at the burner.
4. Install automatic gas valves on gas supplies to gas-fired, domestic water heaters if required for the operation of safety control.

C. Comply with requirements for gas shutoff valves, gas pressure regulators, and automatic gas valves specified in Section 231123 "Facility Natural-Gas Piping."

D. Install commercial domestic water heaters with seismic-restraint devices. Comply with requirements for seismic-restraint devices.

E. Install combination temperature-and-pressure relief valves in the top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend the commercial water heater relief valve outlet, with drain piping same as domestic water piping in continuous downward pitch, and discharge by positive air gap onto the closest floor drain.

F. Install combination temperature-and-pressure relief valves in water piping for domestic water heaters without storage. Extend the commercial water heater relief valve outlet, with drain piping same as domestic water piping in continuous downward pitch, and discharge by positive air gap onto the closest floor drain.

G. Install water-heater drain piping as indirect waste to spill by a positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for domestic water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Section 221119 "Domestic Water Piping Specialties."

H. Install thermometer on outlet piping of domestic water heaters. Comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."

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 a shutoff valve and thermometer in each domestic water heater inlet and outlet, and a throttling valve in each domestic water heater outlet. Comply with requirements for valves specified in Section 220523 General Duty Valves For Plumbing Piping.

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 compression tanks with air.

3.2 CONNECTIONS

A. Comply with requirements for domestic water piping specified in Section 221116 "Domestic Water Piping."

B. Comply with requirements for gas piping specified in Section 231123 "Facility Natural-Gas Piping."

C. Drawings indicate the general arrangement of piping, fittings, and specialties.

D. Where installing piping adjacent to fuel-fired, domestic water heaters allows space for service and maintenance of water heaters. Arrange piping for easy removal of domestic water heaters.

3.3 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
2. Leak Test: After installation, charge the system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Domestic water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 014000 "Quality Requirements" for retesting and reinspecting requirements and Section 017300 "Execution" for requirements for correcting the Work.

C. Prepare test and inspection reports.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train the Owner's maintenance personnel to adjust, operate, and maintain domestic water heaters.

END OF SECTION 223400

SECTION 224213.13 - COMMERCIAL WATER CLOSETS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Wall-mounted water closets. - Back outlet.
   2. Flushometer valves.
   3. Toilet seats.
   4. Supports.

B. Related Requirements:

   1. Section 221316 "Sanitary waste and vent piping”
   2. Section 221319 "Sanitary Waste and Vent Piping specialties.”

1.3 DEFINITIONS

A. Effective Flush Volume: Average of two reduced flushes and one full flush per fixture.

B. Remote Water Closet: Located more than 30 feet from other drain line connections or fixture and where less than 1.5 drainage fixture units are upstream of the drain line connection.

1.4 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 water closets.
   2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

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

1.5 CLOSEOUT SUBMITTALS

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

1.6 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 six of each type.

PART 2 - PRODUCTS

2.1 FLOOR-MOUNTED WATER CLOSETS

A. Water Closets, Wall Mounted, Top Spud, Accessible P-1:

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

a. American Standard.
b. Crane Plumbing, L.L.C.
c. Kohler Co.
d. Sloan Valve Company.
e. Zurn Industries, LLC.

2. Bowl:

a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
b. Material: Vitreous china.
c. Type: Siphon jet.
d. Style: Flushometer valve.
e. Height: Standard.
f. Rim Contour: Elongated.
g. Water Consumption: 1.28 gal. per flush.
h. Spud Size and Location: NPS 1-1/2; top.

3. Flushometer Valve: K-10TD00N10, ADA compliant
4. Toilet Seat: split front - oval
5. Support: Water closet carrier.
6. Water-Closet Mounting Height: Standard height 15” and Handicapped/elderly according to ICC/ANSI A117.1. where indicated on architectural plans.

B. Flush Valve:
1. Flushometer Valve: Kohler model K-10TD00N10, ADA compliant
2. Factory-Installed Battery
3. "Hands free" operation.
4. 24-hour automatic sentinel flush to keep trapway fresh
5. Fully Mechanical Manual Override Button can flush the valve without power
6. Fail-Safe: Valve automatically closes upon loss of power or water pressure and does not need to be reset
7. Adjustable Sanitary Flush cleans the fixture & maintains the trap seal.
8. Chemical Resistant EPDM Seals for extended life
9. Adjustable Tailpiece for rough-in flexibility

10. Can be installed left or right-handed – coordinate in field

2.2 TOILET SEATS

A. Toilet Seats P-1:

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. Zurn Industries, LLC.

2. Standard: IAPMO/ANSI Z124.5.
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.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before water-closet installation.

B. Examine walls and floors for suitable conditions where water closets will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Water-Closet Installation:

1. Install level and plumb according to roughing-in drawings.
2. Install floor-mounted water closets on bowl-to-drain connecting fitting attachments to piping or building substrate.
3. Install accessible, wall-mounted water closets at mounting height for handicapped/elderly, according to ICC/ANSI A117.1.

B. Support Installation:

1. Install supports, affixed to building substrate, for floor-mounted, back-outlet water closets.
2. Use carrier supports with waste-fitting assembly and seal.

3. Install floor-mounted, back-outlet water closets attached to building floor substrate, onto waste-fitting seals; and attach to support.
4. Install wall-mounted, back-outlet water-closet supports with waste-fitting assembly and waste-fitting seals; and affix to building substrate.

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 that are easy for people with disabilities to reach.
5. Install fresh 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 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.

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 fresh 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

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 Cartridges: Equal to 200 percent of amount of each type installed, but no fewer than 12 of each type.
   3. Waterless Urinal Trap-Seal Liquid: Equal to 1 gal. for each urinal installed.

PART 2 - PRODUCTS

2.1 WALL-HUNG URINALS (P-3)

A. Urinals, Square Wall Hung, Back Outlet, Washout

B. Basis of design: American Standard Washbrook, Flowise High efficiency Urinal model with Sloan Flush valve model 8186-1.

C. Manufacturers: Subject to compliance with project requirements, and review and approval by the Engineer provide a comparable product by one of the following:

a. American Standard.
b. Kohler Co.
c. Zurn Industries, LLC.

1. Fixture:
   a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
   b. Material: Vitreous china.
   c. Type: Washout
   d. Strainer or Trapway: with integral trap.
   e. Water Consumption: .5 gpf - 1.0 gpf
   f. Inlet spud Size and Location: NPS 3/4, top.
   g. Outlet Size and Location: NPS 2, back.
   h. Flushing rim
   i. Washout flush action
   j. Meets ASME flush requirements at 0.125 to 1.0 gpf
   k. Color: White.
   l. Mounting height up to 24”. 17” where ADA required.

2. Flushometer Valve: Kohler flush valve K-10UD00G20
   a. Adjustable tailpiece
   b. Chemical resistant EPDM seals are unaffected by chloramines and ammonia.
   c. Valve remains closed and does not need to be reset after loss of power or water pressure.
   d. Fully Mechanical Manual Override Button can flush during a power outage.
   e. Sensor & electronic controls are fully enclosed and water resistant.
   f. Range can be adjusted manually.
   g. Sanitary Flush - Valve automatically flushes after 24 hours of non-use to clean fixture & maintain trap seal.
   h. No external volume adjustment.
   i. 5 second Arming Delay prevents unintentional flushing.
   j. 3-second Flush Delay.
   k. Can be installed left or right-handed.
   l. Operating pressure: 20 psi (flowing) – 80 psi (static)

3. Waste Fitting:

a. Standard: ASME A112.18.2/CSA B125.2 for coupling.
b. Size: NPS 3.

4. Support: Zurn model Z1221 Wall urinal support system with top support plate. Complete with Dura-Coated rectangular steel uprights with welded feet, adjustable support plate, and mounting fasteners.

5. Urinal Mounting Height: Standard and Handicapped/elderly according to ICC A117.1. refer to architectural plans for locations and heights.

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 roughing-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/ANSI 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 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 RELATED DOCUMENTS

A. Drawings 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. Vitreous China Lavatories.
2. Faucets.
3. Supply fittings.
4. Waste fittings.
5. 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 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.

1.4 INFORMATIONAL SUBMITTALS

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

1.5 CLOSEOUT SUBMITTALS

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

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Servicing and adjustments of automatic faucets.

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.
2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.

PART 2 - PRODUCTS

VITREOUS-CHINA, UNDERMOUNTED LAVATORIES (P-2)

Lavatory: Ledge back, vitreous china, wall mounted.

Basis of design; Kohler – K21058

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. American Standard.
   b. Kohler Co.
   c. Peerless Pottery Sales, Inc.
   d. Sloan Valve Company.

2. Fixture:
   a. Standard: ASME A112.19.2/CSA B45.1.
   b. Type: For undermount.
   c. Nominal Size: Rectangular, 21-1/4” by 16 inches
   d. Color: White.

3. Faucet: Solid-Brass, polished chrome finish, 1.2 gpm flow rate

1. Support: Type II, concealed-arm lavatory carrier with escutcheons.

2. Lavatory Mounting Height: Standard.

3.2 SOLID-BRASS, MANUALLY OPERATED LAVATORY FAUCETS (P-2)

A. NSF Standard: Comply with NSF 372 for faucet materials that will be in contact with potable water.

B. Lavatory Faucets (P-2): Single Handle, mixing, solid-brass valve.
   1. Basis of Design Manufacturer/Model: Kohler K-23472-4

2. Standards: ASME A112.18.1/CSA B125.1 and UL 1951.
3. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.
4. Body Type: Single hole.
5. Body Material: Commercial, solid brass.
6. Finish: Polished chrome plate.
7. Maximum Flow Rate: 1.2 gpm.
8. Mounting Type: Deck, concealed.
9. Drain: Not part of faucet.

3.3 SUPPLY FITTINGS

A. NSF Standard: Comply with 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: Wheel handle.

F. Risers:

1. NPS 1/2.
2. ASME A112.18.6, braided- or corrugated-stainless-steel, flexible hose riser.

3.4 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 1-1/4.
2. Material: 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.
3. Material: Stainless-steel, two-piece trap and swivel elbow with 0.012-inch-thick stainless-steel tube to wall; and stainless-steel wall flange.

3.5 SUPPORTS

A. Type II Lavatory Carrier:

1. Standard: ASME A112.6.1M.

B. Type III Lavatory Carrier:

1. Standard: ASME A112.6.1M.

3.6 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Engineered Brass Co.
   b. Insul-Tect Products Co.; a Subsidiary of MVG Molded Products.
   c. McGuire Manufacturing Co., Inc.
   d. Plumberex Specialty Products Inc.
   e. TCI Products.
   f. TRUEBRO, Inc.
   g. Zurn Plumbing Products Group; Tubular Brass Plumbing Products Operation.

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, provide products by one of the following:
   a. TRUEBRO, Inc.

2. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

PART 4 - EXECUTION

4.1 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.

4.2 INSTALLATION

A. Install lavatories level and plumb according to roughing-in drawings.

B. Install supports, affixed to building substrate, for wall-mounted lavatories.

C. Install accessible wall-mounted lavatories at handicapped/elderly mounting height for people with disabilities or the elderly, according to ICC/ANSI A117.1.

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

E. Seal joints between lavatories, counters, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

F. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

4.3 CONNECTIONS

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

B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

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

4.4 ADJUSTING

A. Operate and adjust lavatories and controls. Replace damaged and malfunctioning lavatories, fittings, and controls.

B. Adjust water pressure at faucets to produce proper flow.

C. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

4.5 CLEANING AND PROTECTION

A. After completing installation of lavatories, inspect and repair damaged finishes.

B. Clean lavatories, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.

C. Provide protective covering for installed lavatories and fittings.

D. Do not allow use of lavatories for temporary facilities unless approved in writing by Owner.

END OF SECTION 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 basins.
2. Utility sinks.
3. Handwash sinks.
4. Laminar-flow, faucet-spout outlets.
5. Supports.

B. Related Requirements:

1. Section 224100 "Residential Plumbing Fixtures" for residential sinks.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

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

B. Sustainable Design Submittals:

1. Product Data: For water consumption.

1.4 INFORMATIONAL SUBMITTALS

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

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For sinks to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. 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 SERVICE BASINS

A. Service Basins P-6: Terrazzo, floor mounted.

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

a. Fiat Products
b. Acorn Engineering Company; a Division of Morris Group International.
c. Florestone Products Co., Inc.
d. Stern-Williams Co., Inc.

2. Fixture:

a. Standard: IAPMO PS 99.
b. Shape: Square Five sided.
c. Nominal Size: 36 by 36 inches.
d. Height: 12 inches with dropped front.
e. Tiling Flange: On two sides.
f. Rim Guard: On front top surfaces.
g. Color: Not applicable.
h. Drain: Grid with NPS 3 outlet.

3. Mounting: On floor and flush to wall.
4. Faucet: Speakman commander SC-5811, cast brass, polished chrome, with hose and pail hook and wall brace.
   a. Integral stops.
   b. ¾” treaded end connection
   c. Brass top brace assembly
   d. Adjustable treaded brass wall flanges.
5. Optional components:
   a. Mop service basin fitting
   b. 5’ Hose and hose wall bracket
   c. Wall guards
   d. Pail hook and wall brace

e. Check valve in swivel assembly.
f. 5-year warranty

2.2 UTILITY SINKS

A. Utility Sinks P4&P4A: Stainless steel, counter mounted.

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

a. Elkay Manufacturing Co.
b. Griffin Products, Inc.
c. Just Manufacturing.
d. Kohler Co.

2. Fixture:

a. Standard: ASME A112.19.3/CSA B45.4.
b. Type: Ledge back.
c. Number of Compartments: One.
d. Overall Dimensions: 27”x18”x9” deep (27”x18”x6” ADA)
e. Metal /Thickness: stainless / 18 gauge
f. Compartment:
1) Drain: Grid 3 ½” with NPS 1 1/2 tailpiece
2) Drain Location: rear-centered in compartment
g. Mounting: countertop – undermount

3. 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: Wheel handle.
2) Risers: NPS 1/2 ASME A112.18.6, braided or corrugated stainless-steel flexible hose.

4. Waste Fittings:

a. Standard: ASME A112.18.2/CSA B125.2.
b. Trap(s):

1) Size: NPS 1 ½”
2) Material: Chrome-plated, two-piece, cast-brass trap and swivel elbow with 0.032-inch- thick brass tube to wall; and chrome-plated brass or wall flange.

5. Faucet:
a. Kohler model K-22034, Arc spout lever handle ADA compliant, 1.5 max flow rate with ceramic disk valves.

b. 1 hole
c. 13” height
d. Quarter turn ceramic disc valves
e. Facet hole 1- ¼”
f. 360 swivel

B. Utility Sinks P5: Stainless steel, freestanding

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

a. Elkay Manufacturing Co.
b. Griffin Products, Inc.
c. Just Manufacturing.

2. Fixture:

a. Standard: ASME A112.19.3/CSA B45.4.
b. Type: Ledge back.
c. Number of Compartments: One.
d. Overall Dimensions: 16”x20”x14” deep
e. Metal /Thickness: 300 series stainless / 18 gauge
f. Compartment:
1) Drain: Grid 3 ½” with NPS 1 1/2 tailpiece and twist drain
2) Drain Location: Centered in compartment
g. Mounting: stainless steel legs

3. 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: Wheel handle.
2) Risers: NPS 1/2 ASME A112.18.6, braided or corrugated stainless-steel flexible hose.

4. Waste Fittings:

a. Standard: ASME A112.18.2/CSA B125.2.
b. Trap(s):

1) Size: NPS 2”
2) Material: Chrome-plated, two-piece, cast-brass trap and swivel elbow with 0.032-inch- thick brass tube to wall; and chrome-plated brass or wall flange.

5. Faucet:
a. Elkay model LK940GN05T4S, Arc spout 2-5/8” lever handles ADA compliant, 1.5 max flow rate with ceramic disk valves.

b. 2 hole
c. 11” height
d. Quarter turn ceramic disc valves

6. Accessories:
   a. LK940GN05T4S faucet
   b. LK35 strainer
   c. LK8 drain fitting

2.3 HANDWASH SINKS

A. Handwash Sinks P-6: Stainless steel, counter mounted.

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

   a. AERO Manufacturing Company.
   b. Elkay Manufacturing Co.
   c. Sloan Valve Company.

2. Fixture: Elkay model ECTSRAD25226TBG

   a. Standards: ASME A112.19.3/CSA B45.4 and NSF/ANSI 2.
   b. Type: Basin with rounded corners
   c. Nominal Size: 25” x 22” x 6”
   d. Drain: 3 ½”
   e. Material; 14 gauge stainless steel.

3. Faucet: deck mounted faucet model LK3000CR
   a. Remote Level Handle
   b. Faucet height: 11-1/2”
   c. 360 rotation

4. 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: Wheel handle.
      2) Risers: NPS 1/2, ASME A112.18.6, braided or corrugated stainless-steel flexible hose.
      3) Mechanical mixing valve

5. Waste Fittings:

   a. Standard: ASME A112.18.2/CSA B125.2.
   b. Trap:

      1) Size: NPS 2.

2) Material: Chrome-plated, two-piece, cast-brass trap and swivel elbow with 0.032-inch-thick brass tube to wall; and chrome-plated brass or steel wall flange.

6. Support: Type II sink carrier.
7. Mounting Height: as per plan.

2.4 LAMINAR-FLOW, FAUCET-SPOUT OUTLETS

A. NSF Standard: Comply with NSF 372 for faucet-spout-outlet materials that will be in contact with potable water.

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

1. AM Conservation Group, Inc.
2. Chronomite Laboratories, Inc; a division of Morris Group International.
3. NEOPERL, Inc.
4. T&S Brass and Bronze Works, Inc.

C. Description: Chrome-plated brass, faucet-spout outlet that produces non-aerating, laminar stream. Include external or internal thread that mates with faucet outlet for attachment to faucets where indicated and flow-rate range that includes flow of faucet.

2.5 SUPPORTS

A. Type II Sink 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 Drains.
d. WATTS.
e. Zurn Industries, LLC.

2. Standard: ASME A112.6.1M.

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.

2.7 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers:

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

a. Engineered Brass Co.
b. Insul-Tect Products Co.; a Subsidiary of MVG Molded Products.
c. McGuire Manufacturing Co., Inc.
d. Plumberex Specialty Products Inc.
e. TCI Products.
f. TRUEBRO, Inc.
g. Zurn Plumbing Products Group; Tubular Brass Plumbing Products Operation.

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, provide products by one of the following:

a. TRUEBRO, Inc.

2.8 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 roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before sink installation.

B. Examine walls, floors, and counters for suitable conditions where sinks will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install sinks level and plumb according to roughing-in drawings.

B. Install supports, affixed to building substrate, for wall-hung sinks.

C. Install accessible wall-mounted sinks at handicapped/elderly mounting height according to ICC/ANSI A117.1.

D. Set floor-mounted sinks in leveling bed of cement grout.

E. Install water-supply piping with stop on each supply to each sink faucet.

1. Exception: Use ball valves if supply stops are not specified with sink.
2. Install stops in locations where they can be easily reached for operation.

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

G. Seal joints between sinks and counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

H. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

I. Provide protective shield guard for art room sinks and all Lavatories.

J. Install clay / solids interceptors at all art room utility sinks.

3.3 CONNECTIONS

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

B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

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

3.4 ADJUSTING

A. Operate and adjust sinks and controls. Replace damaged and malfunctioning sinks, fittings, and controls.

B. Adjust water pressure at faucets to produce proper flow.

3.5 CLEANING AND PROTECTION

A. After completing installation of sinks, inspect and repair damaged finishes.

B. Clean sinks, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.

C. Provide protective covering for installed sinks and fittings.

D. Do not allow use of sinks for temporary facilities unless approved in writing by Owner.

END OF SECTION 224216.16

SECTION 224716 - PRESSURE WATER COOLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes pressure water coolers and related components.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of pressure water cooler.

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

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

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For pressure water coolers to include in maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filter Cartridges: Equal to 10 percent of the quantity installed for each type and size indicated, but no fewer than 5 of each.

PART 2 - PRODUCTS

2.1 PRESSURE WATER COOLERS

A. Pressure Water Coolers (P-X) Wall-mounted, standard, bottle filler, vandal-resistant.

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

    a. Elkay Manufacturing Co.
    b. Halsey Taylor.
    c. Haws Corporation.
    d. Larco Inc.
    e. Oasis International.

2. Standards:

    a. Comply with NSF 61 and NSF 372.
    b. Comply with ASHRAE 34, "Designation and Safety Classification of Refrigerants," for water coolers. Provide HFC 134a (tetrafluoroethene) refrigerant unless otherwise indicated.
    c. Comply with ICC A117.1.

3. Cabinet: fully recessed with bi-level drinking fountains all stainless steel.
4. Bubbler: two, with adjustable stream regulator, located on each cabinet deck.
5. Control: Push button
6. Bottle Filler: Push-button activation with 20-second automatic shutoff timer. Fill rate 0.5 to 1.5 gpm.
7. Drain: Grid with NPS 1-1/4 tailpiece.
8. Supply: NPS 3/8 with shutoff valve.
9. Waste Fitting: ASME A112.18.2/CSA B125.2, NPS 1-1/4 brass P-trap.
10. Filter: One or more water filters complying with NSF 42 and NSF 53 for cyst and lead reduction to below EPA standards, with capacity sized for the unit peak flow rate.
11. 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.

    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.

12. Capacities and Characteristics:

    a. Cooled Water: 5 gph.

b. Ambient-Air Temperature: 90 deg F.
c. Inlet-Water Temperature: 80 deg F.
d. Cooled-Water Temperature: 50 deg F.
e. Cooled-Water Storage: .
f. Electrical Characteristics: refer to drawing schedule

13. Support: Type I Water or Cooler Carrier, Type II Water Cooler Carrier as recommended by the manufacturer.
14. Water Cooler Mounting Height: Standard.

B. Bottle Filling Station

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

a. Elkay Manufacturing Co.
b. Halsey Taylor.
c. Haws Corporation.
d. Oasis International.

2. Standards:

a. Comply with NSF 61 and NSF 372.
b. Comply with ASHRAE 34, "Designation and Safety Classification of Refrigerants," for water coolers. Provide HFC 134a (tetrafluoroethene) refrigerant unless otherwise indicated.
c. Comply with ICC A117.1.

3. Cabinet: All stainless steel.
4. Bottle filler: Push button activation with 20-second automatic shut-off timer. Fill rate 0.5 to 1.5 gpm.
5. Drain: Grid with NPS 1-1/4 tailpiece.
6. Supply: NPS 3/8 with shutoff valve.
7. Waste Fitting: ASME A112.18.2/CSA B125.2, NPS 1-1/4 brass P-trap.
8. Filter: One or more water filters complying with NSF 42 and NSF 53 for cyst and lead reduction to below EPA standards, with capacity sized for the unit peak flow rate.
9. 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.

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.

10. Capacities and Characteristics:

a. Cooled Water: 5 gph.
b. Ambient-Air Temperature: 90 deg F.
c. Inlet-Water Temperature: 80 deg F.
d. Cooled-Water Temperature: 50 deg F.
e. Cooled-Water Storage: standard.
f. Electrical Characteristics: as per drawing schedules

11. Ventilation Grille: Stainless steel.
12. Support: Mounting frame for attaching to substrate.
13. Bottle Filling Station Mounting Height: Standard.

2.2 SUPPORTS

A. Type I 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. WATTS.
d. Zurn Industries, LLC.

2. Standard: ASME A112.6.1M.

B. Type II 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. WATTS.
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 the height required by authorities having jurisdiction.

B. Set freestanding pressure water coolers on the floor.

C. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.

D. Install mounting frames, affixed to building construction, and attach recessed, pressure water coolers, and in-wall bottle filling stations to mounting frames.

E. Install water-supply piping with a shutoff valve on the supply to each fixture to be connected to the domestic-water distribution piping. Use a ball. Install valves in locations where they can be easily reached for operation.

F. Install trap and waste piping on the drain outlet of each fixture to be connected to the sanitary drainage system.

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

H. Seal joints between fixtures and walls using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.3 CONNECTIONS

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

B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."

C. Install ball shutoff valve on water supply to each fixture. Install a valve upstream from the filter for the water cooler.

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

3.4 ADJUSTING

A. Adjust fixture flow regulators for proper flow and stream height.

B. Adjust pressure water-cooler temperature settings.

3.5 CLEANING

A. After installing the fixture, inspect the unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match the original finish.

B. Clean fixtures, on completion of installation, according to the 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

SECTION 230500 - COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. These basic Mechanical Requirements apply to all Division 23 Sections.

B. The work of this Section consists of providing all materials, labor, and equipment and the like necessary and/or required for the complete execution of all HVAC and related work for this project, as required by the contract documents.

1.2 RELATED DOCUMENTS

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

1.3 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER RESPECTIVE SECTIONS OF THIS DIVISION

A. Motor starters shall be furnished under this Division. Refer to Specification Section 230513 Common motor requirements for HVAC equipment" for technical information.

1.4 REFERENCES

A. ASHRAE - American Society of Heating, Refrigerating, and Air Conditioning Engineers Guides and Standards, latest editions.

B. SMACNA - Sheet Metal and Air Conditioning Contractors National Association.

C. ASME - American Society of Mechanical Engineers.

D. UL - Underwriters Laboratory.

E. NFPA - National Fire Protection Association.

1.5 REGULATORY REQUIREMENTS/CODES AND STANDARDS

A. All equipment and installation methods shall conform to the applicable standards and/or recommendations outlined in the New York State Building Code, Local Codes, as well as all Codes and Standards listed in the General and Supplemental Conditions sections of the specification, as well as the following specific codes
   1. NY State Building Code,
   2. NY State Mechanical Code
   3. NY State Fuel Gas Code
   4. NY State Plumbing Code
   5. NY State Education Department Planning Standards

1.6 FEES & PERMITS

A. The Contractor shall be responsible for filing drawings, paying necessary fees, and obtaining all permits related to the scope of work.

1.7 QUALITY ASSURANCE

A. The Contractor shall have the work indicated on the drawings and/or specified in each section performed by vendors or mechanics experienced and skilled in its implementation or by a “Specialist”, “Specialty Contractor”, or “Specialty Subcontractor” under contractual agreement with the Contractor. These terms mean an individual or firm of established reputation, or, if newly organized, whose personnel have previously established a reputation in the same field, which is regularly engaged in, and which maintains a regular force of workmen skilled in either manufacturing or fabricating items required by the Contract, installing items required by the Contract, or otherwise performing work required by the Contract.

B. Where the Contract Specifications require installation by a "Specialist," that term shall also be deemed to mean either the manufacturer of the item, an individual or firm licensed by the manufacturer, or an individual or firm who will perform such work under the manufacturer's direct supervision.

1.8 PROJECT/SITE CONDITIONS

A. Install Work in locations shown on Drawings, unless prevented by Project conditions.

B. Prepare drawings showing the proposed arrangement of Work to meet Project conditions, including changes to Work specified in other Sections.

1.9 SCOPE OF WORK

A. This Contractor shall be responsible for coordinating his work with all other trades.

B. The Contractor shall provide all materials, labor, equipment, tools, appliances, services, hoisting, scaffolding, supervision, and overhead for the furnishing and installation of all mechanical work and related work, indicated on the plans, specifications, and notes.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 GENERAL

A. Construct all apparatus of materials and pressure ratings suitable for the conditions encountered during continuous operation.

B. Construct all equipment in accordance with the requirements of all applicable codes. All pressure vessels and safety devices that fall within the scope of the ASME Code shall conform to the Code and bear the ASME label or stamp.

C. Match and balance all system components to achieve compatibility of equipment or satisfactory operation and performance throughout the entire operating temperature and control ranges. All installations shall be in accordance with the manufacturer's recommendations.

D. Provide all controls, wiring, piping, valves, accessories, and other components necessary to make all systems complete and operable.

E. The contractor shall warranty all work, including labor and materials, and equipment furnished and installed as part of this contract for a minimum period of one year from the date of acceptance by the owner, in writing. Certain equipment, such as underground fuel tanks, may have longer warranties as indicated in the specifications. In such cases, the longer of the two warranties shall prevail.

3.2 SHOP DRAWINGS AND SUBMITTALS (COORDINATE WITH DIVISION 1)

A. Shop drawings and samples shall be prepared and submitted in accordance with the requirements established in the contract and shall consist of all items listed in the following paragraphs.

B. Manufacturer's data or shop drawings giving full information as to dimensions, materials, and all information pertinent to the adequacy of the submitted equipment shall be submitted for review. Shop drawings shall include, but not be limited to, the following:

C. Submit all Mechanical equipment noted and scheduled on plans, including but not limited to the following:
1. Automatic Temperature Controls, Operation Sequences & Wiring Diagrams, and Control Diagrams, hardware and software
2. Motor Starters and Controllers
3. Hydronic piping, valves, and specialties
4. Expansion tanks
5. Water Treatment Equipment
6. Fans
7. Boilers
8. Unit heaters
9. Ductwork
10. Piping
11. Pumps
12. Equipment
13. DOAS systems
14. Chillers, heat pumps, and energy recovery units
15. VRF systems
16. Vibration isolation
17. Hangers and Inserts
18. Equipment Supports and Vibration Eliminators

19. Sheet Metal Construction Standards
20. Piping Layout (1/4 scale)
21. Ductwork Layout (1/4 scale)
22. Insulation (piping and ductwork)
23. Fan Curves and Sound Rating
24. Motor starters and disconnectors and VFD controllers.
25. Fire dampers, Motorized Dampers, Smoke dampers
26. Diffusers, Registers, and Grilles
27. Testing and Balancing Reports Water and air
28. Coordinated Composite Drawings on Mylar with Piping, Ductwork, Conduits, Lights, registers, Grilles, and Smoke Detectors, etc.
29. Commissioning
30. Phasing plan, rigging plan, protection plan
31. As-built documents
32. Warranties
33. O&M manuals

D. The contractor shall, upon award, submit a schedule for the engineer's review indicating when each of the above shop drawings shall be submitted. Submittals shall be made promptly as the project progresses in accordance with the Construction manager or General contractor's work schedules. The contractor shall allow sufficient time for the engineers to perform their review. A minimum of 10 business days shall be required. Untimely submittals shall be cause for the owner to make a delay against the contractor.

E. Demolition, purchase, and or installation shall not begin until shop drawings pertaining to the equipment associated with any related portion of the work have been submitted.

F. Sheet metal shop drawings shall indicate all existing and/or new lights, walls, piping, structural elements, existing work, etc., and dimension locations of ductwork, including elevations in relation to these items.

G. Where shop drawings have been reviewed by the Engineer, such review shall not be considered as a guarantee of measurements or building conditions. Where drawings have been reviewed, said review does not mean that drawings have been checked in detail; said review does not substantiate any quantities and in any way relieve the Contractor from his responsibility nor the necessity of furnishing materials or performing work required by the Contract Drawings and Specifications. It does not relieve the contractor of the responsibility to perform all work to accepted industry standards and in a code-compliant manner. Approval of shop drawings containing errors does not relieve the contractor from making corrections at his expense.

H. Where substitutions are submitted for approval, the review shall be for general performance comparison to the specified product. Products shall not be reviewed for size, clearance, or coordination with other trades. Coordination with other trades shall be the responsibility of the contractor. And changes to existing conditions or changes required to the work of other trades, such as a result of substituted material or equipment approved or not, shall be the responsibility of this contractor.

I. Approval of shop drawings

1. The Contractor shall be specifically responsible for checking equipment dimensions and clearances and confirming that equipment will fit into the designated space and connect properly to adjoining equipment and/or materials.

2. Submittals marked "Make Corrections Noted" give authority to proceed in accordance with the notes. However, if drawings are also marked "Amend and Resubmit", corrected drawings must be resubmitted for final review.

3. Submittals marked "Rejected" do not give authority to proceed with any portion of the work shown thereon. Drawings must be resubmitted.

4. Submittals marked "Rejected" or "Amend and Resubmit" shall include a specific written response to the engineer's comments. Resubmission of a submittal without a written response to the engineer's comments will be considered incomplete and shall be returned unreviewed.

3.3 CHARTS AND TAGS

A. The Contractor shall provide three sets of charts and diagrams of all piping systems, indicating the number and location of valves, controls, etc.

B. All valves, dampers, and controls shall be designated with brass tags. Refer to section 23 05 23 Identification for HVAC Piping and equipment

C. General and Supplementary Conditions and Division 01 Specification Sections apply to this Section

3.4 PAINTING

A. All field-erected apparatus, stands, supports, and supplemental steel and hangers shall be painted with one coat of primer and one coat of machinery enamel black or grey, or they shall be galvanized. All finishes shall be cleaned and touched up to repair any damage incurred during construction. All factory-manufactured and assembled apparatus and equipment shall be factory-painted with the manufacturer's standard coating, suitable for the environment in which the equipment will be used.

B. All piping shall be painted in colors conforming to OSHA Standards. And labeled according to specifications.

C. All fasteners, nuts, bolts, hanger rods, and "Kindorf" shall be galvanized steel or nickel plated.

3.5 RIGGING

A. Furnish all labor, materials, and equipment required to rig equipment and materials.

B. The rigger shall secure any necessary permits and comply with all applicable Federal, State, and local safety regulations. A copy of the permits is to be kept at both the project site and the Engineer's Office.

C. The rigger shall have a minimum of five (5) years of practical experience and hold a master riggers license if required.

D. The procedure for rigging shall be submitted to the Engineer for review. All possible precautions should be taken to prevent damage to the structure, streets, sidewalks, curbs, lawns, etc.

3.6 CUTTING AND PATCHING

A. All cutting and patching required for piping, ductwork, control conduits, etc., passing through walls, floors, and roof shall be provided by the Contractor under this contract unless otherwise noted. This Contractor shall be responsible for any damage done to the structure due to his negligence.

B. Patching materials and application shall match existing construction.

C. Where applicable, new holes for piping installation shall be core drilled.

D. Pipe Sleeves & Fire-stopping:

1. Provide for all pipes, conduits, ducts, and other elements passing through floors, walls, partitions, and structural elements, sleeves as specified. Sleeves shall be of adequate diameter to allow for a minimum of 3/4 inches clear all around the sleeve and pipe. When a pipe, conduit, duct, or other such element penetrates a fire-rated assembly and is insulated, insulation shall pass continuously through sleeves with 1/2-inch clearance between insulation and sleeve.

2. Where pipes, conduits, and other such elements penetrate fire-rated assemblies, or where holes or voids are created to extend mechanical systems through fire-rated assemblies (walls, floors, ceilings, structure, etc.), sleeves and fire-stopping systems shall be installed.

E. Furnish access doors to the General Contractor for installation where required in finished walls, partitions, and the like for access to junction boxes, controls, valves, etc., concealed behind finished construction.

F. Submit location drawings and sizes for review before installation.

3.7 PROTECTION-COORDINATE WITH DIVISION 1

A. Special protection is required for the installation of a Derrick or other device for rigging purposes. This Contractor shall coordinate with the rigger to facilitate rigging work.

B. Recommendations and Provisions of ANSI Bulletin A10.2 and OSHA shall be complied with, so far as applicable to the work.

C. The Contractor shall provide temporary partitions or tarpaulins to protect adjacent spaces and/or equipment. He shall be responsible for any damage or injury to person or property of any character resulting from any act, omission, neglect, or misconduct in his manner or method of executing his work.

D. The Contractor shall restore at his own expense such property to a condition similar or equal to that existing before such damage or injury in an acceptable manner.

E. The Contractor, furthermore, shall conduct his operations in such a manner as to prevent dust and debris from transferring onto adjoining property or into existing spaces.

F. All openings cut in walls, floors, roof, or ceilings of the building, for conduit, pipe, ductwork, etc., shall be closed off with box-type temporary protective enclosures of ¼" tempered hardboard, except when mechanics are actually working at the particular opening. Enclosures shall be constructed of a fireproof 2x4 frame, four (4) sides covered and made completely dust and water-tight.

G. All finished floor areas through which the contractor must pass with materials or equipment shall be protected with a layer of ¼" hardboard, "Masonite, “Ram board” laid with joints taped together.

H. The roof shall be protected with ½” plywood in all areas of work.

3.8 EQUIPMENT SUPPORTS

A. A.Provide supplementary steel dunnage, curbs, angle iron stands, etc., to properly set and install all equipment, including support necessary to properly pitch piping.

B. Existing dunnage shall be supplemented with angle iron supports and cross members as required to support new equipment at all support points or continuously as recommended by the manufacturer. Provide spring isolators under all new dunnage-mounted equipment.

3.9 WELDING

A. A.Welding and equipment shall conform to the American Welding Society’s Code for Welding in Building Construction, latest edition, as well as state and local laws and ordinances.

B. The handling and storage of all welding materials, acetylene and oxygen tanks, burners, and other equipment required for the execution of welding and cutting work shall be subject at all times to the approval of the Owner and/or Architect. All welding materials and gas tanks shall be promptly removed from the premises upon completion of each day’s work or stored in a manner satisfactory to the owner. Welding and equipment shall conform to the American Welding Society’s Code for Welding in Building Construction, latest edition, as well as state and local laws and ordinances.

C. Provide all temporary ventilation and ventilation air systems required during welding operations as required by OSHA.

3.10 AS-BUILT DRAWINGS

A. The Contractor shall provide a complete set of As-Built drawings showing actual installation and locations of all new and existing equipment, piping, and ductwork in the entire building. Schedules shall be revised to indicate the actual equipment installed.

B. As-Built drawings shall be submitted as per contract requirements in accordance with Division 1 and shall be submitted in paper format for review. Accepted as built drawings shall then be submitted in AutoCAD and PDF electronically on a hard disc.

3.11 CONDITIONS

A. Inspection: Before all work of this Section, carefully inspect the installed work of all other trades and verify that all such work is complete to the point where this installation may properly commence. Verify that the work of this Section may be completed in strict accordance with all pertinent codes and regulations, the approved Shop Drawings, and the Manufacturers' recommendations.

B. Discrepancies: In the event of a discrepancy, immediately notify the Engineer. Do not proceed in areas of discrepancy until all such discrepancies have been fully resolved.

3.12 INSTALLATION OF EQUIPMENT

A. Locations: Install all equipment in the locations shown on the approved Shop Drawings except where specifically otherwise approved on the job by the Owner and/or Engineer.

B. Interferences: Avoid interference with structure, and with the work of other trades, preserving adequate headroom and clearing all doors and passageways to the approval of the Engineer.

C. Inspection: Check each piece of equipment in the system for defects, verifying that all parts are properly furnished and installed, and that all items function properly, and that all adjustments have been made.

3.13 CLOSING IN OF UNINSPECTED WORK

A. General: Do not allow or cause any of the work to be covered up or enclosed until it has been inspected, tested, and accepted by the Engineer and by all other authorities having jurisdiction.

B. Uncovering: Should any of the work of this Section be covered up or enclosed before it has been completely inspected, tested, and approved, do all things necessary to uncover all such work. After the work has been completely inspected, tested, and approved, provide all materials and labor necessary and make all repairs necessary to restore the work to its original and proper condition at no additional cost to the owner.

3.14 BUILDING ACCESS

A. The Contractor shall inform himself fully regarding the peculiarities and limitations of space available for the passage and installation of all equipment and materials under the Contract.

B. Verify and coordinate removal of existing construction and/or knock-down of equipment to suit conditions. Special attention should be given to equipment installation. Provide all labor and materials to facilitate installation.

3.15 COOPERATION WITH OTHER TRADES PHASING

A. Cooperate with other trades so that all systems in the work may be installed in the best arrangements.

B. Coordinate as required with all other trades to share space in common areas and to provide maximum access to each system.

C. This Contractor shall submit fully coordinated shop drawings showing all piping, ductwork, and equipment, as well as relevant work of all other trades such as light, conduits, structural, and steel, which may impact the final size or placement of piping, ductwork, equipment, diffusers, and grilles.

D. The work shall be scheduled and phased in accordance with the requirements of the contract and the client. Before the commencement of work, the HVAC contractor shall submit a schedule in writing to the Architect and owner for approval. There shall be no shutdowns of any systems without prior written approval from the owner.

3.16 CLEANING

A. It is the intent of the contract documents that all work, including the inside of equipment, be left in a clean condition. All construction dirt shall be removed from material and equipment.

B. All removed items shall be taken off the premises and discarded in a manner satisfactory to the Owner.

3.17 COMPLETENESS

A. It is the intent of the contract documents to provide complete systems. Completeness shall mean not only that all material and equipment have been installed properly, but that all material and equipment is installed, adjusted, and operating as per the design intent in the opinion of the Engineer and in accordance with generally accepted industry good practice.

B. After work, the contractor shall fill the hydroponic system with 30% propylene glycol solution and provide 5 gallons of spare stock of propylene glycol.

3.18 FIRE PREVENTION DURING HOT WORK

A. Before starting operations, the Contractor shall furnish trained personnel to provide fire watches for locations where hot work is to be performed. One fire watcher may observe several locations in a relatively small contiguous area. Contractor shall furnish a suitable type, fully charged, operable portable fire extinguisher to each fire watcher.

B. The Contractor shall provide fire watchers who know how to operate the fire extinguisher, how to turn on a fire alarm, and how to summon the fire department.

C. Before starting operations, take suitable precautions to minimize the hazard of a fire communicating to the opposite side of walls, floors, ceilings, and roofs from the operations.

3.19 SAFETY MEASURES

A. Hot work shall not be done in or near rooms or areas where flammable liquids or explosive vapors are present or thought to be present. A combustible gas indicator (explosimeter) test shall be conducted to ensure that each area is safe. The Contractor is responsible for arranging and paying for each test.

B. Insofar as possible, the Contractor shall remove and keep the area free from all combustibles, including rubbish, paper, and waste within a radius of 25 feet from hot operations.

C. If combustible material cannot be removed, the Contractor shall furnish fireproof blankets to cover such materials. At the direction of the owner, floors, walls, and ceilings of combustible material shall be wet thoroughly with water before, during, and after operations sufficiently to afford adequate protection.

D. Where possible, the Contractor shall furnish and use baffles of metal or gypsum board to prevent the spraying of sparks, hot slag, and other hot particles into surrounding combustible material.

E. The Contractor shall prevent the spread of sparks and particles of hot metal through open windows, doors, holes, and cracks in floors, walls, ceilings, and roofs.

F. Cylinders used in hot work shall be placed at a safe distance from the work. The Contractor shall provide hoses and equipment free of deterioration, malfunction, and leaks. Suitable supports shall be provided to prevent accidental overturning of cylinders. All cylinder control valves shall be shut off while in use, with the gas pressure regulator set at 15 psi or less.

G. When hot work operations are completed or ended for the day, each location of the day's work shall be inspected by the Contractor 30 to 60 minutes after completion of operations to detect hidden or smoldering fires and to ensure that proper housekeeping is maintained. Contractor shall clean up the area of work at the end of each shift or workday.

H. Where sprinkler protection exists, the sprinkler system shall be maintained without interruption while operations are being performed. If operations are performed close to automatic sprinkler heads, gypsum board sheets or damp cloth guards may be used to shield the individual heads temporarily. The heads shall be inspected by the Contractor immediately after hot work operations cease, to ensure all materials have been removed from the heads and that the heads have not been damaged.

I. A suitable type, fully charged, operable portable fire extinguisher shall be available at all times during hot work operations.

J. If any of the above safeguards are not employed, or are violated, the Contracting Owner's Representative may, by written notice, stop the work until compliance is obtained. Such stoppage shall not relieve the Contractor from performing his work within the Contract period for the Contract price.

3.20 USE OF OWNERS' EQUIPMENT

A. The contractor shall not use any of the owner’s HVAC system or equipment, new or existing, for any purpose. The contractor shall provide temporary HVAC equipment, ductwork, power, and controls for use during construction for the purpose of ventilation or heating during the construction process. All such equipment, ductwork, power, and controls shall be removed upon the completion of work.

B. Upon completion of all phases of work or before there is any danger from freezing, the contractor fills the heating and cooling systems with a 35% glycol solution. Furnish 15 extra gallons in a steel drum for storage on-site and future use by the owner. The contractor shall also fill the 10,000-gallon oil tank with #2 oil

3.21 CONCRETE BASES

A. Concrete Bases: Anchor equipment to a concrete base according to the equipment manufacturer's written instructions and according to seismic codes at the Project.

1. Construct concrete bases of dimensions indicated, but not less than 6 inches larger in both directions than the supported unit.
2. Install dowel rods to connect the concrete base to the concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through the concrete base, and anchor into the structural concrete floor.
4. Place and secure anchorage devices. Use the supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to the anchor-bolt manufacturer's written instructions.
7. Use 3000-psi, 28-day compressive-strength concrete.

B. Grouting:
1. Mix and install grout for equipment base bearing surfaces, pump and other equipment base plates, and anchors. Clean and provide a smooth bearing surface for the area that will come into contact with grout. Provide forms as required for the placement of grout. Avoid air entrapment during the placement of grout. Place grout, filling equipment bases. Place grout on concrete bases and provide a smooth bearing surface for equipment. Place grout around anchors.

C. Steel Reinforcement:
1. Galvanized Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed bars, ASTM A 767/A 767M, Class I zinc-coated after fabrication and bending
2. Epoxy-Coated Wire: ASTM A 884/A 884M, Class A, Type 1 coated, as-drawn, plain-steel wire, with less than 2 percent damaged coating in each 12-inch wire length.

3.22 CONSTRUCTION PHOTOGRAPHS

1. Maintain a key plan with each set of construction photographs that identifies each photographic location.

B. Preconstruction Photographs: Before commencement of the Work, take photographs of the Project site and surrounding properties, including existing items to remain during construction, from different vantage points, as directed by the Construction Manager.

1. Flag and areas construction limits before taking construction photographs.
2. Take a minimum of 24 photographs of existing areas of work, either on or adjoining property, to accurately record physical conditions at the start of construction.

C. Concealed Work Photographs: Before proceeding with installing work that will conceal mechanical work, such as ductwork or piping, take photographs sufficient in number, with annotated descriptions, to record the nature and location of concealed work, including, but not limited to, the following:

1. existing utilities.
2. Piping
3. Ductwork
4. Electrical conduit.
5. Waterproofing and weather-resistant barriers.

END OF SECTION 230500

SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Division 24 - Equipment Wiring Systems: Electrical characteristics and wiring connections.

1.2 SUMMARY

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

1.3 COORDINATION

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

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

1.4 REFERENCES

A. AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings.

B. AFBMA 11 - Load Ratings and Fatigue Life for Roller Bearings.

C. NEMA MG 1 - Motors and Generators.

D. NFPA 70 - National Electrical Code.

1.5 REGULATORY REQUIREMENTS

A. Conform to UL Component Recognition for appropriate sizes.

B. Conform to NFPA 70, applicable electrical code, Underwriters Laboratories, Inc., and NEMA

C. Conform to I ECC 2015

1.6 DELIVERY, STORAGE, AND PROTECTION

A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weatherproof covering. For extended outdoor storage, remove motors from equipment and store them separately.

1.7 WARRANTY

A. Provide five year manufacturer's warranty for all motors larger than ½ horsepower.

PART 2 - PRODUCTS

MANUFACTURERS

A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

1. Gould.
2. Century.
3. General Electric.
4. Square D

2.2 GENERAL MOTOR REQUIREMENTS

A. Comply with NEMA MG 1 unless otherwise indicated.

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

C. All electric motors of sizes and types as specified for driving mechanical equipment shall be provided under this section.

D. Electrical Service: All motors shall be 60 Hertz unless otherwise noted. Refer to Electrical Specifications for required electrical characteristics.

E. Motors: Design for continuous operation in a 40° C environment, and for temperature rise in accordance with ANSI/NEMA MG limits for insulation class, Service Factor, and motor enclosure type. Motors shall be of sufficient size for the duty to be performed.

F. Visible Nameplate: Indicating manufacturer's name and model number, motor horsepower, RPM, frame size, voltage, phase, full load amps, insulation system class, service factor, maximum ambient temperature, temperature rise at rated horsepower, minimum efficiency, and power factor.

G. Electrical Connection: Conduit connection boxes, threaded for conduit. For fractional horsepower motors where connection is made directly, provide a screwed conduit connection in end frame. Size motor boxes to receive motor feeders and ground cable, as indicated on electrical drawing schedules.

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

I. 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 MOTOR EFFICIENCY

A. Electric motors shall meet the minimum efficiency requirement of the following tables in accordance with the International Energy Conservation Code when tested in accordance with DOE CFR 431. Performance data shall be certified by an approved testing agency.

B. Subtype I motors – NEMA premium efficiency as per table NEMA MG 1 table 12-12 and Energy Conservation code table 405.8(1). This shall apply to general purpose, T-frame, single speed, squirrel cage, induction type; 230/460-V, NEMA Designs A or B, continuous rated, 60 Hz, from 1 to 200 hp, 2-, 4- and 6-pole (3600-, 1800- and 1200-rpm), open and enclosed. Subtype I motors 250 hp to 500 hp motor efficiency shall be able to meet NEMA MG 1 table 12-11 and Energy Conservation Code table 405.8(1).

C. Subtype II motors – NEMA efficiency as per table NEMA MG 1 table 12-11 and Energy Conservation code table 405.8(2). This shall apply to general-purpose motors but can be configured as U-frame motors; NEMA Design C motors; close-coupled pump motors; footless motors; vertical solid shaft normal thrust motors (as tested in a horizontal position); eight-pole (900 rpm) motors, and polyphase motors with a voltage of not more than 600 V (other than 230 or 460 V).

D. Minimum average full load efficiency of polyphase small electric motors up to 3 hp shall be in accordance with Table C405.8(3) of the International Energy Conservation Code

E. Minimum average full load efficiency for capacitor-start, capacitor-run, and capacitor-start induction-run small electric motors up to 3 hp shall be in accordance with Table C405.8(4) of the International Energy Conservation Code.

2.4 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Service Factor: 1.15.

C. Multispeed Motors: Variable torque.

1. For motors with a 2:1 speed ratio, consequent pole, single winding.
2. For motors with other than a 2:1 speed ratio, separate winding for each speed.

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. Grease lubricated anti-friction ball bearings with housings equipped with a plugged provision for relubrication, rated for minimum AFBMA 9, L-10 life of 200,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at the end of NEMA standard shaft extension. Stamp bearing sizes on the nameplate.

G. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors embedded in motor windings and epoxy encapsulated solid state control relay with wiring to the terminal box.

H. Sound Power Levels: To NEMA MG 1.

I. Temperature Rise: Match insulation rating.

J. Insulation: Class B or better.

K. 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.

L. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.5 ADDITIONAL REQUIREMENTS FOR POLYPHASE MOTORS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for the controller with the required motor leads. Provide terminals in the motor terminal box, suited to the control method.

B. Use part winding. Start above 254T Frame Size: Use part of the winding to reduce locked rotor starting current to approximately 60 percent of full winding locked rotor current while providing approximately 50 percent of full winding locked rotor torque.

C. Motors Used with Variable-Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by the 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.

D. Severe-Duty Motors: Comply with IEEE 841, with a 1.15 minimum service factor.

2.6 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 the power supply circuit to the motor when winding temperature exceeds a safe value calibrated to the temperature rating of motor insulation. The thermal-protection device shall automatically reset when the motor temperature returns to the normal range.

F. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, pre-lubricated sleeve ball bearings.

2.7 POWER FACTOR CORRECTION

A. Provide a capacitor for each three-phase, single-speed motor rated 3 HP or larger shall be provided to correct the full load power factor to 95%. The capacitor shall be mounted at the motor for connection across the motor terminals by the Electrical Contractor

B. Capacitors;
1. Capacitors shall be totally enclosed, fused, and have discharge resistors.
2. Capacitors based on nominal motor RPM shall be provided in accordance with the following table to correct the power factor to 95% and verify sizes with the motor manufacturer.

Motor HP	Capacitor KVAR 3600 RPM Motor	Capacitor KVAR 1800 RPM Motor
3	1.5	1.5
5	2	2
7.5	2.5	2.5
10	3	3
15	4	4
20	5	5
25	6	6
30	7	7
40	9	9
50	12	12
60	14	14

2.8 STARTERS

A. GENERAL

1. See specification Section 16485 and Division 1 for additional information.
2. Starters for motors operating at 120 volts shall be manual starters unless otherwise indicated. Starters for motors operating at other than 120 volts shall be magnetic starters.
3. All starters shall be enclosed. Enclosures shall be surface-mounted NEMA 1 unless otherwise indicated.
4. Where weatherproof starters are required, the enclosure shall be NEMA 4.
5. It shall be verified that the correct overload heaters have been installed in the starter before energizing any motor. Sizing shall be based on motor nameplate current and taking into account any reduction in current due to power factor correction.
6. Alternate Manufacturers –
   a. Allen-Bradley
   b. Crouse-Hinds Co.
   c. Cutler-Hammer, Inc.

d. General Electric Co.
e. Square D Co.
f. Westinghouse Electric Corp.

B. MANUAL STARTERS

1. Two-pole, toggle-operated, thermal overload device in each phase leg, handle guard for padlocking toggle handle, and with indicated control and signal devices.

2. Where a motor is controlled automatically by an interlock or pilot device, a “HAND-OFF-AUTO” switch shall be provided in the starter cover. Where the rating of the interlock or pilot device is inadequate to control the motor currents directly, a properly rated contactor shall be provided between the controlling device and the motor.

3. An “ON” pilot light shall be provided in the starter cover.

C. MAGNETIC STARTERS

1. Starters shall be sized in accordance with NEMA standards and the following table, except that starters shall not be smaller than NEMA size 0. Starters shall be provided with one N.O. electrical holding interlock, under-voltage protection, and two additional auxiliary contacts within the same enclosure. NEMA size starters shall be provided as follows

STARTER SIZE	MAX HP AT 460 VOLTS
0	5
1	10
2	25

2. All starters shall be combination type with the starter and disconnect in the same enclosure. All starters shall be Type 2 coordination-protected. Fuses shall be Bussman “Low Peak” type or equal sized at 125% of motor nameplate rating. Verify and coordinate requirements for fused disconnect switches with the Electrical Contractor prior to ordering starters.

3. Provide S.S.P.B. or H-O-A switches and pilot light in covers as required to facilitate control operation sequences.

D. CRITICAL FAULT

1. Where starters are not integral to equipment and are furnished and installed separately from equipment by the contractor, provide a 3-phase line voltage monitor by ICM Controls model 450 or approved equal. Unit shall be installed in the motor starter or in a separate enclosure with the same rating as the starter. It shall be arranged to monitor critical faults, including phase loss or reversal, and

when detected, de-energize the load. It shall monitor non-critical faults, including high/low voltage, voltage unbalance, and when detected, after a time delay, de-energize the load.

PART 3 - EXECUTION

A. Suitable starting and controlling equipment and devices shall be furnished and installed as specified hereinafter and as shown on the Drawings. The starting equipment shall be arranged, generally, in control groups, or in certain cases, as isolated combination starters as specified or indicated. The Heating, Ventilating, and Air Conditioning Sequences of Operation, drawings, and specifications shall be referred to for the manner of control, operation, and monitoring of motors and the electrically operated equipment.

B. A starter and disconnect switch or combination motor starter disconnect shall be provided for every motor and each and every electrically operated piece of equipment by this contractor, except where complete starters and controls are furnished by the manufacturer of the motor or piece of equipment. Starters shall be internally wired to provide the required control operation and monitoring. All control devices, such as push buttons, break-glass stations, alternators, relays, pilot lights, etc., shall be provided as required for operation of mechanical equipment. All rooftop and remotely located equipment shall have remote starters as located on the plan and shall have local disconnect switches. All equipment located in equipment rooms can use combination starters/disconnects located within line of sight of the controlled equipment. All starters and disconnect switches shall be in enclosures suitable for the environment in which they are installed. Starters and disconnect switches located in machine rooms shall use NEMA 1. Starters and disconnect switches located outdoors shall use NEMA 4x. Starters and disconnect switches located in machine rooms, which are subject to potential water damage, shall use NEMA 2

C. Starting equipment and devices specified in this section (and section 23 29 13 Variable Frequency Controllers) shall be furnished by the mechanical subcontractor and shall be installed by the Electrical subcontractor. In general, the mechanical subcontractor shall furnish all motor starters and disconnect switches except where they are an integral part of a motor control center; in this case, starters and disconnects shall be provided (furnished and installed) by the electrical contractor. The Electrical subcontractor shall also provide all wiring necessary to supply power to the electric motors specified under this section, including connections from the starters to the motors. Starters and disconnects shall also include variable frequency drives.

D. The mechanical Contractor shall furnish and install all wiring between control devices and controlled equipment furnished under this Section, including interlock control wiring between motor starters, and all automatic temperature control wiring. All wiring shall be installed in conformance with applicable codes and the requirements of the Electrical Division of the Specifications.

E. The Electrical Contractor shall furnish a 120-volt power source to temperature control panels and equipment requiring a separate 120-volt control power source. Power for control circuits for all devices connecting to motor starters shall be obtained from 120-

volt control transformers provided in each starter operating at other than 120 volts. Provide transformers for all low-voltage control systems as required.

F. Furnish detailed composite wiring diagrams and such other information necessary to assure the proper connection, operation, and control of motorized equipment, including interlocks, automatic controls, safety controls, and all auxiliary circuits.

G. All control units shall be furnished with a nameplate indicating which device or equipment it controls and the voltage. Additional nameplates on each push button, selector switch, and pilot light indicating their functions shall be provided. Nameplates shall be laminated phenolic with white letters on black background, minimum 2” high.

H. All motors supplied either with equipment or installed separately that are to be used in conjunction with a variable frequency drive shall be inverter duty motors.

END OF SECTION 230513

SECTION 230517 - SLEEVES AND ESCUTCHEONS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Sleeves.
2. Stack-sleeve fittings.
3. Sleeve-seal systems.
4. Sleeve-seal fittings.
5. Grout.
6. Escutcheons.
7. Floor plates.
8. Acoustic split seal rings

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

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

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

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

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

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

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

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

2.2 STACK-SLEEVE FITTINGS

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

1. Underdeck Clamp: Clamping ring with setscrews.

2.3 SLEEVE-SEAL SYSTEMS

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

1. Advance Products & Systems, Inc.
2. Airex Manufacturing.
3. CALPICO, Inc.
4. Metraflex Company (The).
5. Link Seal

B. Description: Modular sealing-element unit, designed for field assembly, for filling the annular space between piping and sleeve.

1. Sealing Elements: EPDM-rubber interlocking links shaped to fit the surface of the pipe. Include the type and number required for pipe material and the size of pipe.
2. Pressure Plates: Carbon steel or Stainless steel.
3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, or Stainless steel of the 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. GPT; an EnPro Industries company.
3. Metraflex Company (The).
4. Proco Products, Inc.
5. Fernco

B. Description: Manufactured heavy rubber or EPDM, sleeve-to-pipe water stop assembly. Unit has a rubber water stop collar with a center opening to match piping OD. Connected with stainless steel hose clamps. Made for copper or plastic carrier pipes. Size up to 4” sleeve and 3” carrier pipe.

2.5 GROUT

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

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

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

D. Packaging: Premixed and factory packaged.

2.6 ESCUTCHEONS

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

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

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

D. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed hinge, and spring-clip fasteners.

2.7 FLOOR PLATES

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

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

2.8 ACOUSTIC SPLIT SEALS

A. Acoustic Split Seals consist of pipe halves with a minimum 3/4" thick neoprene sponge cemented to the inner faces. The seal shall be tightened around the pipe to eliminate clearance between the inner sponge face and the piping. Grout seals to make it integral with the floor, wall, or ceiling in masonry construction. Seals shall project a minimum of 1" past the face of the wall. Where temperatures exceed 240°F, 10 lb. density fiberglass may be used in place of the sponge. Seals shall be Type SPS or SWS as manufactured by Mason Industries, Inc.

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 a sleeve-seal system installed, select sleeves of size large enough to provide a 1-inch annular clear space between piping and concrete slabs and walls.

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

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

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

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

3. Using grout, seal the space outside of sleeves in slabs and walls without a 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 a 1/4-inch annular clear space between the sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for the size, depth, and location of the joint. Comply with requirements for sealants specified in Section 079200 "Joint Sealants."

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

3.2 STACK-SLEEVE-FITTING INSTALLATION

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

1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.

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

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

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into the 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 the center of the sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in the annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

C. Coordinate the minimum size of sleeves with the pipe. Sleeves for plumbing piping shall be 2x the diameter of the service pipe.

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 the water stop flange to be centered in the concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around the outside of sleeve-seal fittings.

3.5 SLEEVE AND SLEEVE-SEAL SCHEDULE

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

1. Exterior Concrete Walls above Grade:

a. Piping Smaller Than NPS 6: Galvanized-steel wall sleeves, Sleeve-seal fittings.

b. Piping NPS 6 and Larger: Galvanized-steel wall sleeves.

2. Exterior Concrete Walls below Grade:

a. Piping Smaller Than NPS 6: Galvanized-steel wall sleeves with sleeve-seal system, Sleeve-seal fittings.

1) Select the sleeve size to allow for a 1-inch annular clear space between piping and sleeve for installing the sleeve-seal system.

b. Piping and Larger: Galvanized-steel wall sleeves with sleeve-seal system.

1) Select the sleeve size to allow for a 1-inch annular clear space between piping and sleeve for installing the sleeve-seal system.

3. Concrete Slabs-on-Grade:

a. Piping Smaller Than NPS 6: Galvanized-steel wall sleeves with sleeve-seal system.

1) Select the sleeve size to allow for a 1-inch annular clear space between piping and sleeve for installing the sleeve-seal system.

b. Piping NPS 6 and Larger: Galvanized-steel wall sleeves with sleeve-seal system.

1) Select the sleeve size to allow for a 1-inch annular clear space between piping and sleeve for installing the sleeve-seal system.

4. Concrete Slabs above Grade:

a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves or Stack-sleeve fittings with Sleeve-seal fittings.
b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves or Stack-sleeve fittings.

5. Interior Partitions:

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

3.6 ESCUTCHEON 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 the opening.

1. Escutcheons for New Piping:

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

2. Escutcheons for Existing Piping:

    a. Chrome-Plated Piping: Split-casting brass type with polished, chrome-plated finish.
    b. Insulated Piping: Split-plate, stamped-steel type with concealed or exposed-rivet hinge.
    c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge.
    d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge.
    e. Bare Piping in Unfinished Service Spaces: Split-plate, stamped-steel type with concealed hinge.
    f. Bare Piping in Equipment Rooms: Escutcheons not required

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 the opening.

1. New Piping: One-piece, floor-plate type.
2. Existing Piping: Split-casting, floor-plate type.

3.7 ACOUSTIC SPLIT SEAL

A. Install Acoustic split seals on all hydronic piping 3” and over, penetrating mechanical equipment room walls.

3.8 FIELD QUALITY CONTROL

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

END OF SECTION 230517.5

SECTION 230519 - METERS AND GAGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Bimetallic-actuated thermometers.
2. Filled-system thermometers.
3. Liquid-in-glass thermometers.
4. Light-activated thermometers.
5. Thermowells.
6. Dial-type pressure gages.
7. Gage attachments.
8. Test plugs.
9. Test-plug kits.
10. Sight flow indicators.
11. Orifice flow Meters

B. Related Sections:

1. Section 231113 "Hydronic piping”

1.3 ACTION SUBMITTALS

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

B. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

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

1.5 CLOSEOUT SUBMITTALS

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

PART 2 - PRODUCTS

2.1 Thermometer Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Trerice, H. O. Co.
2. Watts; a Watts Water Technologies company.
3. Weiss Instruments, Inc.
4. Weksler Glass Thermometer Corp.

2.2 BIMETALLIC-ACTUATED THERMOMETERS

A. Standard: ASME B40.200.

B. Case: Liquid-filled and sealed type(s); stainless steel with 5-inch nominal diameter.

C. Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg F and deg C.

D. Connector Type(s): Union joint, adjustable angle, with unified-inch screw threads.

E. Connector Size: 1/2 inch, with ASME B1.1 screw threads.

F. Stem: 0.25 or 0.375 inch in diameter; stainless steel.

G. Window: Plain glass.

H. Ring: Stainless steel.

I. Element: Bimetal coil.

J. Pointer: Dark-colored metal.

K. Accuracy: Plus or minus 1 percent of scale range.

2.3 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Compact-Style, Liquid-in-Glass Thermometers:
1. Standard: ASME B40.200.

2. Case: Cast aluminum; 6-inch nominal size.
3. Case Form: Back angle unless otherwise indicated.
4. Tube: Glass with a magnifying lens and blue or red organic liquid.
5. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C.
6. Window: Glass or plastic.
7. Stem: Aluminum or brass, and of length to suit installation.

    a. Design for Air-Duct Installation: With ventilated shroud.
    b. Design for Thermowell Installation: Bare stem.

8. Connector: 3/4 inch, with ASME B1.1 screw threads.
9. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

B. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:
1. Standard: ASME B40.200.
2. Case: Cast aluminum; 9-inch nominal size unless otherwise indicated.
3. Case Form: Adjustable angle Back angle unless otherwise indicated.
4. Tube: Glass with a magnifying lens and blue or red organic liquid.
5. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C.
6. Window: Glass.
7. Stem: Aluminum and of length to suit installation.

    a. Design for Air-Duct Installation: With ventilated shroud.
    b. Design for Thermowell Installation: Bare stem.

8. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
9. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.4 DUCT-THERMOMETER MOUNTING BRACKETS

A. Description: Flanged bracket with screw holes, for attachment to an air duct, and made to hold a thermometer stem.

2.5 THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into a piping tee fitting.
3. Material for Use with Copper Tubing: CNR or CUNI.
4. Material for Use with Steel Piping: CRES CSA.

5. Type: Stepped shank unless a 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 the size of the thermowell's internal screw thread to the size of the thermometer connection.

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

2.6 PRESSURE GAGES

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

a. Trerice, H. O. Co.
b. Watts; a Watts Water Technologies company.
c. Weiss Instruments, Inc.
d. Weksler Glass Thermometer Corp.

B. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Standard: ASME B40.100.

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

2.7 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 an extension for use on insulated piping.

B. Siphons: Loop-shaped section of brass or stainless-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.

2.8 TEST PLUGS

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

1. Trerice, H. O. Co.
2. Watts; a Watts Water Technologies company.
3. Weiss Instruments, Inc.
4. Weksler Glass Thermometer Corp.

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

C. Body: Brass or stainless steel with core inserts and a gasketed and threaded cap. Include an 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.

2.9 TEST-PLUG KITS

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

1. Sisco Manufacturing Company, Inc.
2. Trerice, H. O. Co.
3. Watts; a Watts Water Technologies company.
4. Weiss Instruments, Inc.

B. Furnish one test-plug kit(s) containing two thermometers (s), one pressure gage and adapter, and carrying case. Thermometer sensing elements, pressure gage, and adapter probes shall be of a diameter to fit test plugs and of a length to project into piping.

C. Low-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch-diameter dial and tapered-end sensing element. Dial range shall be at least 25 to 125 °F.

D. High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch-diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220°F.

E. Pressure Gage: Small, Bourdon-tube insertion type with 2- to 3-inch-diameter dial and probe. Dial range shall be at least 0 to 200 psig.

F. Carrying Case: Metal or plastic, with formed instrument padding.

2.10 SIGHT FLOW INDICATORS

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

1. ARCHON Industries, Inc.
2. Dwyer Instruments, Inc.
3. Emerson Process Management; Rosemount Division.
4. OPW Engineered Systems; OPW Fluid Transfer Group; a Dover company.
5. Pentair Valves & Controls; Penberthy Brand.

B. Description: Piping inline installation device for visual verification of flow.

C. Construction: Bronze or stainless-steel body, with sight glass and ball, flapper, or paddle wheel indicator, and threaded or flanged ends.

D. Minimum Pressure Rating: 150 psig.

E. Minimum Temperature Rating: 200 deg F.

F. End Connections for NPS 2 and Smaller: Threaded.

G. End Connections for NPS 2-1/2 and Larger: Flanged.

2.11 FLOWMETERS

A. Turbine Flowmeters:

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

a. Advantage Controls.
b. EMCO Flow Systems.
c. ERDCO Engineering Corp.
d. Hoffer Flow Controls, Inc.
e. ONICON Incorporated.

2. Description: Flowmeter with sensor and indicator. Construction shall meet all sections of AWWA standard C-708.

3. Flow Range: Sensor and indicator shall cover the operating range of the equipment or system served.
4. Sensor: Impeller turbine; for inserting into pipefitting or for installing in piping and measuring flow directly in gallons per minute.

    a. Design: Device or pipe fitting with an inline turbine and integral direct-reading scale for water.
    b. Construction: Bronze or stainless-steel body, with plastic turbine or impeller.
    c. Minimum Pressure Rating: 150 psig.
    d. Minimum Temperature Rating: 40 deg F.

5. Indicator: Hand-held meter; either an integral part of the sensor or a separate meter.
6. Accuracy: Plus or minus 1-1/2 percent.
7. Display: Shows rate of flow, with a register to indicate total volume in gallons.
8. Operating Instructions: Include complete instructions with each flowmeter.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermowells with a socket extending one-third of pipe diameter and in a vertical position in piping tees.

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

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

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

F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.

G. Install duct-thermometer mounting brackets in the walls of ducts. Attach to the duct with screws.

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

I. Install remote-mounted pressure gages on the panel.

J. Install valve and snubber in piping for each pressure gauge for fluids (except steam).

K. Install valve and syphon fitting in piping for each pressure gauge for steam.

L. Install test plugs in piping tees.

M. Install flow indicators in piping systems in accessible positions for easy viewing.

N. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to the manufacturer's written instructions.

O. Install flowmeter elements in accessible positions in piping systems.

P. Install wafer-orifice flowmeter elements between pipe flanges.

Q. Install differential-pressure-type flowmeter elements, with at least minimum straight lengths of pipe, upstream and downstream from the element according to the manufacturer's written instructions.

R. Install permanent indicators on walls or brackets in accessible and readable positions.

S. Install connection fittings in accessible locations for attachment to portable indicators.

T. Mount thermal-energy meters on the wall if accessible; if not, provide brackets to support meters.

U. 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.

V. Install pressure gages in the following locations:

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

3.2 CONNECTIONS

A. Install meters and gauges adjacent to machines and equipment to allow 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 the manufacturer's written instructions.

B. Adjust faces of meters and gauges to the proper angle for best visibility.

3.4 THERMOMETER SCHEDULE

A. Industrial type, liquid in glass type thermometers shall be installed at all the inlets and outlets of each of the following equipment;
   1. Hydronic boiler
   2. Chiller
   3. Thermal storage tank
   4. heat pump
   5. Inlet and outlet of each hydronic coil in air-handling units.
   6. Two inlets and two outlets of each hydronic heat exchanger
   7. Provide a test with EPDM self-sealing rubber inserts

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

3.5 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Chilled-Water Piping: 0 to 150 deg F.

B. Scale Range for Condenser-Water Piping: 0 to 150 deg F.

C. Scale Range for Heating, Hot-Water Piping: 0 to 250 deg F.

D. Scale Range for Air Ducts: 0 to 150 deg F.

3.6 PRESSURE-GAGE SCHEDULE

A. Pressure gages at all the inlet and discharge connections of each of the following equipment shall be liquid-filled and sealed directly mounted to a metal case.
   1. Pressure-reducing valve
   2. Hydronic pump
   3. Hydronic boiler
   4. Chiller

5. Thermal storage tank
6. Water source heat pump
7. Cooling tower
8. Heat exchanger
9. Air handling and duct-mounted units coils
10. Provide a test with EPDM self-sealing rubber inserts

3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Chilled-Water Piping: 0 to 200 psi.

B. Scale Range for Condenser-Water Piping: 0 to 150 psi.

C. Scale Range for Heating, Hot-Water Piping: 0 to 160 psi.

D. Scale Range for Steam Piping: 0 to 100 psi.

3.8 FLOWMETER SCHEDULE

A. Flowmeters for Cooling Tower cold-water make-up piping: Turbine type.

END OF SECTION 230519

SECTION 230523.11 - 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 angle valves.
2. Globe valves.
3. Ball Valves
4. Butterfly Valves.
5. Check Valves
6. Gate Valves
7. Chainwheels.

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, grooves, and weld ends.
3. Set angle and globe valves closed to prevent rattling.

B. Use the following precautions during storage:

1. Maintain valve end protection.

2. Store valves indoors and maintain at a higher-than-ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use a sling to handle large valves; rig the 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 a single source from a 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. Refer to the HVAC valve schedule articles for applications of valves.

D. Valve Pressure and 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. 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.

G. 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 a chain for mounting height, according to "Valve Installation" Article.

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

a. Apollo Valves; Conbraco Industries, Inc.
b. Crane; Crane Energy Flow Solutions.
c. Milwaukee Valve Company.
d. NIBCO INC.
e. Stockham; Crane Energy Flow Solutions.
f. Watts; a Watts Water Technologies company.
g. Keystone

GLOBE VALVES

2.2 BRONZE GLOBE VALVES

A. Class 125 Bronze Globe Valves:

1. Description:

a. Standard: MSS SP-80, Type 1.
b. CWP Rating: 200 psig.
c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
d. Ends: Threaded or solder joint.
e. Stem and Disc: Bronze.
f. Packing: Asbestos free.
g. Handwheel: Malleable iron, bronze, or aluminum.

B. Class 150 Bronze Globe Valves:

1. Description:

a. Standard: MSS SP-80, Type 2.
b. CWP Rating: 300 psig.
c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
d. Ends: Threaded.
e. Stem: Bronze.
f. Disc: Bronze or PTFE.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron, bronze, or aluminum.

2.3 IRON GLOBE VALVES

A. Class 125 Iron Globe Valves:
1. Description:

a. Standard: MSS SP-85, Type I.
b. CWP Rating: 200 psig.
c. Body Material: ASTM A 126, gray iron with bolted bonnet.
d. Ends: Flanged.

e. Trim: Bronze.
f. Packing and Gasket: Asbestos free.
g. Operator: Handwheel or chainwheel.

B. Class 250 Iron Globe Valves:
1. Description:

a. Standard: MSS SP-85, Type I.
b. CWP Rating: 500 psig.
c. Body Material: ASTM A 126, gray iron with bolted bonnet.
d. Ends: Flanged.
e. Trim: Bronze.
f. Packing and Gasket: Asbestos free.
g. Operator: Handwheel or chainwheel.

2.4 BALL VALVES

A. One-Piece Brass Ball Valves:
1. Description:

a. Standard: MSS SP-110.
b. CWP Rating: 400 psig.
c. Body Design: One piece.
d. Body Material: Forged brass.
e. Ends: Threaded.
f. Seats: PTFE.
g. Stem: Brass.
h. Ball: Chrome-plated brass.
i. Port: Reduced.

B. Two-Piece Brass Ball Valves with Full Port and Brass Trim:
1. Description:

a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Two piece.
e. Body Material: Forged brass.
f. Ends: Threaded.
g. Seats: PTFE.
h. Stem: Brass.
i. Ball: Chrome-plated brass.
j. Port: Full.

C. Two-Piece Brass Ball Valves with Full Port and Stainless-Steel Trim:
1. Description:

a. Standard: MSS SP-110.

b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Two piece.
e. Body Material: Forged brass.
f. Ends: Threaded.
g. Seats: PTFE.
h. Stem: Stainless steel.
i. Ball: Stainless steel, vented.
j. Port: Full.

D. Two-Piece Brass Ball Valves with Regular Port and Brass Trim:
1. Description:

a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Two piece.
e. Body Material: Forged brass.
f. Ends: Threaded.
g. Seats: PTFE.
h. Stem: Brass.
i. Ball: Chrome-plated brass.
j. Port: Regular.

E. Two-Piece Brass Ball Valves with Regular Port and Stainless-Steel Trim:
1. Description:

a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Two piece.
e. Body Material: Brass or bronze.
f. Ends: Threaded.
g. Seats: PTFE.
h. Stem: Stainless steel.
i. Ball: Stainless steel, vented.
j. Port: Regular.

2.5 BRONZE BALL VALVES

A. One-Piece Bronze Ball Valves with Bronze Trim:
1. Description:

a. Standard: MSS SP-110.
b. CWP Rating: 400 psig.
c. Body Design: One piece.
d. Body Material: Bronze.

e. Ends: Threaded.
f. Seats: PTFE.
g. Stem: Bronze.
h. Ball: Chrome-plated brass.
i. Port: Reduced.

B. One-Piece Bronze Ball Valves with Stainless-Steel Trim:
1. Description:

a. Standard: MSS SP-110.
b. CWP Rating: 600 psig.
c. Body Design: One piece.
d. Body Material: Bronze.
e. Ends: Threaded.
f. Seats: PTFE.
g. Stem: Stainless steel.
h. Ball: Stainless steel, vented.
i. Port: Reduced.

C. Two-Piece Bronze Ball Valves with Full Port and Bronze or Brass Trim:
1. 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: Bronze.
i. Ball: Chrome-plated brass.
j. Port: Full.

D. Two-Piece Bronze Ball Valves with Full Port and Stainless-Steel Trim:
1. 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.

E. Two-Piece Bronze Ball Valves with Regular Port and Bronze or Brass Trim:

1. 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: Bronze.
    i. Ball: Chrome-plated brass.
    j. Port: Regular.

F. Two-Piece Bronze Ball Valves with Regular Port and Stainless-Steel Trim:
    1. 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: Regular.

2.6 HIGH-PERFORMANCE BUTTERFLY VALVES

A. Class 150, Single-Flange, High-Performance Butterfly Valves:
    1. Description:

        a. Standard: MSS SP-68.
        b. CWP Rating: 285 psig at 100 deg F.
        c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
        d. Body Material: Carbon steel, cast iron, ductile iron, or stainless steel. Match piping system
        e. Seat: Reinforced PTFE or metal.
        f. Stem: Stainless steel; offset from seat plane.
        g. Disc: Carbon steel.
        h. Service: Bidirectional.

B. Class 300, Single-Flange, High-Performance Butterfly Valves:
    1. Description:

        a. Standard: MSS SP-68.

b. CWP Rating: 720 psig at 100 deg F.
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: Carbon steel, cast iron, or ductile iron. Match piping system
e. Seat: Reinforced PTFE or metal.
f. Stem: Stainless steel; offset from seat plane.
g. Disc: Carbon steel.
h. Service: Bidirectional.

CHECK VALVES

2.7 BRONZE LIFT CHECK VALVES

A. Class 125 Lift Check Valves with Bronze Disc:
1. Description:

a. Standard: MSS SP-80, Type 1.
b. CWP Rating: 200 psig.
c. Body Design: Vertical flow.
d. Body Material: ASTM B 61 or ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: Bronze.

B. Class 125 Lift Check Valves with Nonmetallic Disc:
1. Description:

a. Standard: MSS SP-80, Type 2.
b. CWP Rating: 200 psig.
c. Body Design: Vertical flow.
d. Body Material: ASTM B 61 or ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: NBR or PTFE.

2.8 BRONZE SWING CHECK VALVES

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

a. Standard: MSS SP-80, Type 3.
b. CWP Rating: 200 psig.
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: Bronze.

B. Class 125, Bronze Swing Check Valves with Nonmetallic Disc:
1. Description:

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

C. Class 150, Bronze Swing Check Valves with Bronze Disc:
1. Description:

a. Standard: MSS SP-80, Type 3.
b. CWP Rating: 300 psig.
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: Bronze.

D. Class 150, Bronze Swing Check Valves with Nonmetallic Disc:
1. Description:

a. Standard: MSS SP-80, Type 4.
b. CWP Rating: 300 psig.
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: PTFE.

2.9 IRON SWING CHECK VALVES

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

a. Standard: MSS SP-71, Type I.
b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
c. NPS 14 to NPS 24, CWP Rating: 150 psig.
d. Body Design: Clear or full waterway.
e. Body Material: ASTM A 126, gray iron with bolted bonnet.
f. Ends: Flanged.
g. Trim: Bronze.
h. Gasket: Asbestos free.

B. Class 125, Iron Swing Check Valves with Nonmetallic-to-Metal Seats:
1. Description:

a. Standard: MSS SP-71, Type I.
b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
c. NPS 14 to NPS 24, CWP Rating: 150 psig.
d. Body Design: Clear or full waterway.

e. Body Material: ASTM A 126, gray iron with bolted bonnet.
f. Ends: Flanged.
g. Trim: Composition.
h. Seat Ring: Bronze.
i. Disc Holder: Bronze.
j. Disc: PTFE.
k. Gasket: Asbestos free.

C. Class 250, Iron Swing Check Valves with Metal Seats:
1. Description:

a. Standard: MSS SP-71, Type I.
b. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig.
c. NPS 14 to NPS 24, CWP Rating: 300 psig.
d. Body Design: Clear or full waterway.
e. Body Material: ASTM A 126, gray iron with bolted bonnet.
f. Ends: Flanged.
g. Trim: Bronze.
h. Gasket: Asbestos free.

2.10 IRON SWING CHECK VALVES WITH CLOSURE CONTROL

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

a. Standard: MSS SP-71, Type I.
b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
c. NPS 14 to NPS 24, CWP Rating: 150 psig.
d. Body Design: Clear or full waterway.
e. Body Material: ASTM A 126, gray iron with bolted bonnet.
f. Ends: Flanged.
g. Trim: Bronze.
h. Gasket: Asbestos free.
i. Closure Control: Factory-installed, exterior lever and spring.

2.11 IRON, CENTER-GUIDED CHECK VALVES

A. Class 125, Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat:
1. Description:

a. Standard: MSS SP-125.
b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
c. NPS 14 to NPS 24, CWP Rating: 150 psig.
d. Body Material: ASTM A 126, gray iron.
e. Style: Compact wafer.
f. Seat: [EPDM].

B. Class 150, Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat:
   1. Description:

      a. Standard: MSS SP-125.
      b. NPS 2-1/2 to NPS 12, CWP Rating: 300 psig.
      c. NPS 14 to NPS 24, CWP Rating: 250 psig.
      d. Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
      e. Style: Compact wafer.
      f. Seat: EPDM.

C. Class 250, Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat:
   1. Description:

      a. Standard: MSS SP-125.
      b. NPS 2-1/2 to NPS 12, CWP Rating: 400 psig.
      c. NPS 14 to NPS 24, CWP Rating: 300 psig.
      d. Body Material: ASTM A 126, gray iron.
      e. Style: Compact wafer, spring-loaded.
      f. Seat: [EPDM].

2.12 IRON, PLATE-TYPE CHECK VALVES

A. Class 125, Iron, Single or dual Plate Check Valves with Resilient Seat:
   1. Description:

      a. Standard: API 594.
      b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
      c. NPS 14 to NPS 24, CWP Rating: 150 psig.
      d. Body Design: Wafer, spring-loaded plate.
      e. Body Material: ASTM A 126, gray iron.
      f. Seat: EPDM NBR.

B. Class 150, Iron, single or Dual-Plate Check Valves with Resilient Seat:
   1. Description:

      a. Standard: API 594.
      b. NPS 2-1/2 to NPS 12, CWP Rating: 300 psig.
      c. NPS 14 to NPS 24, CWP Rating: 250 psig.
      d. Body Design: Wafer, spring-loaded plates.
      e. Body Material: ASTM A 395/A 395M or ASTM A 536, ductile iron.
      f. Seat: EPDM.

C. Class 250, Iron, Wafer, Single or Dual -Plate Check Valves with Resilient Seat:
   1. Description:

      a. Standard: API 594.
      b. NPS 2-1/2 to NPS 12, CWP Rating: 400 psig.
      c. NPS 14 to NPS 24, CWP Rating: 300 psig.

d. Body Design: Wafer, spring-loaded plate.
e. Body Material: ASTM A 126, gray iron.
f. Seat: EPDM.

GATE VALVES

A. Class 125, RS, Bronze Gate Valves:
1. Description:

a. Standard: MSS SP-80, Type 2.
b. CWP Rating: 200 psig.
c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
d. Ends: Threaded.
e. Stem: Bronze.
f. Disc: Solid wedge; bronze.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron, bronze, or aluminum.

B. Class 150, RS, Bronze Gate Valves:
1. Description:

a. Standard: MSS SP-80, Type 2.
b. CWP Rating: 300 psig.
c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
d. Ends: Threaded.
e. Stem: Bronze.
f. Disc: Solid wedge; bronze.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron.

C. Class 125, OS&Y, Iron Gate Valves:
1. Description:

a. Standard: MSS SP-70, Type I.
b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
c. NPS 14 to NPS 24, CWP Rating: 150 psig.
d. Body Material: ASTM A 126, gray iron with bolted bonnet.
e. Ends: Flanged.
f. Trim: Bronze.
g. Disc: Solid wedge.
h. Packing and Gasket: Asbestos-free.

D. Class 250, OS&Y, Iron Gate Valves:
1. Description:

a. Standard: MSS SP-70, Type I.
b. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig.
c. NPS 14 to NPS 24, CWP Rating: 300 psig.

d. Body Material: ASTM A 126, gray iron with bolted bonnet.
e. Ends: Flanged.
f. Trim: Bronze.
g. Disc: Solid wedge.
h. Packing and Gasket: Asbestos free.

2.13 CHAINWHEELS

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

1. Babbitt Steam Specialty Co.
2. Roto Hammer Industries.
3. Trumbull Industries.

B. Description: Valve actuation assembly with sprocket rim, chain guides, chain, and attachment brackets for mounting chainwheels directly to handwheels.

1. Sprocket Rim with Chain Guides: Ductile or cast iron, Aluminum, of the type and size required for the valve.
2. Chain: Hot-dip-galvanized steel, of size required to fit sprocket rim.

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

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

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that the 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 them 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 the stem at or above the center of the pipe.

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

E. Install chain wheels on operators for all valves NPS 4 and larger and more than 96 inches above the floor. Extend chains to 60 inches above the finished floor.

F. Install valve tags. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for valve tags and schedules.

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

1. Swing Check Valves: In horizontal position with hinge pin level.
2. Center-Guided and Plate-Type Check Valves: In horizontal or vertical position, between flanges.
3. Lift Check Valves: With stem upright and plumb.

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. Throttling Service: Globe valves or ball valves.
2. Positive Shutoff: globe, ball, gate, or butterfly

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

C. Select valves with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where the solder-joint valve-end option is indicated in valve schedules.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where the threaded valve-end option is indicated in valve schedules.
3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where the threaded valve-end option is indicated in valve schedules.
6. For Steel Piping, NPS 5 and Larger: Flanged ends.

7. For valves exposed to fuel, oil, gasoline or other hydrocarbons, use NBR nitrile-butadiene rubber gaskets and seats.
8. For valves exposed to glycol, UV, and hydronic applications, EPDM gaskets and seats.

D. Valves pressure rating shall be rated for the service that they are installed in, with a 150% factor of safety. All valves shall be class 150 or greater at a minimum.

3.5 CHILLED-WATER HOT WATER SCHEDULE VALVE SCHEDULE

A. Pipe NPS 3 ½" and Smaller: Bronze angle or globe valves, Class 150, bronze nonmetallic disc, with soldered or threaded ends.

B. Pipe NPS over 3-1/2: Iron globe valves, Class 150 with flanged ends.

END OF SECTION 230523.11

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. Pipe stands.
7. Equipment supports.

B. Related Sections:

1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Section 230516 "Expansion Fittings and Loops for HVAC Piping" for pipe guides and anchors.
3. Section 233113 "Metal Ducts" for duct hangers and supports.

1.3 DEFINITIONS

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

1.4 PERFORMANCE REQUIREMENTS

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

B. Structural Performance: Hangers and support 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 multiple pipes, including pipe stands, capable of supporting the combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting the combined operating weight of supported equipment and connected systems and components.
3. Design seismic-restraint hangers and supports for piping and equipment.

1.5 ACTION SUBMITTALS

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

B. Shop Drawings: Show fabrication and installation details and include calculations for the following: Product Data for components:

1. Trapeze pipe hangers.
2. Metal framing systems.
3. Pipe stands.
4. Equipment supports.

C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of trapeze hangers.
2. Design Calculations: Calculate requirements for designing trapeze hangers.

1.6 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.7 QUALITY ASSURANCE

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

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

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

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

C. Copper Pipe Hangers:

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

2.2 TRAPEZE PIPE HANGERS

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

2.3 FIBERGLASS HANGERS FOR STEEL PIPE.

A. Clevis-Type, Fiberglass Pipe Hangers:

1. Description: Similar to MSS SP-58, Type 1, steel pipe hanger except the hanger is made of fiberglass or fiberglass-reinforced resin.
2. Hanger Rods: Continuous-thread rod, washer, and nuts made of stainless steel.

B. Strap-Type, Fiberglass Pipe Hangers:

1. Description: Similar to MSS SP-58, Type 9 or Type 10, steel pipe hanger except the hanger is made of fiberglass-reinforced resin.
2. Hanger Rod and Fittings: Continuous-thread rod, washer, and nuts made of stainless steel.

2.4 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. B-line, an Eaton business.
    b. Flex-Strut Inc.
    c. Thomas & Betts Corporation; A Member of the ABB Group.
    d. Unistrut; Part of Atkore International.
    e. Wesanco, Inc.

2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.

3. Standard: MFMA-4.
4. Channels: Continuous slotted steel channel with inturned lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into a channel slot and, when tightened, prevent slipping along the channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washers made of carbon steel or stainless steel.
7. Metallic Coating: Electroplated zinc, Hot-dipped galvanized, Mill galvanized, In-line, hot galvanized, or Mechanically deposited zinc.
8. Paint Coating: Epoxy or Alkyd.
9. Plastic Coating: PVC or Polyurethane.
10. Combination Coating: .

B. Non-MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Anvil International.
    b. ERICO International Corporation.
    c. PHD Manufacturing, Inc.

2. Description: Shop- or field-fabricated pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.

3. Standard: Comply with MFMA-4.
4. Channels: Continuous slotted steel channel with inturned lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel or stainless steel.
7. Coating: Zinc, Paint or PVC.

2.5 THERMAL-HANGER SHIELD INSERTS

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

1. Clement Support Services.
2. ERICO International Corporation.
3. National Pipe Hanger Corporation.
4. Pipe Shields Inc.
5. Piping Technology & Products, Inc.
6. Rilco Manufacturing Co., Inc.

B. Insulation-Insert Material for Hot and cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig minimum compressive strength.

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

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

E. Insert Length: Extend 2 inches beyond the sheet metal shield for piping operating below ambient air temperature.

2.6 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened Portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

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

2.7 PIPE STANDS

A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

C. Low-Type, Single-Pipe Stand: One-piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.

D. High-Type, Single-Pipe Stand:

1. Description: Assembly of base, vertical, and horizontal members, and pipe support, for roof installation without membrane penetration.
2. Base: Stainless steel.
3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel roller-type pipe support.

E. High-Type, Multiple-Pipe Stand:

1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
2. Bases: One or more; plastic.
3. Vertical Members: Two or more protective-coated-steel channels.
4. Horizontal Member: Protective-coated steel channel.
5. Pipe Supports: Galvanized steel, clevis-type pipe hangers.

F. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on a permanent, stationary roof curb.

2.8 EQUIPMENT SUPPORTS

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

2.9 MISCELLANEOUS MATERIALS

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

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, 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.

C. Hanger Rods:
1. Hanger Rods: Hot-rolled steel threaded both ends, threaded one end, or continuously threaded. In accordance with the following schedule.

HANGER ROD SIZE SCHEDULE	
Pipe Size (in)	Min Rod Dia (in)
¾” to 2”	3/8”
½” to 3-1/2”	½”
4” to 5”	5/8”

6”	¾”
8” to 12”	7/8”
14”	1”
16” to 18”	1-1/8”
20”	1-1/4”
24”	1-1/2”
30”	1-7/8”

2. Hanger spacing shall be in accordance with the following schedule for the maximum allowable distance. Provide a hanger for all changes in direction.

PIPE SUPPORT SPACING SCHEDULE		
Pipe Material/ Size (in)	Maximum Horizontal Spacing (ft)	Maximum Vertical Spacing (ft)
Steel		
Up to 1 ¼”	8	15
1 ½” to 2 ½”	10	15
3” and over	12	15
Copper Pipe	8	10
Copper Tubing		
Up to 1 ¼”	6	10
1 ½” and over	8	10
PVC / HDPE		
Up to 1”	3	10
1 1/4” and over	4	10

3. Fiberglass piping supports spacing shall be in accordance with the manufacturer's guidelines.

2.10 VIBRATION ISOLATION HANGERS

A. Vibration isolation pipe hangers: pre-compressed and locked at the rated deflection by means of a resilient up-stop to keep the piping or equipment at a fixed elevation during installation. The hangers shall be designed with a release mechanism to free the spring after the installation is complete, and the hanger is subjected to its full load. Deflection shall be clearly indicated by means of a scale. Submittals shall include a drawing of the hanger showing the 30° capability. Hangers shall be type PC30N as manufactured by Mason Industries, Inc

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

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

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

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

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

D. Thermal-Hanger Shield Installation: Install in a 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 the concrete is placed and completely cured. Use operators that are licensed by the powder-actuated tool manufacturer. Install fasteners according to the powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete after the concrete is placed and completely cured. Install fasteners according to the 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. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

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

I. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

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

K. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger, and changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at the top of inserts.

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

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

N. Insulated Piping:

1. Attach clamps and spacers to piping.

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

2. Install MSS SP-58, Type 39, protection saddles on all piping with roller hangers installed outside of insulation. Fill interior voids with insulation that matches adjoining insulation.

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

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier not on roller hangers. Shields shall span an arc of 180 degrees.

    a. Option: Thermal-hanger shield inserts may be used. Include a steel weight-distribution plate for pipe NPS 4 and larger if the 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 inches thick.
    c. NPS 5 and NPS 6: 18 inches long and 0.06 inches 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 the protective shield.
6. Thermal-Hanger Shields: Install with insulation of the same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

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

B. Grouting: Place grout under supports for equipment and make the bearing surface smooth.

C. Provide lateral bracing to prevent swaying for equipment support.

3.3 METAL FABRICATIONS

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

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

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

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

3.4 ADJUSTING

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

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

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use the 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 cold galvanizing-repair paint to comply with ASTM A 780. ZRC cold galvanizing compound

3.6 HANGER AND SUPPORT SCHEDULE

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

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

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have a 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 or metal trapeze pipe hangers and metal framing systems and attachments for general service applications.

F. Use stainless-steel pipe hangers and stainless-steel attachments for hostile environment applications.

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. 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.
5. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8.
6. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
7. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
8. 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.
9. 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.
10. 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.
11. 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.
12. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from a single rod if horizontal movement caused by expansion and contraction might occur.
13. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur, but vertical adjustment is not necessary.
14. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24, if small horizontal movement caused by expansion and contraction might occur, and vertical adjustment is not necessary.
15. 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 °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 the concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to the top flange of a structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to the bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to the center of the bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to the 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 the top of beams if a hanger rod is required tangent to the flange edge.
8. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to the bottom of steel I-beams for heavy loads.
9. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to the bottom of steel I-beams for heavy loads, with link extensions.
10. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
11. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using a clip and rod. Use one of the following for the indicated loads:

    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.

12. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
13. Plate Lugs (MSS Type 57): For attaching steel beams if flexibility at the beam is required.

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 the 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.
9. Install vibration isolation hangers or supports on all piping connected to motor-driven equipment for a distance of 20’ or the first two hangers.

P. Comply with MSS SP-69 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 powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

3.7 MISCELLANEOUS:

A. Equipment bases and supports.
1. Provide housekeeping pads of concrete, minimum 4 inches thick and extending 6 inches beyond supported equipment. Champers edges all four sides. Provide dowels in the concrete floor for equipment that is seismically braced.

2. Provide templates, anchor bolts, and accessories for mounting and anchoring equipment. Provide all equipment, pumps, air handling units, etc.
3. Refer to 23 0548 Vibration controls for HVAC piping and piping and equipment for vibration inertia bases.
4. Construct supports of steel members. Brace and fasten with flanges bolted to the structure.
   Provide rigid anchors for pipes after vibration isolation components are installed.

B. Flashing.
   1. Provide flexible flashing and metal counterflashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.
   2. Flash piping projecting above finished roof surface with prefabricated steel reinforced boot and counter flashing sleeve.

C. Sleeves.
   1. Sleeves are required for all piping passing through walls and/or slabs. Sleeve diameter to be large enough to accommodate insulated piping.
   2. Sleeves through interior non-fire-rated walls are to have an annular space between pipe and sleeve filled with materials specified in Division 1.
   3. Sleeves through fire-rated walls to have an annular space filled with fire-stopping wrapping strips and expanding caulking applied with a caulking gun for a minimum depth of 3” or in another manner suitable for the application as recommended by the manufacturer.
      See Division 1.

D. Escutcheons:
   1. Provide escutcheons on all wall pipe penetrations that are visible outside MER spaces. All escutcheons shall be chrome-plated.

END OF SECTION 230529

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING EQUIPMENT

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Equipment labels
   2. Warning signs and labels.
   3. Pipe labels.
   4. Stencils.
   5. Valve tags.

1.3 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 be included in maintenance manuals.

1.4 COORDINATION

A. Coordinate the installation of identifying devices with the completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate the installation of identifying devices with the locations of access panels and doors.

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

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable manufacturers offering equivalent products

1. Atlantic Engraving Company.
2. Seton Name Plate Co.
3. MSI Services

B. Substitutions as per Contract Requirements

2.2 EQUIPMENT LABELS

A. Metal Labels for Equipment:
1. Material and Thickness: Brass 0.032-inch, stainless steel 0.025-inch, aluminum, 0.032-inch or anodized aluminum, 0.032-inch minimum thickness, with predrilled holes.
2. Letter Color: Black
3. Background Color: White
4. Minimum Label Size: Length and width vary for required label content, but not less than 3”x5”
5. Minimum Letter Size: 1” inch for equipment mounted on the floor or on a stand. 2” for hanging equipment.
6. Fasteners: Stainless steel rivets or self-tapping screws.
7. Adhesive: not allowed.

B. Plastic Labels for Equipment:
1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, with predrilled holes.
2. Letter Color: Black
3. Background Color: White
4. Minimum Label Size: Length and width vary for required label content, but not less than 3”x5”
5. Minimum Letter Size: 1” inch for equipment mounted on the floor or on stands. 2” for hanging equipment.
6. Fasteners: Stainless steel rivets or self-tapping screws.
7. Adhesive: Contact-type permanent adhesive, compatible with the label and with substrate.

C. Label Content: Include the equipment's drawing designation or unique equipment number based on (plans, details, and schedules). is specified.

2.3 WARNING SIGNS

A. Material and Thickness: Multilayer, multicolor, plastic signs for mechanical engraving, 1/8 inch thick, with predrilled holes.

B. Letter Color: White.

C. Background Color: Red

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

E. Minimum Label Size: 6” x 6”.

F. Minimum Letter Size: 1” inch for name plates for equipment mounted on stands or on the floor. 2” for hanging equipment.

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

H. Adhesive: Not applicable

I. Label Content: Include caution and warning information, plus emergency notification instructions.
   1. Example. “BYPASS VALVE – NORMALLY CLOSED”. “SUMMER WINTER CHANGE OVER VALVE”

2.4 PIPE AND DUCT LABELS

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

B. Pretensioned Pipe Labels: Recoiled, semirigid plastic formed to fully cover the circumference of the pipe with permanent adhesive backing.

C. Label Contents: Include identification of piping or duct service using the same designations or abbreviations as used on the drawings. Include flow direction arrows.

D. Lettering Size: Minimum 1-1/2 inches high.

E. Color; green or red background, white lettering, or as per ANSI requirements.

2.5 STENCILS- Not Used.

2.6 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/2-inch letters.
   1. Tag Material: Brass, 0.032-inch minimum thickness with predrilled holes.
   2. Fasteners: Brass or stainless steel, wire, beaded chain, or S-hook.
   3. Indicate service and valve number.
   4. Example: HW-1

2.7 VALVE SCHEDULES:

1. Minimum size 8-1/2” x 11”
2. Type written on bond paper and laminated in clear plastic.
3. Frame in a metal frame with glass.

4. Provide a separate schedule for each service.
5. Example:

VALVE TAG SCHEDULE			
No.	size	Service	N.O./N.C.

PART 3 EXECUTION

3.1 PREPARATION

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

3.2 EQUIPMENT

A. Install identifying devices after completion of insulation coverings or painting.

B. Identify all equipment, including pumps, air handlers, air-cooled condensers, boilers, chillers, pumps, packaged AC units, and hot water heaters with nameplates. Small devices, such as in-line pumps, may be identified with metal tags. Identify the service of all air handling units, AC units, split, and packaged units. I.E., Ground floor offices.

C. Identify control panels and major control components outside panels with nameplates

D. Tag automatic controls, instruments, and relays. Key to control schematic.

3.3 DUCT LABEL INSTALLATION

A. Install identifying ductwork after completion of insulation coverings. Painted ductwork in occupied areas such as theaters, classrooms, or offices does not require labels.

B. Identify all ductwork every 20’ with flow arrows and unit or air handler served, as well as service, such as SUPPLY AIR, RETURN AIR, EXHAUST AIR.

C. All smoke purge system components (including supply and exhaust ductwork) shall be clearly labeled. Identify the function and zone on the components, e.g., SMOKE PURGE SUPPLY - ZONE 1; SMOKE PURGE EXHAUST - ZONE 3; SMOKE DAMPER NO. 5; etc. Labeling shall be 6" high red letters located (every 10 feet along the duct).

D. Identify all Smoke Dampers and Fire Dampers. All dampers shall be sequentially numbered by floor. For example, fire damper - FD-1-1 (Fire damper #1, floor 1). The tag shall be 1" high red letters located on the damper. Provide a red dot stencil on the ceiling below the damper.

3.4 PIPE LABEL INSTALLATION

A. Install identifying devices after completion of insulation coverings or painting.

B. Painting of Pipe: All piping that does not receive insulation shall be painted with rust-inhibiting machine enamel. The color shall be in accordance with ANSI requirements for the specific service.
   1. Clean piping in accordance with paint manufacturer recommendations. Remove all grease, oil, and surface rust before painting.
   2. All new and existing fuel oil piping shall be painted yellow before labeling.
   3. All new and existing gas piping shall be painted yellow before labeling.
   4. Label piping as per ANSI color code

C. Locate pipe labels where piping is exposed and 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 the flow pattern is not obvious, mark each pipe at the branch.
   3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
   4. At access doors, manholes, and similar access points that permit a view of concealed piping.
   5. Near major equipment items and other points of origination and termination.
   6. Spaced at maximum intervals of 25’ along each run. Reduce intervals to 15 feet in areas of congested piping and equipment.

D. Directional Flow Arrows: provide directional flow arrows spaced at maximum intervals of 25’ along each run. Reduce intervals to 15 feet in areas of congested piping and equipment.

E. All HVAC piping shall be labeled. The background color and service name shall be in accordance with ANSI and industry standards.

3.5 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in all HVAC piping systems, except check valves, and valves within factory-fabricated equipment units, and shutoff valves.

B. For renovation applications, all new mechanical valves shall be tagged in sequence with the existing valve.

C. Provide a valve tag scheduled as described in section 2.8

D. Identify valves in main and branch piping. with brass tags. Main shutoff valves for boilers shall be furnished with special wording as required by ASME IV HG 710.5 "Supply or Return Valve No. X - Do Not Close Without Also Closing Supply or Return Valve No. Y".

3.6 WARNING-TAG INSTALLATION

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

END OF SECTION 230553

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Balancing Air Systems:

    a. Constant-volume air systems.

2. Balancing Hydronic Piping Systems:
    a. Variable-flow hydronic systems.
    b. Primary-secondary hydronic systems.

3. Balancing steam systems.
4. Testing, Adjusting, and Balancing Equipment:

    a. Heat exchangers.
    b. fans
    c. Motors.
    d. Chillers.
    e. Condensing units.
    f. Boilers.
    g. Heat-transfer coils.

5. Testing, adjusting, and balancing existing systems and equipment.
6. Duct leakage tests.
7. Control system verification.

1.3 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.

1.4 PREINSTALLATION MEETINGS

A. TAB Conference: If requested by the engineer, 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.

1.5 ACTION SUBMITTALS

1.6 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 30 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.

C. Certified TAB reports.

D. Sample report forms.

E. 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.

1.7 QUALITY ASSURANCE

A. TAB Specialists Qualifications: Certified by AABC NEBB or TABB.

1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC or NEBB.
2. TAB Technician: Employee of the TAB specialist and certified by AABC or NEBB as a TAB technician.

B. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

1.8 FIELD CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during the entire TAB period. Cooperate with the Owner during TAB operations to minimize conflicts with the Owner's operations.

B. Partial Owner Occupancy: Owner may occupy completed areas of the building before Substantial Completion. Cooperate with the Owner during TAB operations to minimize conflicts with the 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, gauge cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that the locations of these balancing devices are applicable for the 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 the 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 gauge connections are installed directly at the pump inlet and outlet flanges or in the discharge and suction pipe before 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," ASHRAE 111, NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing," 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, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."
   2. Install and join new insulation that matches the 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 ALL SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain the 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 the 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 the air duct system is sealed as specified in Section 233113 "Metal Ducts."

M. Code requirements;

Each supply air outlet and zone terminal device shall be equipped with means for air balancing in accordance with the requirements of Chapter 6 of the International Mechanical Code. Discharge dampers used for air-system balancing are prohibited on constant-volume fans and variable-volume fans with motors 10 hp and larger. Air systems shall be balanced in a manner to first minimize throttling losses, then, for fans with system power greater than 1 hp, fan speed shall be adjusted to meet design flow conditions.

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by the fan manufacturer.

1. Measure total airflow.

    a. Set outside-air, return-air, and relief-air dampers for a 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. Obtain approval from the Engineer for the adjustment of fan speed higher or lower than the indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve the 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 indicate 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 indicate 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 the 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 GENERAL PROCEDURES FOR ALL HYDRONIC SYSTEMS

A. Prepare test reports for pumps, coils, and heat exchangers. Obtain approved submittals and manufacturer-recommended testing procedures. Cross-check the summation of required coil and heat exchanger flow rates with the 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 the liquid level in the expansion tank.
2. Check the 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.

D. Code requirements;
1. Individual hydronic heating and cooling coils shall be equipped with means for balancing and measuring flow. Hydronic systems shall be proportionately balanced in a manner to first minimize throttling losses, then the pump impeller

shall be trimmed, or the pump speed shall be adjusted to meet design flow conditions. Each hydronic system shall have the capability to measure pressure across the pumps and test ports at each side of each pump.

2. For systems 10 Hp and over, where throttle or balance valves are used on the discharge side of pumps, balancing shall be performed by adjusting the pump's speed at the variable frequency drive. The balance or throttle valves shall be used for positive shut-off and as a means of reading flow across the ports.

3. Flow shall be balanced to the total GPM given in the schedule for the pump and branch GPM as given on the plan. Total dynamic head (TDH), given in the plans, schedule, or specifications, is an estimate. The system shall be balanced such that the required flow is achieved by adjusting pump speed and branch balancing valves, as well as terminal unit balancing valves. Upon completion of balancing, the actual required TDH can be established. This shall be used as the design set point used to modulate pump speed.

3.7 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

A. Adjust pumps to deliver the total design GM

1. Measure total water flow.

   a. Position valves for full flow through coils.
   b. Measure flow by the main flow meter, if installed.
   c. If the main flow meter is not installed, determine the 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 the discharge pipe prior to any valves.
   b. Measure inlet pressure directly at the pump inlet flange or in the suction pipe prior to any valves or strainers.
   c. Convert pressure to head and correct for differences in gauge heights.
   d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on the 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 the pump discharge valve until the design water flow is achieved.

3. Monitor motor performance during procedures and do not operate the motor in an overloaded condition.

B. 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.

C. 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.

D. For systems with pressure-independent valves at terminals:

1. Measure differential pressure and verify that it is within the manufacturer's specified range.
2. Perform temperature tests after flows have been verified.

E. For systems without pressure-independent valves or flow-measuring devices at terminals:

1. Measure and balance coils by either the coil pressure drop or temperature method.
2. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

F. Verify final system conditions as follows:

1. Re-measure and confirm that the total water flow is within design.
2. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
3. Mark final settings.

G. Verify that memory stops have been set.

3.8 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

B. Adjust the variable-flow hydronic system as follows:

1. Verify that the differential-pressure sensor is located as indicated.
2. Determine whether there is diversity in the system.

C. For systems with no diversity:

1. Adjust pumps to deliver total design GPM

    a. Measure total water flow.

        1) Position valves for full flow through coils.
        2) Measure flow by the main flow meter, if installed.
        3) If the main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.

    b. Measure pump TDH as follows:

        1) Measure discharge pressure directly at the pump outlet flange or in the discharge pipe prior to any valves.
        2) Measure inlet pressure directly at the pump inlet flange or in the suction pipe prior to any valves or strainers.
        3) Convert pressure to head and correct for differences in gauge heights.
        4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on the manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
        5) With valves open, read pump TDH. Adjust the pump discharge valve until the design water flow is achieved.

    c. Monitor motor performance during procedures and do not operate the motor in an overloaded condition.

2. Adjust flow-measuring devices installed in mains and branches to design water flows.

    a. Measure flow in main and branch pipes.
    b. Adjust main and branch balance valves for design flow.
    c. Re-measure each main and branch after all have been adjusted.

3. Adjust flow-measuring devices installed at terminals for each space to design water flows.

    a. Measure flow at terminals.
    b. Adjust each terminal to design flow.
    c. Re-measure each terminal after it is adjusted.
    d. Position control valves to bypass the coil and adjust the bypass valve to maintain design flow.
    e. Perform temperature tests after flows have been balanced.

4. For systems with pressure-independent valves at terminals:

    a. Measure differential pressure and verify that it is within the manufacturer's specified range.
    b. Perform temperature tests after flows have been verified.

5. For systems without pressure-independent valves or flow-measuring devices at terminals:

    a. Measure and balance coils by either the coil pressure drop or temperature method.
    b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

6. Prior to verifying final system conditions, determine the system differential-pressure set point.
7. If the pump discharge valve was used to set total system flow with a variable-frequency controller at 60 Hz, at completion, open the discharge valve 100 percent and allow the variable-frequency controller to control the system differential-pressure set point. Record pump data under both conditions.
8. Mark final settings and verify that all memory stops have been set.
9. Verify final system conditions as follows:

    a. Re-measure and confirm that total water flow is within design.
    b. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
    c. Mark final settings.

10. Verify that memory stops have been set.

D. For systems with diversity:

1. Determine diversity factor.
2. Simulate system diversity by closing the required number of control valves, as approved by the design engineer.
3. Adjust pumps to deliver total design GPM

    a. Measure total water flow.

        1) Position valves for full flow through coils.
        2) Measure flow by the main flow meter, if installed.
        3) If the main flow meter is not installed, determine the flow by pump TDH or exchanger pressure drop.

    b. Measure pump TDH as follows:

        1) Measure discharge pressure directly at the pump outlet flange or in the discharge pipe prior to any valves.
        2) Measure inlet pressure directly at the pump inlet flange or in the suction pipe prior to any valves or strainers.
        3) Convert pressure to head and correct for differences in gauge heights.
        4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on the manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.

5) With valves open, read pump TDH. Adjust the pump discharge valve until the design water flow is achieved.

c. Monitor motor performance during procedures and do not operate the motor in an overloaded condition.

4. Adjust flow-measuring devices installed in mains and branches to design water flows.

   a. Measure flow in main and branch pipes.
   b. Adjust main and branch balance valves for design flow.
   c. Re-measure each main and branch after all have been adjusted.

5. Adjust flow-measuring devices installed at terminals for each space to design water flows.

   a. Measure flow at terminals.
   b. Adjust each terminal to design flow.
   c. Re-measure each terminal after it is adjusted.
   d. Position control valves to bypass the coil and adjust the bypass valve to maintain design flow.
   e. Perform temperature tests after flows have been balanced.

6. For systems with pressure-independent valves at terminals:

   a. Measure differential pressure and verify that it is within the manufacturer's specified range.
   b. Perform temperature tests after flows have been verified.

7. For systems without pressure-independent valves or flow-measuring devices at terminals:

   a. Measure and balance coils by either the coil pressure drop or temperature method.
   b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

8. Open control valves that were shut. Close a sufficient number of control valves that were previously open to maintain diversity, and balance terminals that were just opened.
9. Prior to verifying final system conditions, determine the system differential-pressure set point.
10. If the pump discharge valve was used to set total system flow with a variable-frequency controller at 60 Hz, at completion, open the discharge valve 100 percent and allow the variable-frequency controller to control the system differential-pressure set point. Record pump data under both conditions.
11. Mark final settings and verify that memory stops have been set.
12. Verify final system conditions as follows:

a. Re-measure and confirm that total water flow is within design.
b. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
c. Mark final settings.

13. Verify that memory stops have been set.

3.9 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 GPM

a. Position valves for full flow through coils.
b. Measure flow by the main flow meter, if installed.
c. If the 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 the discharge pipe before any valves.
b. Measure inlet pressure directly at the pump inlet flange or in the suction pipe before any valves or strainers.
c. Convert pressure to head and correct for differences in gauge heights.
d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on the 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 the pump discharge valve until the design water flow is achieved.

3. Monitor motor performance during procedures and do not operate the 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 the 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 the 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 the 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.

3.10 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 the 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 the number of fans and entering- and leaving-air temperatures.

3.11 PROCEDURES FOR CONDENSING UNITS

A. Verify proper rotation of fans.

B. Measure entering and leaving air temperatures.

C. Record fan and motor operating data.

3.12 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.

3.13 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 steam coil:

1. Dry-bulb temperature of entering and leaving air.
2. Airflow.
3. Inlet steam pressure.

D. 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.

3.14 DUCT LEAKAGE TESTS

A. All Ducts shall be sealed in accordance with specifications Section 23 31 13 Metal Ducts. All duct systems designed to operate at static pressures in excess of 3 inches w.g. or ductwork that is part of a life safety system, including smoke control, smoke purge, stair pressurization, and all ductwork that is located outdoors, shall be leak tested in accordance with the procedures given in the *SMACNA HVAC Air Duct Leakage Test Manual.*

Leakage and Seal Classification Table			
System operating pressure in wc	<2" low	2"≥med<3"	High≥3"
Seal Class	C	B	A
Sealing	Transverse joints	Transverse joints and seams	Transverse joints and seams and all wall penetrations
Leakage class CL factor - Rectangular me	24	12	4
Leakage class CL factor - round metal	12	6	3

B. Air leakage rates must *(CL)* less than or equal to 4.0 as determined in accordance with the equations below

1. $CL=F/P^{0.65}$ where:
2. *F* -The measured leakage rate in cfm per 100 square feet of duct surface.
3. *P* -The static pressure of the test.

C. Documentation shall be furnished by the test and balancing contractor demonstrating that representative sections totaling at least 25 percent of the duct area have been tested and that all tested sections meet the requirements of this section.

D. Perform duct pressure testing in coordination with the Installer.

E. Verify that proper test methods are used and that leakage rates are within specified tolerances.

F. Report: Submit a report indicating which ductwork sections were tested. Provide a single-line or double-line duct submittal drawing. The drawing shall indicate all systems

in their entirety to 3/8’ =1’-0” scale. Sections where air leakage testing shall be clearly indicated.

G. The report shall include a full test procedure, including how the ductwork was isolated for pressure testing, the pressure of the test, and the duration of the test.

H. Submit duct pressure test procedures used for this project.

I. Submit a summary of test results on a section-by-section basis, to include all CL, F, P, and time.

J. Witness the duct pressure testing performed by the Installer.

K. Verify that proper test methods are used and that leakage rates are within specified tolerances.

L. Report deficiencies observed.

3.15 CONTROLS VERIFICATION

A. In conjunction with system balancing, perform the following:

1. Verify the temperature control system is operating within the design limitations.
2. Confirm that the sequences of operation comply 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 the correct controller.
8. Verify that controlled devices travel freely and are in the position indicated by the controller: open, closed, or modulating.
9. Verify the location and installation of sensors to ensure that they sense only the intended temperature, humidity, or pressure.

B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

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 the "Examination" Article, prepare a report on the adequacy of design for systems balancing devices. Recommend changes and additions to systems balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: Prepare progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.18 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
2. Include a list of instruments used for procedures, along with proof of calibration.
3. Certify the 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 the 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 affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with a single-line diagram and include the following:

1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Water and steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.
6. Balancing stations.
7. Position of balancing devices.

E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:

1. Unit Data:

    a. Unit identification.
    b. Location.
    c. Make and type.
    d. Model number and unit size.
    e. Manufacturer's serial number.

f. Unit arrangement and class.
g. Discharge arrangement.
h. Sheave make, size in inches, and bore.
i. Center-to-center dimensions of sheave and amount of adjustments in inches.
j. Number, make, and size of belts.
k. Number, type, and size of filters.

2. Motor Data:

a. Motor make, and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches, and bore.
f. Center-to-center dimensions of sheave and amount of adjustments in inches.

3. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan rpm.
d. Discharge static pressure in inches wg.
e. Filter static-pressure differential in inches wg.
f. Preheat-coil static-pressure differential in inches wg.
g. Cooling-coil static-pressure differential in inches wg.
h. Heating-coil static-pressure differential in inches wg.
i. Outdoor airflow in cfm.
j. Return airflow in cfm.
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 o.c.
f. Make and model number.
g. Face area in sq. ft..
h. Tube size in NPS.
i. Tube and fin materials.
j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

    a. Airflow rate in cfm.
    b. Average face velocity in fpm.
    c. Air pressure drop in inches wg.
    d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
    e. Return-air, wet- and dry-bulb temperatures in deg F.
    f. Entering-air, wet- and dry-bulb temperatures in deg F.
    g. Leaving-air, wet- and dry-bulb temperatures in deg F.
    h. Water flow rate in gpm.
    i. Water pressure differential in feet of head or psig.
    j. Entering-water temperature in deg F.
    k. Leaving-water temperature in deg F.
    l. Refrigerant expansion valve and refrigerant types.
    m. Refrigerant suction pressure in psig.
    n. Refrigerant suction temperature in deg F.
    o. Inlet steam pressure in psig.

G. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

    a. System identification.
    b. Location.
    c. Make and type.
    d. Model number and size.
    e. Manufacturer's serial number.
    f. Arrangement and class.
    g. Sheave make, size in inches, and bore.
    h. Center-to-center dimensions of sheave and amount of adjustments in inches.

2. Motor Data:

    a. Motor make, and frame type and size.
    b. Horsepower and rpm.
    c. Volts, phase, and hertz.
    d. Full-load amperage and service factor.
    e. Sheave make, size in inches, and bore.
    f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
    g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):

    a. Total airflow rate in cfm.
    b. Total system static pressure in inches wg.
    c. Fan rpm.

d. Discharge static pressure in inches wg.
e. Suction static pressure in inches wg.

H. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:

a. System and air-handling-unit number.
b. Location and zone.
c. Traverse air temperature in deg F.
d. Duct static pressure in inches wg.
e. Duct size in inches.
f. Duct area in sq. ft.
g. Indicated airflow rate in cfm.
h. Indicated velocity in fpm.
i. Actual airflow rate in cfm.
j. Actual average velocity in fpm.
k. Barometric pressure in psig.

I. Air-Terminal-Device Reports:

1. Unit Data:

a. System and air-handling unit identification.
b. Location and zone.
c. Apparatus used for test.
d. Area served.
e. Make.
f. Number from system diagram.
g. Type and model number.
h. Size.
i. Effective area in sq. ft.

2. Test Data (Indicated and Actual Values):

a. Airflow rate in cfm.
b. Air velocity in fpm.
c. Preliminary airflow rate as needed in cfm.
d. Preliminary velocity as needed in fpm.
e. Final airflow rate in cfm.
f. Final velocity in fpm.
g. Space temperature in deg F.

J. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data:

a. System and air-handling-unit identification.
b. Location and zone.
c. Room or riser served.
d. Coil make and size.
e. Flowmeter type.

2. Test Data (Indicated and Actual Values):

a. Airflow rate in cfm.
b. Entering-water temperature in deg F.
c. Leaving-water temperature in deg F.
d. Water pressure drop in feet of head or psig.
e. Entering-air temperature in deg F.
f. Leaving-air temperature in deg F.

K. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:

1. Unit Data:

a. Unit identification.
b. Location.
c. Service.
d. Make and size.
e. Model number and serial number.
f. Water flow rate in GPM
g. Water pressure differential in feet of head or psig.
h. Required net positive suction head in feet of head or psig.
i. Pump rpm.
j. Impeller diameter in inches.
k. Motor make and frame size.
l. Motor horsepower and rpm.
m. Voltage at each connection.
n. Amperage for each phase.
o. Full-load amperage and service factor.
p. Seal type.

2. Test Data (Indicated and Actual Values):

a. Static head in feet of head or psig.
b. Pump shutoff pressure in feet of head or psig.
c. Actual impeller size in inches.
d. Full-open flow rate in gpm.
e. Full-open pressure in feet of head or psig.
f. Final discharge pressure in feet of head or psig.
g. Final suction pressure in feet of head or psig.
h. Final total pressure in feet of head or psig.
i. Final water flow rate in gpm.

j. Voltage at each connection.
k. Amperage for each phase.

L. 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 inspect in the presence of the commissioning authority.

B. 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.

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

SECTION 230713 - HVAC DUCTWORK INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Ductwork insulation.

B. Duct Liner.

C. Insulation jackets.

1.02 RELATED SECTIONS

A. Section 23 05 53 - Identification for HVAC Piping and Equipment.

B. Section 23 31 13 - Ductwork.

1.03 REFERENCES

A. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.

B. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation.

C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

D. NAIMA National Insulation Standards.

E. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials.

F. SMACNA - HVAC Duct Construction Standards - Metal and Flexible.

G. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.

H. ASHRAE 90-75 – Insulation Standards

1.04 SUBMITTALS

A. Division 1 - Submittals: Procedures for submittals.

B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

C. Submit manufacturers' insulation instructions under the provisions of Division 1.

1.05 QUALITY ASSURANCE

A. Applicator Qualifications: Company specializing in performing the work of this section with a minimum of three years of experience approved by the manufacturer.

1.06 REGULATORY REQUIREMENTS

A. Materials: Flame spread/fuel contributed/smoke developed rating of 25/50/50 in accordance with NFPA 255.

B. Insulation thickness shall comply with all applicable energy conservation codes.

1.07 ENVIRONMENTAL REQUIREMENTS

A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.

B. Maintain temperature during and after installation for a minimum period of 24 hours.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS - INSULATION

A. Owen Corning Fiberglass Corp.

B. Manville Industrial Products

C. Certain Teed Corporation

D. 3M Corporation "Firemaster" for Kitchen Exhaust

E. Substitutions: Under provisions of Division 1.

2.02 GLASS FIBER, RIGID

A. Type A: Flexible glass fiber duct insulation; ANSI/ASTM C612; commercial grade; "K" value of 0.25 at 75º F; minimum density of 1-1/2 pounds per cu. ft.; factory applied vapor barrier jacket of 0.7 mil minimum aluminum foil laminated to glass fiber reinforced Kraft paper. Similar to Owens-Corning type FRK-25-ED Type 150 commercial grade.

B. Type B: Rigid glass fiber board insulation with resin binder; ANSI/ASTM C612, Class 1; "K" value of 0.23 at 75º F, minimum density of 6 pounds per cu. ft; factory applied white Kraft faced flame retardant vapor barrier jacket of aluminum laminated to heavy Kraft paper with a flame retardant snuffer type adhesive and reinforced with glass fibers; permeability of 0.2. Similar to Owens-Corning type 705 with AST jacket.

C. Type C: Molded block or board insulation made of asbestos-free hydrous calcium silicate; "K" value of 0.42 at 200º F; minimum density of 14 pounds per cubic foot; temperature range up to 1200º F.

D. Type D1: Flexible Glass Duct Liner: (For standard applications)

ANSI/ASTM C553; "K" value of 0.23 at 75º F; minimum density of 1.5 pounds per cu. ft.; surface finish of black pigmented fire-resistant, resilient mastic coated on the air side for maximum velocity of 4000 feet per minute.

a. Maximum Thermal Conductivity

1) Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
2) Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.

b. 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 shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.

c. Solvent Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.

E Type D2: Flexible Elastomeric Duct Liner: (Wet Or Damp Applications Including Natatorium And Saunas).

Flexible Elastomeric Duct Liner: Preformed, cellular, closed-cell, sheet materials complying with ASTM C 534, Type II, Grade 1; and with NFPA 90A or NFPA 90B.

1. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
2. Liner Adhesive: As recommended by the insulation manufacturer and complying with NFPA 90A or NFPA 90B.

F. Type "E" – Fire-resistant duct wrap consisting of lightweight, non-asbestos high temperature non-organic ceramic fiber blanket encapsulated in foil/scrim having a service temperature rating of 2300º F. Wrap shall be applied in two temperature layers to provide a two-hour rated enclosure assembly. Bonding material shall be 304 stainless steel, ¾" wide and .015" thick.

G Adhesives: Waterproof, fire-retardant type. Smoke and flame spread rating less then 50.

H. Indoor Jacket: Pre-sized glass cloth, minimum 7.8 oz/sq. yd unless otherwise specified above.

I. Outdoor Jackets: All exterior ductwork shall be jacketed as per the specification and jacketed with Alumaguard Cool Wrap by Polyguard. For a watertight insulation jacket, install as per the manufacturer's recommendations. Furnish all mastics and adhesives as per the manufacturer's system.

PART 3 EXECUTION

3.01 EXAMINATION

A. Install insulation materials only after ductwork has been sealed, tested, and approved.

B. All insulated surfaces are to be cleaned and dried of any foreign material. This includes but is not limited to oil, water, dirt, rust, and scale. Completely cover the entire surface to present a tight, smooth appearance.

3.02 INSTALLATION

A. Division 1 - Quality Control: Install materials in accordance with the manufacturer's instructions, specification requirements, and in compliance with local code

B. Install in accordance with NAIMA National Insulation Standards.

C. Apply insulation in such a way as to permit expansion and/or contraction of metal without causing damage to insulation, joints, seams, or finish.

D. Do not apply additional coats of mastic, adhesive, or sealers until previous coats have thoroughly dried.

E. Fill in all surface imperfections such as chipped edges, small joints, cracks, holes, and small voids with materials to match the insulation. Make smooth with a skim coat of insulation cement. Extend surface finish to protect all surfaces and leave no exposed edges.

F. Provide flashing for insulation installed outdoors to enclose all exposed edges or ends.

G. Repair existing insulation where damaged by new work. Use materials to match the existing.

H. Cut, score, or miter insulation to fit the slope and contour of the surface to be covered. Insulation up to 3 inches thick is to be applied in a single layer. Over 3 inches apply in multiple layers, with joints staggered.

3.03 HVAC DUCT INSULATION SCHEDULE

Service	Type	Insulation Thickness
[1]Interior H&V, AC systems; SA, RA & EA, ductwork that is exposed in equipment rooms.	B	1-1/2"
[1]Interior H&V, AC systems; SA, RA & EA including flexible run-outs, that is concealed.	A	2"
Outside air intake ductwork All	B	1 1/2"
[2]Exterior H&V, AC systems; SA, RA & RA, ductwork that is exposed outdoors.	B	2”
Acoustically line all SA & RA ductwork For a distance of 20’ from the fan inlet and outlet and 10’ downstream of all VAV boxes.	D1/D2	1/2”
[5]Interior exposed H&V, AC systems; SA, RA located in conditioned spaces rectangular, spiral, round or oval ductwork;		

Located in conditioned space	D1/D2	1 "
Located in unconditioned space, plenum or equipment room.	D1/D2	11/2”
[4]Smoke purge exhaust and supply	E	2” (not used)
All Stair pressure ductwork	E	2” (not used)
Generator exhaust pipe and muffler	C	2” (not used)
Kitchen hood exhaust (grease duct) layers.	E	2” applied in (2) 1”

1. Reduce external insulation to 1” for internally lined ductwork except for outdoor installations. On outdoor installations, insulation thickness shall be as scheduled but not less than the height of the standing seams or angle bracing.
2. Insulation Thickness shall be no less than the size indicated or the height of standing seams or angle bracing.
3. Outside air intake and Kitchen exhaust ducts shall not be internally lined.
4. Smoke purge system supply and exhaust ducts passing through a rated Exit-way or within a fire-rated suspended ceiling assembly, and all Kitchen Hood exhaust ducts shall be wrapped with thermal fiber - two (2) hour or encased in a two (2) hour-rated enclosure. Trapeze hangers are to be outside of thermal wrapping.
5. All square or rectangular ductwork that is exposed to view in finished spaces shall be internally insulated.
6. All exterior ductwork shall be insulated and jacketed.

END OF SECTION 230713

SECTION 230719 - HVAC PIPING INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Piping insulation

B. Jackets and accessories

1.02 RELATED SECTIONS

A. Section 23 05 53 – Identification for HVAC Piping and Equipment.

B. Section 23 21 13 - Hydronic Piping.

1.03 REFERENCES

A. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded Hot Plate Apparatus

B. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement.

C. ASTM C449/C449M - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement

D. ASTM C518 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus

E. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.

F. ASTM C547 - Standard Specification for Mineral Fiber Preformed Pipe Insulation

G. ASTM C552 - Standard Specification for Cellular Glass Thermal Insulation.

H. ASTM C578 - Standard Specification for Preformed, Cellular Polystyrene Thermal Insulation

I. ASTM C610 - Standard Specification for Expanded Perlite Block and Pipe Thermal Insulation

J. ASTM E84, NFP 255, UL 723 - Standard Test Method for Surface Burning Characteristics of Building Materials

N. ASHRAE 90-75 - Insulation Standards

1.04 SUBMITTALS FOR REVIEW

A. Division 1 – Submittal Requirements.

B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

C. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: A Company specializing in manufacturing the Products specified in this section, with a minimum of three years of experience.

1.06 REGULATORY REQUIREMENTS

A. Conform to the maximum flame spread/smoke developed rating of 25/50 in accordance with NFPA 255

B. Insulation thickness shall comply with applicable Energy Conservation Codes.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Pittsburgh Corning Corporation

B. CertainTeed Corporation.

C. Armstrong Corporation.

D. Manville Industrial Products.

E. Owens-Corning Fiberglass Corporation

F. Polyguard

2.02 INSULATION

A. Type A: Molded glass fiber insulation; ANSI/ASTM C547; 'k' value of 0.23 at 75º F; noncombustible. Minimum density of 3.5 lbs./cu. Ft.; temperature range 35º F to 450º F. Water Vapor Transmission: 0.05 perm-inch. Flame-spread index of less than 25 and a smoke-developed index of less than 50. White fire retardant all service jacket.

B. Type B: Cellular glass insulation; ASTM C552; 'K' Value of 0.53 at 75°F; non-combustible. Minimum density of 8.0 lbs./cu. ft. similar to Pittsburgh Corning Foamglass.

C. Type C: Elastomeric insulation; ASTM C518, C177; 'K' Value of 0.27 at 75°F; non-combustible. Similar to Armstrong “AP Armaflex” 25/50. Temperature range -40°F to 220º F. Water Vapor Transmission: 0.05 perm-inch. flame-spread index of less than 25 and a smoke-developed index of less than 50.

2.03 JACKETS

A. Interior Applications:

1. Insulation Type A - Factory applied, white, flame retardant, all service (ASJ) vapor barrier jacket of .001" aluminum foil laminated to Kraft paper with a flame retardant snuffer type adhesive reinforced with glass fibers and having a self-sealing lap. Provide 2" longitudinal lap and 4" circumferential sealing strips. Permeability .02 perm.

B. Exterior Applications:

1. Insulation Type A thickness as scheduled with ASJ vapor barrier jacket (if applicable) - Cover factory interior jacket with Alumaguard Cool Wrap by Polyguard, rubberized bitumen membrane designed specifically to be installed over insulation on exterior piping, tanks, vessels, and equipment. The membrane shall be 'peel and stick', self-healing if punctured, UV stable, and will expand and contract with the mechanical system. All seams shall be sealed water-tight. Permeability .0053 perm

C. Piping exposed in Mechanical Rooms or any space:

1. All exposed piping and fittings shall be completely covered with white Zeston 2000 PVC insulated piping and fitting covers. Apply as per the manufacturer with perma-weld adhesive.

2.04 ACCESSORIES

A. Insulation Bands: ¾" wide; 0.007-inch-thick aluminum.

B. Metal Jacket Bands: 3/8" wide; 0.015-inch-thick aluminum.

C. Insulating Cement: ANSI/ASTM C195; hydraulic setting mineral wool.

D. Finishing Cement: ASTM C449

E. Fibrous Glass Cloth: Untreated; 9 oz/sq. yd weight.

F. Adhesives: Compatible with insulation and fire retardant.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that piping has been tested before applying insulation materials.

B. Verify that surfaces are clean and dry, with all foreign material removed. This includes but is not limited to water, oil, dirt, scale, and rust.

D. Only insulation and finish materials, including adhesive cements and mastic, which conform to the requirements of all governing codes and ordinances, shall be used.

3.02 INSTALLATION

A. Division 1 – Quality Control: Install materials in accordance with the manufacturer's instructions and the best practice of the trade.

B. Install in accordance with NAIMA National Insulation Standards.

C. Insulation on all piping shall be vapor sealed. On insulated piping with a vapor barrier, insulate all fittings, valves, unions, flanges, strainers, flexible connections, and expansion joints. Vapor seal all exposed edges with jacket material and vapor barrier-type adhesive.

D. Repair or replace any existing insulation and surface finish disturbed or damaged by the installation of new work using materials to match existing.

E. Apply insulation to cover the metal surface completely. Surface shall be applied to present a tight, smooth appearance.

F. Exposed Piping: Locate insulation and cover seams in the least visible locations.

G. For hot piping conveying fluids 140 degrees F or less, and on insulated piping without vapor barrier, do not insulate flanges and unions at the equipment, but bevel and seal ends of insulation.

H. For hot piping conveying fluids over 140 degrees F, insulate flanges and unions at the equipment.

I. Neatly finish insulation at supports, protrusions, and interruptions.

J. Do not use staples on vapor barrier insulation.

L. Inserts and Shields:

1. Application: All insulated Piping 2 inches in diameter or larger shall be installed with inserts and shields as follows.
2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
3. Insert location: Between the support shield and piping under the finish jacket.
4. Insert configuration: Minimum 6 inches long, of the same thickness and contour as adjoining insulation; may be factory fabricated.
5. Insert material: Hydrous calcium silicate insulation or other heavy-density insulating material suitable for the planned temperature range.

M. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions.

3.3 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 the roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation. Seal the joint with joint sealant.
3. Extend the jacket of outdoor insulation outside the roof flashing at least 2 inches below the top of the roof flashing.
4. Seal the jacket to the 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 the wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation. Seal the joint with joint sealant.
3. Extend the jacket of outdoor insulation outside wall flashing and overlap the wall flashing at least 2 inches (50 mm).
4. Seal the 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 Division 7 Section "Through-Penetration Firestop Systems" 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 Division 7 Section "Through-Penetration Firestop Systems."

3.4 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from the same material and density as adjacent pipe insulation. Each piece shall be butted tightly against the adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of the same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with a tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of the same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of the same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so the 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 a vapor barrier.

6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install a fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match the size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make a removable flange and union insulation from sectional pipe insulation of the same thickness as that on the adjoining pipe. Install the same insulation jacket as the adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or unions long at least two times the insulation thickness over adjacent pipe insulation on each side of the flange or union. Secure the 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 the same manner as for flanges, except divide the two-part section on the vertical center line of the 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 a tie wire. Extend insulation at least 2 inches (50 mm) over adjacent pipe insulation on each side of the valve. Fill the space between the flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After the first coat is dry, apply and trowel a second coat to a smooth finish.

3.05 INSULATION SCHEDULE

HVAC PIPE INSULATION SCHEDULE							
SERVICE	INSULATION	TEMPERATURE	NOMINAL PIPE SIZE				
	TYPE	RANGE (F°)	<1"	1" to< 1 1/2"	1 1/2" to< 4"	4" to< 8"	≥ 8"
			INSULATION THICKNESS				
Hot Water (HW)	A	> 350°	4 1/2	5	5	5	5
		251°-350°	3	4	4 1/2	4 1/2	4 1/2
		201°-250°	2 1/2	2 1/2	3	3	3
		141°-200°	1 1/2	1 1/2	2	2	2
		105°-140°	1	1	1 1/2	1 1/2	1 1/2
Buried (HW)	C	> 350°	4 1/2	5	5	5	5
		251°-350°	3	4	4	4 1/2	4 1/2
		201°-250°	2 1/2	2 1/2	2 1/2	3	3
		141°-200°	2	2	2 1/2	2 1/2	2 1/2
		105°-140°	1 1/2	1 1/2	2	2	2
Chilled Water (CHW)	A	40°- 60°	*1/2*	*1*	*1 1/2*	*2*	*2*
		< 40°	1/2	1	1	1	1 1/2
Buried (CHW)	C	40°- 60°	1	1 1/2	1 1/2	1 1/2	1 1/2
		< 40°	1	1 1/2	1 1/2	1 1/2	1 1/2
Steam & Condensate	A	Low Pressure	2 1/2	2 1/2	3	3	3
Steam Condensate	A	Low Pressure	1 1/2	1 1/2	2	2	2
Condensate Drains	A	All	1/2	1/2	1	1	1
Cold Water Make up	A	All	1/2	1/2	1	1	1
Refrigerant Hot Gas	C	All	1 1/2	1 1/2	2	2	2
Humidifier Steam	A	All	2 1/2	2 1/2	2 1/2	3	3
Refrigerant Suction	C	All	1/2	1/2	1	1	1

END OF SECTION 230719

SECTION 230800 - COMMISSIONING OF HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes commissioning process requirements for HVAC&R systems, assemblies, and equipment.

B. Related Sections:

1. Division 23 and 24.

1.3 SCOPE

A. Commissioning requires the participation of Division 23, Mechanical Contractor and Subcontractors, to ensure that all systems are operating in a manner consistent with the Contract Documents. The general commissioning requirements and coordination are detailed in Section 019113. Division 23, Mechanical Contractor and Subcontractors shall be familiar with Section 019113 and the Commissioning Plan issued by the Commissioning Agent (CA) and shall execute all commissioning responsibilities assigned to them in the Contract Documents.

1.4 SYSTEMS TO BE COMMISSIONED

A. The following Mechanical systems will be commissioned on this project:
1. Mechanical Systems:

a. Air handling units
b. Boiler systems, including pumps and all associated equipment
c. Chiller heater – heat pump system and all associated equipment.
d. Fan coil units
e. ERV units
f. Split system heat pumps
g. Split system AC units
h. All Control Dampers and Control Valves
i. Automatic Controls

2. Spot checking of air balancing readings, including total building space pressurization.
3. All Direct Digital Controls (DDC) shall be verified for proper operation as it relates to the above equipment, including interfaces for remote monitoring.
4. Fire Alarm System: Verification of the fire alarm system as it interfaces with the HVAC system, such as duct smoke detectors and fire/smoke dampers, shall be verified.

1.5 RESPONSIBILITIES

A. Commissioning responsibilities applicable to the Mechanical contractor of Division 23 are as described in Section 019113.

1.6 OPERATION AND MAINTENANCE (O&M) MANUALS

A. Compile and prepare documentation for all equipment and systems covered in Division 23, Mechanical, and deliver to the Construction Manager for inclusion in O&M Manuals in accordance with Division 1.

B. Provide the Commissioning Agent with a copy of the O&M Manuals for review.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

A. Provide test equipment necessary to fulfill the testing requirements of Division 23, Mechanical.

B. Refer to Section 019113 and other Division 23 Sections for additional Division 23, Mechanical requirements.

PART 3 - EXECUTION

3.1 PREFUNCTIONAL CHECKLISTS AND STARTUP

A. Pre-functional tests and checklists (PFT's) are important to ensure that the equipment and systems are connected properly and are operational. PFT's ensure that functional performance testing may proceed without unnecessary delays. The Contractor shall be responsible for performing Pre-functional testing. EVERY piece of equipment to be commissioned receives a full Pre-functional checkout.

B. Division 23, Mechanical contractor, has start-up responsibility and is required to complete systems and sub-systems so they are fully functional, meeting design objectives of the Contract Documents. Commissioning procedures and functional testing do not relieve or lessen this responsibility or shift that responsibility partially to CA or Owner.

3.2 FUNCTIONAL PERFORMANCE TESTS

A. Functional testing is intended to begin upon completion of a system. Functional testing may proceed prior to completion of systems or sub-systems at the discretion of CA and CM. Beginning system testing before full completion does not relieve the Contractor from fully completing the system as soon as possible, including pre-functional checklists.

B. Functional performance testing requirements are in addition to and do not replace any testing required by Code or listed elsewhere in Division 23.

C. Functional performance testing procedures will be performed on, but not be limited to, the following system types and equipment. Final functional testing requirements and procedures will be developed based on approved equipment shop drawings.
   1. Mechanical Systems:

      a. Air handling units
      b. Boiler systems, including pumps and all associated equipment
      c. Chiller heater – heat pump system and all associated equipment.
      d. Fan coil units
      e. ERV units
      f. Split system heat pumps
      g. Split system AC units
      h. All Control Dampers and Control Valves
      i. Automatic Controls

3.3 ISSUES AND DEFICIENCIES

A. Refer to Section 019113 for details relating to the resolution of issues and deficiencies.

3.4 TRAINING OF OWNER PERSONNEL

A. Contractor shall be responsible for training coordination and scheduling, and ultimately, for ensuring that training is completed. Refer to Section 019113 for details.

B. Duration of Training: Mechanical Contractor shall provide training on each piece of equipment. Allow at least (2) separate 4-hour sessions. Refer to sections 017900 and 019113 for more information.

END OF SECTION 230800

SECTION 230901 – DIRECT DIGITAL CONTROLS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. These basic Mechanical Requirements apply to all Division 23 Sections.

B. The work of this Section consists of providing of all materials, labor and equipment and the like necessary and/or required for the complete execution of all mechanical for this project, as required by the contract documents.

1.2 Qualifications of Bidder

A. All bidders must be building automation contractors in the business of installing direct digital control building automation systems for a minimum of 5 years.

B. All bidders must have a service and installation office in the Westchester area.

C. All bidders must be authorized distributors or branch offices of the manufacturers specified.

D. All bidders must have a trained staff of application engineers, who have been certified by the manufacturer in the configuration, programming and service of the automation system.

E. Manufacturers: Subject to compliance with requirements, provide products by the following pre-qualified manufacture:
   1. Andover Controls Corporation by Schneider Electric

1.3 Scope of Work

A. Except as otherwise noted, the control system shall consist of all Ethernet Network Controllers, Standalone Digital Control Units, software, sensors, transducers, relays, valves, dampers, valve and damper operators, control panels, and other accessory equipment, along with a complete system of electrical interlocking wiring to fill the intent of the specification and provide for a complete and operable system. Unless otherwise specified, provide operators for equipment such as dampers and valves if the equipment manufacturer does not provide these. Coordinate requirements with the mechanical contractors.

B. The Building Automation System (BAS) contractor shall review and study all HVAC drawings and the entire specification to familiarize himself with the equipment and system operation, and to verify the quantities and types of dampers, operators, alarms, controllers, etc. to be provided. Review the existing temperature control equipment installed in the building. All new temperature control equipment shall be Schneider Electric Ecostruxure.

C. All interlocking, wiring, and installation of control devices associated with the equipment listed below shall be provided under this Contract. When the BAS system is fully installed and operational, the BAS Contractor and representatives of the Owner will

review and check out the system. At that time, the BAS contractor shall demonstrate the operation of the system and prove that it complies with the intent of the drawings and specifications.

D. The Contractor shall furnish and install a complete building automation system, including all necessary hardware, network wiring, all operating applications software, and all programming necessary to perform the control sequences of operation as called for in the specifications. The scope of work shall include control over and graphic representation of all new mechanical equipment installed as part of this project.

E. At a minimum, provide controls for the following:
   a. Air handling units
   b. Boiler systems, including pumps and all associated equipment
   c. Chiller heater – heat pump system and all associated equipment.
   d. Fan coil units
   e. ERV units
   f. Split system heat pumps
   g. Split system AC units
   h. All Control Dampers and Control Valves
   i. Automatic Controls

F. New packaged rooftop units, DOAS, and VRF split systems shall be supplied with the manufacturer's operating controller. Provide BACnet interface with all new equipment as required, provide scheduling and reset functions, as well as the sequence of operations for all equipment as given in specific specification sections.

G. Provide services and manpower necessary for commissioning of the system in coordination with the HVAC Contractor, Balancing Contractor, and Owner's representative.

H. All work performed under this section of the specifications will comply with all codes, laws, and governing bodies. If this specification and associated drawings exceed governing code requirements, the specification will govern. The Contractor shall obtain and pay for all necessary construction permits and licenses.

I. Provide all labor and materials to perform all programming necessary at the owner's existing operator workstation located in the Elementary School. Graphically represent and control each and every piece of equipment in the lists above, all input and output status points, and functional points.

1.4 System Description

A. The Building Automation System (BAS) shall consist of a PC-based workstation and microcomputer controllers of modular design providing distributed processing capability and allowing future expansion of both input/output points and processing/control functions. For this project, the system shall consist of the following components:

B. Operator Workstations. (Not in Scope)

The BAS Contractor shall furnish (1) Operator Workstation Computer and (1) printer as described in Part 2 of the specification. This workstation must be running the standard

workstation software developed and tested by the manufacturer of the network controllers and the standalone controllers. No third-party front-end workstation software will be acceptable. Provide all necessary software and licensing as required.

C. Ethernet-based Network Controllers.

1. The BAS Contractor shall furnish Ethernet-based network controllers as described in Part 2 of the specification. These controllers will connect directly to the Operator Workstation over Ethernet, provide communication to the Standalone Digital Control Units and/or other Input/Output Modules, and serve as a gateway to equipment furnished by others (if applicable).

D. Standalone Digital Control Units (SDCUs).

1. Provide the necessary quantity and types of SDCUs to meet the requirements of the project for mechanical equipment control, including air handlers, control, and terminal unit control. Each SDCU will operate completely standalone, containing all of the I/O and programs to control its associated equipment.

E. Service Tool. (Not in Scope)

1. Provide a portable service tool for monitoring and commissioning of the network and Standalone Digital Control Units. The tool shall have all the appropriate software for system access and have the same functionality as the main workstation.

F. Modem. (Not in Scope)

1. A modem shall be furnished for remote interrogation of the system. The modem shall operate at a minimum of 28.8 KBaud and allow for access to the entire network of controllers.

1.5 Work by Others

A. The BAS Contractor shall cooperate with other contractors performing work on this project, as necessary to achieve a complete and neat installation. To that end, each contractor shall consult the drawings and specifications for all trades to determine the nature and extent of others' work.

B. The BAS Contractor shall furnish all control valves, sensor wells, flow meters, and other similar equipment for installation by the Mechanical Contractor.

C. The BAS Contractor shall provide field supervision to the designated contractor for the installation of the following, as required:

1. Automatic control dampers
2. Fire/smoke dampers
3. Sheet metal baffle plates to eliminate stratification.

D. The Electrical Contractor shall provide:

1. All 120v power wiring to motors, heat trace, and junction boxes for power to BAS panels.
2. Smoke detectors. HVAC Contractor to mount devices. BAS Contractor to hardwire the fan shut-down. BAS contractor to coordinate this with the electrical contractor.

E. The BAS Contractor shall provide:

1. BAS Contractor to hardwire the fan shut-down. BAS contractor to coordinate this with the electrical contractor.

1.6 Code Compliance

A. Provide BAS components and ancillary equipment, which are UL-916 listed and labeled.

B. All equipment or piping used in conditioned air streams, spaces or return air plenums shall comply with NFPA 90A Flame/Smoke/Fuel contribution rating of 25/50/0 and all applicable building codes or requirements.

C. All wiring shall conform to the National Electrical Code.

D. All smoke dampers shall be rated in accordance with UL 555S.

E. Comply with FCC rules, Part 15, regarding Class A radiation for computing devices and low-power communication equipment operating in commercial environments.

F. Comply with FCC, Part 68 rules for telephone modems and data sets.

1.7 Submittals

A. The Contractor shall furnish all submittals in PDF format. Drawings shall be B size or larger.

B. Shop drawings shall include a riser diagram depicting locations of all controllers and workstations, with associated network wiring. Also included shall be individual schematics of each mechanical system showing all connected points with reference to their associated controller. Typical will be allowed where appropriate.

C. Submittal data shall contain the manufacturer's data on all hardware and software products required by the specification. Valve, damper, and air flow station schedules shall indicate the size, configuration, capacity, and location of all equipment.

D. Software submittals shall contain narrative descriptions of sequences of operation, program listings, point lists, and a complete description of the graphics, reports, alarms, and configuration to be furnished with the workstation software. All literature, descriptions, equipment spec sheets, sequences etc., shall be on 8 1/2 x 11 or larger-sized sheets. All details, diagrams, and schematics shall be on 11X17-sized sheets or larger.

E. Submit shop drawings to the Engineer for review and approval prior to ordering or fabrication of the equipment. The Contractor, prior to submitting, shall check all documents for accuracy.

F. The Engineer will make corrections and return to the Contractor. The Contractor will then resubmit with the corrected or additional data. No controls submittals shall be approved until all controls have been fully coordinated with equipment manufacturers' requirements.

G. Submit a training class syllabus and training manual for review with the temperature controls submittal. The training manual shall be custom-made for this project. Manufacturers' brochures and installation manuals will not be acceptable for this purpose. Submit a typed overview and a written summary of each topic to be covered. The document shall be suitable for a system operator to use as a quick reference guide to basic system operation as applicable for this project. Refer to section 1.9, paragraph B, for the minimum requirement of training to be included.

1.8 System Startup & Commissioning

A. Each point in the system shall be tested for both hardware and software functionality. In addition, each mechanical and electrical system under the control of the BAS will be tested against the appropriate sequence of operation specified herein. Successful completion of the system test shall constitute the beginning of the warranty period. A written report will be submitted to the owner indicating that the installed system functions in accordance with the plans and specifications.

B. The BAS contractor shall commission and set in operating condition all major equipment and systems, such as the chilled water, hot water, and all air handling systems, in the presence of the equipment manufacturer’s representatives, as applicable, and the Owner and Architect’s representatives.

C. The BAS Contractor shall provide all manpower and engineering services required to assist the HVAC Contractor and Balancing Contractor in testing, adjusting, and balancing all systems in the building. The BAS Contractor shall have a trained technician available on request during the balancing of the systems. The BAS Contractor shall coordinate all requirements to provide a complete air balance with the Balancing Contractor and shall include all labor and materials in his contract.

1.9 Training

A. The BAS Contractor shall provide both on-site training to the Owner’s representative and maintenance personnel per the following description:

B. On-site training shall consist of a minimum of (2) separate 2-hour sessions of hands-on instruction geared at the operation and maintenance of the systems. The sessions shall be scheduled at the beginning of substantial completion and spaced out over the first year of owner use. The first session curriculum shall include.

1. System Overview
2. System Software and Operation

    a. System access
    b. Software features overview
    c. Changing set-points and other attributes
    d. Scheduling

e. Editing programmed variables
f. Displaying color graphics
g. Running reports
h. Workstation maintenance
i. Application programming

3. Operational sequences including start-up, shutdown, adjusting, and changing system variables. These items shall be reviewed for all equipment installed under this project and or connected to the BMS under this project.
4. Equipment and hardware overview and maintenance. This shall include:

a. Review of all hardware installed under this project.
b. Review of a system schematic.
c. Review of where each controller is located in the building and what its function is. This shall include a walking, hands-on tour and demonstration of each and every controller.

1.10 Operating and Maintenance Manuals

A. The operation and maintenance manuals shall contain all information necessary for the operation, maintenance, replacement, installation, and parts procurement for the entire BAS. This documentation shall include specific part numbers, software versions and dates. A complete list of recommended spare parts shall be included with the lead-time and expected frequency of use of each part clearly identified.

B. Following project completion and testing, the BAS contractor will submit as-built drawings reflecting the exact installation of the system. The as-built documentation shall also include a copy of all application software, both in written form and on diskette.

1.11 Warranty

A. The BAS contractor shall warrant the system for 12 months after system acceptance and beneficial use by the owner. During the warranty period, the BAS contractor shall be responsible for all necessary revisions to the software as required to provide a complete and workable system consistent with the letter and intent of the Sequence of Operation section of the specification.

B. Updates to the manufacturer’s software shall be provided at no charge during the warranty period.

1.12 Programming

A. Sequence of operations: The controls contractor shall review the sequences of operation given in section 23 09 93 of this specification. “Canned”, preprogrammed, or typical sequences by the manufacturer may not be acceptable and shall only be used if accepted by the engineer. Otherwise, the controls contractor shall be capable of and responsible for providing custom programming, hardware, software, and labor as required to achieve the sequences of operation as specified.

PART 2 - SYSTEM ARCHITECTURE

2.1 General

A. The Building Automation System (BAS) shall consist of all new Network Control Units (NCUs), a family of Standalone Digital Control Units (SDCUs), Input/Output Unit Modules (IOU Modules), Operator Workstations (OWs), and one File Server to support system configurations where more than one operator workstation is required. The BAS shall provide control, alarm detection, scheduling, reporting, and information management for the entire classroom building and all new and existing equipment in the building, and Wide Area Network (WAN) if applicable, from a single ODBC-compliant database.

B. Level 1 Network Description

C. Level 1, the main backbone of the system, shall be an Ethernet LAN/WAN. Network Control Units, Operator Workstations, and the Central File Server shall connect directly to this network without the need for Gateway devices. The contractor shall visit the site and review the existing Andover temperature controls equipment installed in the building and in the physical plant. Certain of these controllers may be suitable for reuse. The network shall be an extension of the existing in the building as required to achieve a complete system,

D. Level 2 Network Description

E. Level 2 of the system shall consist of one or more field buses managed by the Network Control Units. The Level 2 field buses may consist of one or both of the following types:

F. An RS485, token-passing bus that supports up to 127 Standalone Digital Control Units (SDCUs) for operation of HVAC equipment and lighting, or

G. An RS485 field bus that supports up to 32 devices from a family of plug-in, IOU modules.

H. These IOU modules may be mounted within the NCU enclosure or remotely mounted via a single, twisted, shielded pair of wires.

I. The BAS shall be capable of being segmented, through software, into multiple local area networks (LANs) distributed over a wide area network (WAN), sharing a single file server. This enables workstations to manage a single LAN (or building), and/or the entire system, with all devices being assured of being updated by and sharing the most current database. In the case of a single workstation system, the workstation shall contain the entire database, with no need for a separate file server.

J. Standard Network Support

K. All NCUs, Workstation(s), and File Server shall be capable of residing directly on the owner’s Ethernet TCP/IP LAN/WAN with no required gateways. Furthermore, the NCU’s, Workstation(s) and File Server shall be capable of using standard, commercially available, off-the-shelf Ethernet infrastructure components such as routers, switches, and hubs. With this design, the owner may utilize the investment of an existing or new enterprise network or structured cabling system. This also allows the option of the

maintenance of the LAN/WAN to be performed by the owner's Information Systems Department, as all devices utilize standard TCP/IP components.

L. Remote Communications

M. In addition to the above LAN/WAN architecture support, the same workstation software (front end) must be capable of managing remote systems via standard dial-up phone lines as a standard component of the software. Front-end "add-on" software modules to perform remote site communication shall not be acceptable.

N. The remote system architecture shall consist of two levels providing control, alarm detection, reporting, and information management for the remote facility. Level 1 shall contain the Remote Site Control Unit, communicating to the remotely located Operator Workstation(s) through the use of a modem and a standard dial-up phone line. Level 2 shall consist of one or more field buses controlled by the RSCU. The field buses may consist of one or both of the two types:

O. 1) An RS485, token passing bus that supports up to 127 Standalone Digital Control Units (SDCUs) for the operation of HVAC equipment and lighting, or

P. 2) An RS485 field bus that supports up to 32 devices from a family of plug-in, IOU modules that may be mounted within the RSCU enclosure or remotely mounted on a single, twisted, shielded pair of wires.

Q. System Expansion

R. The BAS system shall be scalable and expandable at all levels of the system using the same software interface and the same Level 1 and Level 2 controllers. Systems that require replacement of either the workstation software or field controllers in order to expand the system shall not be acceptable.

S. The BAS shall be expandable to include Security and Access Control functions at any time in the future with no additional workstations, front-end software or Level 1 controllers required. Standalone Digital Control Units or IOU modules shall be able to be added to the existing Level 1 controller's field bus(es), to perform security and card access applications. In this way, an owner's existing investment in wiring infrastructure may be leveraged, and the cost and inconvenience of adding new field bus wiring will be minimized.

T. Additionally, an integrated video badging option must be able to be included with no additional workstations required. This photo ID option must share the same database as the BAS in order to eliminate the need for updating multiple databases.

U. The system shall use the same application programming language for all levels: Operator Workstation, Network Control Unit, Remote Site Control Unit, and Standalone Digital Control Unit. Furthermore, this single programming language shall be used for all applications: environmental control, card access control, intrusion detection and security, lighting control, leak detection / underground storage tank monitoring, and digital data communication interfaces to third party microprocessor-based devices.

V. Support For Open Systems Protocols

The BAS design must include solutions for the integration of the following “open systems” protocols: BACnet, LonTalk™, and digital data communication to third-party microprocessors such as chiller controllers, fire panels, and variable frequency drives (VFDs).

W. The system shall also provide the ability to program custom ASCII communication drivers, that will reside in the NCU, for communication to third-party systems and devices. These drivers will provide real-time monitoring and control of the third-party systems.

2.2 Network Control Units (NCUs)

A. Network Control Units shall be microprocessor based, multi-tasking, multi-user, and employ a real-time operating system. Each NCU control panel shall consist of modular hardware, including power supply, CPU board, and input/output modules. A sufficient number of NCUs shall be supplied to fully meet the requirements of this specification and the attached point list. NCU’s for telephone dial-up sites shall be of the same design as the Ethernet control units but without the plug-in Ethernet network interface card (NIC), i.e., NCUs, which include a NIC, shall be interchangeable whether used on a LAN/WAN or a dial-up site.

B. Webserver Functionality

All NCUs on the Ethernet TCP/IP LAN/WAN shall be capable, out of the box, to be set up as a Web Server. The NCU shall have the ability to store HTML code and “serve” pages to a web browser. This provides the ability for any computing device utilizing a TCP/IP Ethernet connection and capable of running a standard Internet browser (Microsoft Internet Explorer™, Netscape Navigator™, etc.) to access real-time data from the entire BAS via any NCUs.

Graphics and text-based web pages shall be constructed using standard HTML code. The interface shall allow the user to choose any of the standard text or graphics-based HTML editors for page creation. It shall also allow the operator to generate custom graphical pages and forms.

The WEB server interface shall be capable of password security, including validation of the requesting PC’s IP address. The WEB server interface shall allow the sharing of data or information between any controller, process, or network interface (BACnet, LonTalk and TCP/IP) that the BMS has knowledge of, regardless of where the point is connected on the BAS network or where it is acquired from.

The BAS network controller must act directly as the WEB server. It must directly generate the HTML code to the requesting user (i.e. WEB browser), eliminating the need for and reliance on any PC-based WEB server hardware or software. To simplify graphic image space allocation, HTML graphic images, if desired, shall be stored on any shared network device. The BAS WEB server shall have the ability to acquire any necessary graphics using standard pathing syntax within the HTML code mounted within the BAS WEB server. External WEB server hardware and software are not acceptable.

C. Hardware Specifications

1. Memory:

A minimum of 64MB of RAM shall be provided for NCUs with expansion up to 128 MB. The 64 MB versions shall include a floating-point math co-processor.

2. Communication Ports:

   Each NCU shall provide communication to both the Workstation(s) and the field buses. In addition, each NCU must have at least 3 other communications ports that support a telephone modem, portable service tool, serial printer, and connection to third party controllers such as a chiller control panel. On a LAN/WAN system, the NCU shall be provided with a 10Mbps plug-in Ethernet TCP/IP network interface card (NIC).

3. Input/Output (I/O):

   Each NCU shall support the addition of the following types of inputs and outputs:

   - Digital Inputs for status/alarm contacts
   - Counter Inputs for summing pulses from meters.
   - Thermistor inputs for measuring temperatures in space, ducts, and thermowells.
   - Analog inputs for pressure, humidity, flow, and position measurements.
   - Digital Outputs for on/off equipment control.
   - Analog Outputs for valve and damper position control, and capacity control of primary equipment, including all air handler and fan coil control valves.

4. Modular Expandability:

   The system shall employ a modular I/O design to allow easy expansion. Input and output capacity is to be provided through plug-in modules of various types or DIN-mountable IOU modules. It shall be possible to combine I/O modules as desired to meet the I/O requirements for individual control applications.

5. Hardware Override Switches:

   All digital output units shall include three position manual override switches to allow selection of the ON, OFF, or AUTO output state. These switches shall be built into the unit and shall provide feedback to the controller so that the position of the override switch can be obtained through software. In addition, each analog output shall be equipped with an override potentiometer to allow manual adjustment of the analog output signal over its full range when the 3-position manual override switch is placed in the ON position.

6. Local Status Indicator Lamps:

   Provide a minimum LED indication of CPU status, Ethernet LAN status, and field bus status. For each output, provide LED indication of the value of the output (On/Off). For each output module, provide an LED that gives a visual indication of whether any outputs on the module are manually overridden.

7. Real Time Clock (RTC):

   Each NCU shall include a battery-backed, real-time clock, accurate to 10 seconds per day. The RTC shall provide the following: time of day, day, month, year, and day of week. In normal operation, the system clock will be based on the frequency of the AC power. The system shall automatically correct for daylight savings time and leap years and be Year 2000 compliant.

8. Power Supply:

   The power supply for the NCUs shall be auto sensing, 120-220VAC, 60/50 Hz power, with a tolerance of +/- 20%. Line voltage below the operating range of the system shall be considered an outage. The controller shall contain overvoltage

surge protection and require no additional AC power signal conditioning. Optionally, if indicated on the drawings, the power supply shall accept an input voltage of (–48 VDC).

9. Automatic Restart After Power Failure:

   Upon restoration of power after an outage, the ECU shall automatically and without human intervention: update all monitored functions; resume operation based on current, synchronized time and status, and implement special start-up strategies as required.

10. Battery backup:

    Each NCU with the standard 120-220VAC power supply shall include a programmable DC power backup system rated for a minimum of 72 hours of battery backup to maintain all volatile memory or a minimum of 2 hours of full UPS, including modem power. This power backup system shall be configurable such that at the end of a settable timeframe (such as 1 hour) of running on full UPS, the unit will shut off full UPS and switch to memory retention-only mode for the remainder of the battery power. The system shall allow the simple addition of more batteries to extend the above minimum battery backup times.

D. Software Specifications

1. General.

   The NCU shall contain flash ROM as the resident operating system. Application software will be RAM resident. Application software will only be limited by the amount of RAM memory. There will be no restrictions placed on the type of application programs in the system. Each NCU shall be capable of parallel processing, executing all control programs simultaneously. Any program may affect the operation of any other program. Each program shall have full access of all I/O facilities of the processor. This execution of the control function shall not be interrupted due to normal user communications, including interrogation, program entry, printout of the program for storage, etc.

2. User Programming Language:
   The application software shall be user programmable. This includes all strategies, sequences of operation, control algorithms, parameters, and setpoints. The source program shall be English language-based and programmable by the user. The language shall be structured to allow for the easy configuration of control programs, schedules, alarms, reports, telecommunications, local displays, mathematical calculations, passwords, and histories. The language shall be self-documenting. Users shall be able to place comments anywhere in the body of a program. Program listings shall be configurable by the user in logical groupings.

E. Control Software:

1. The NCU shall have the ability to perform the following pre-tested control algorithms:

   a. Proportional, Integral plus Derivative Control (PID)
   b. Self-Tuning PID
   c. Two Position Control
   d. Digital Filter

e. Ratio Calculator
f. Equipment Cycling Protection

2. Mathematical Functions:

a. Each controller shall be capable of performing basic mathematical functions (+, -, *, /), squares, square roots, exponential, logarithms, Boolean logic statements, or combinations of both. The controllers shall be capable of performing complex logical statements, including operators such as >, <, =, and, or, exclusive or, etc. These must be able to be used in the same equations with the mathematical operators and nested up to five parentheses deep.

3. Energy Management Applications:

a. NCUs shall have the ability to perform any or all of the following energy management routines:
b. Time of Day Scheduling
c. Calendar-Based Scheduling
d. Holiday Scheduling
e. Temporary Schedule Overrides
f. Optimal Start
g. Optimal Stop
h. Night Setback Control
i. Enthalpy Switchover (Economizer)
j. Peak Demand Limiting
k. Temperature Compensated Duty Cycling
l. CFM Tracking
m. Heating/Cooling Interlock
n. Supply air temp Reset

4. History Logging:
a. Each controller shall be capable of logging any system variable over user-defined time intervals ranging from 1 second to 1440 minutes. Any system variables (inputs, outputs, math calculations, flags, etc.) can be logged in history. A maximum of 32767 values can be stored in each log. Each log can record either the instantaneous, average, minimum, or maximum value of the point. Logs can be automatic or manual. Logged data shall be downloadable to the Operator Workstation for long-term archiving based upon user-defined time intervals or manual command.

5. Alarm Management:

a. For each system point, alarms can be created based on high/low limits or conditional expressions. All alarms will be tested on each scan of the NCU and can result in the display of one or more alarm messages or reports. Up to 8 alarms can be configured for each point in the controller. Messages and reports can be sent to a local terminal, to the front-end workstation(s), or via modem to a remote-computing device. Alarms will be generated based on their priority. A minimum of 255 priority levels shall be provided. If communication with the Operator Workstation is temporarily interrupted, the

alarm will be buffered in the NCU. When communications return, the alarm will be transmitted to the Operator Workstation if the point is still in the alarm condition.

6. Reporting.

a. The NCU shall be able to generate user-definable reports to a locally connected printer or terminal. The reports shall contain any combination of text and system variables. Report templates shall be able to be created by users in a word processing environment. Reports can be displayed based on any logical condition or through a user command.

2.3 Standalone Digital Control Units (SDCUs)

A. General:

1. Standalone Digital Control Units shall provide control of HVAC and lighting. Each controller shall have its own control programs and will continue to operate in the event of a failure or communication loss to its associated NCU.

B. Memory:

1. Control programs shall be stored in battery-backed-up RAM and EPROM. Each controller shall have a minimum of 32K bytes of user RAM memory and 128K bytes of EPROM.

C. Communication Ports:

1. SDCUs shall provide a communication port to the field bus. In addition, a port shall be provided for connection of a portable service tool to support local commissioning and parameter changes with or without the NCU online. It shall be possible from a service port on any SDCU to view, enable/disable, and modify values of any point or program on any controller on the local field bus, any NCU or any SDCU on a different field bus.

D. Input/Output:

1. Each SDCU shall support the addition of the following types of inputs and outputs:

a. Digital Inputs for status/alarm contacts
b. Counter Inputs for summing pulses from meters.
c. Thermistor Inputs for measuring temperatures in space, ducts, and thermowells.
d. Analog inputs for pressure, humidity, flow, and position measurements.
e. Digital Outputs for on/off equipment control.
f. Analog Outputs for valve and damper position control, and capacity control of primary equipment.

E. Expandability:

1. Input and output capacity shall be expandable through the use of plug-in modules. A minimum of two modules shall be added to the base SDCU before additional power is required.

F. Networking:

1. Each SDCU will be able to exchange information on a peer-to-peer basis with other Standalone Digital Control Units during each field bus scan. Each SDCU shall be capable of storing and referencing global variables (on the LAN) with or without any workstations online. Each SDCU shall be able to have its program viewed and/or enabled/disabled either locally through a portable service tool or through a workstation connected to an NCU.

G. Indicator Lamps:

1. SDCUs will have as a minimum, LED indication of CPU status and field bus status.

H. Real Time Clock (RTC):

1. An SDCU shall have a real-time clock in either hardware or software. The accuracy shall be within 10 seconds per day. The RTC shall provide the following information: time of day, day, month, year, and day of week. Each SDCU shall receive a signal, every hour, over the network from the NCU, which synchronizes all SDCU real-time clocks.

I. Automatic Restart After Power Failure:

1. Upon restoration of power, the SDCU shall automatically and without human intervention update all monitored functions, resume operation based on the current, synchronized time and status, and implement special start-up strategies as required.

J. Battery Back Up:

1. Each SDCU shall have at least 3 years of battery backup to maintain all volatile memory.

K. Alarm Management:

1. For each system point, alarms can be created based on high/low limits or conditional expressions. All alarms will be tested on each scan of the SDCU and can result in the display of one or more alarm messages or reports. Up to 8 alarms can be configured for each point in the controller, enabling the escalation of the alarm priority (urgency) based upon which alarm(s) is/are triggered. Alarm messages can be sent to a local terminal or modem connected to an NCU or to the Operator’s Workstation(s). Alarms will be generated based on their priority. A minimum of 255 priority levels shall be provided. If communication with the NCU is temporarily interrupted, the alarm will be buffered in the SDCU. When

communications return, the alarm will be transmitted to the NCU if the point is still in the alarm condition.

L. Air Handler Controllers

1. AHU Controllers shall be capable of meeting the requirements of the sequence of operation found in the Execution portion of this specification, and for future expansion.
2. AHU Controllers shall support all the necessary point inputs and outputs as required by the sequence and operate in a standalone fashion.
3. AHU Controllers shall be fully user programmable to allow for modification of the application software.
4. An LCD display shall be optionally available for readout of point values and to allow operators to change setpoints and system parameters.
5. A manual override switch shall be provided for all digital and analog outputs on the AHU Controller. The position of the switch shall be monitored in software and available for operator displays and alarm notification.

M. VAV Terminal Unit Controllers (Not Used)

1. VAV Terminal Unit Controllers shall support, but not be limited to the control of the following configurations of VAV boxes to address current requirements as described in the Execution portion of this specification, and for future expansion:

   a. Single Duct Cooling Only
   b. Single Duct Cooling with Reheat (Electric or Hot Water)
   c. Fan Powered (Parallel or Series)
   d. Dual Duct (Constant or Variable Volume)
   e. Supply/Exhaust

2. VAV Controllers for single duct applications will come equipped with a built-in actuator for modulation of the air damper. The actuator shall have a minimum torque rating of 35 in.-lb. and contain an override mechanism for manual positioning of the damper during startup and service. VAV Controllers shall contain an integral velocity sensor accurate to +/- 5% of the full range of the box's CFM rating. Each controller shall perform the sequence of operation described in Part 3 of this specification, and have the capability for time-of-day scheduling, occupancy mode control, after-hours operation, lighting control, alarming, and trending. VAV Controllers shall be able to communicate with any other Standalone Digital Control Unit on the same field bus, with or without communication to the NCU managing the field bus. Systems that fail to provide this (true peer-to-peer) capability will be limited to a maximum of 32 VAV controllers per field bus.

3. Unitary Controllers

   a. Unitary Controllers shall support, but not be limited to, the control of the following systems as described in the Execution portion of this specification, and for future expansion:

      1) Cabinet heater and convectors

2) Rooftop top air handling units
3) Fan Coils
4) Unit and cabinet heaters

b. The I/O of each Unitary Controller shall contain sufficient quantity and types as required to meet the sequence of operation found in the Execution portion of this specification. In addition, each controller shall have the capability for time-of-day scheduling, occupancy mode control, after-hours operation, lighting control, alarming, and trending.

N. Display Controllers (Not used)

1. Display controllers are standalone, touch screen-based operator interfaces. The controller shall be designed for flush mounting in a finished space, with a minimum display size of 9 x 9 inches. Software shall be user programmable, allowing for custom graphical images that simulate floor plans, menus, equipment schematics, along with associated real-time point values coming from any NCU on the network. The touch screen display shall contain a minimum of 64 possible touch cells that permit user interaction for changing screens, modifying set-points, or operating equipment. Systems that do not offer a display controller as specified must provide a panel-mounted computer with touch screen capability as an alternative. All air handling units shall use display controllers.

2.4 Operator Workstation Requirements (NOT USED)

2.5 Portable Operator's Terminal (NOT USED)

2.6 DDC Sensors and Point Hardware

A. Temperature Sensors

1. All temperature devices shall use precision thermistors accurate to +/- 1 degree F over a range of –-30 to 230 degrees F. Space temperature sensors shall be accurate to +/- .5 degrees F over a range of 40 to 100 degrees F.

2. Space sensors shall have an off-white enclosure and shall be mounted on a standard electrical box. Space sensors shall use a surface-mounted finished cast electrical box for surface mounting with a metal "wire-mold" to conceal wiring for all solid masonry partitions. For space sensors located on gypsum board partitions, wiring shall be concealed inside the walls with recessed flush-mounted electrical boxes. In general, control wiring shall run from the ceiling plenum to the box, which shall be wall-mounted next to the door or as shown on the plan. (This shall be the standard for this project)

3. The space sensor housing shall utilize buttons for adjusting the space temperature set-point, as well as a push button for selecting after-hours operation, fan speed, and all other operator-selectable parameters. Operators shall be able to adjust set points directly from the sensor. All space sensors (located in public locations, offices, and classrooms), shall incorporate either an LED or LCD display for

viewing the space temperature, set-point, and other operator-selectable parameters. Space sensors located in store rooms, MER, and unoccupied space are not required to have LED or LCD display.

4. Duct temperature sensors shall incorporate a thermistor bead embedded at the tip of a stainless steel tube. Probe-style duct sensors are usable in air handling applications where the coil or duct area is less than 14 square feet.
5. Averaging sensors shall be employed in ducts that are larger than 14 square feet. The averaging sensor tube must contain at least one thermistor for every 3 feet, with a minimum tube length of 12 feet.
6. Immersion sensors shall be employed for the measurement of temperature in all chilled and hot water applications, as well as refrigerant applications. Thermal wells shall be brass or stainless steel for non-corrosive fluids below 250 degrees F and 300 series stainless steel for all other applications.
7. A pneumatic signal shall not be allowed for sensing temperature.

B. Humidity Sensors

1. Humidity devices shall be accurate to +/- 5% at full scale for space and +/- 3% for duct and outside air applications. Suppliers shall be able to demonstrate that accuracy is NIST traceable.
2. Provide a handheld field calibration tool that both reads the output of the sensor and contains a reference sensor for ongoing calibration.

C. Pressure Sensors

1. Air pressure measurements in the range of 0 to 10” water column will be accurate to +/- 1% using a solid-state sensing element. Acceptable manufacturers include Modus Instruments and Mamac.
2. Differential pressure measurements of liquids or gases shall be accurate to =/- 0.5% of range. The housing shall be NEMA 4 rated.

D. Current and KW Sensors

1. Current status switches shall be used to monitor fans, pumps, motors, and electrical loads. Current switches shall be available in solid and split core models, and offer either a digital or an analog signal to the automation system. An acceptable manufacturer is Veris or an approved equal.
2. Measurement of three-phase power shall be accomplished with a kW/kWh transducer. This device shall utilize direct current transformer inputs to calculate the instantaneous value (kW) and a pulsed output proportional to the energy usage (kWH). Provide Veris Model 6000 Power Transducer or approved equal.

E. Flow Sensors

1. Provide an insertion vortex flowmeter for measurement of liquid, gas, or steam flows in pipe sizes above 3 inches.
2. Install the flow meter on an isolation valve to permit removal without process shutdown.
3. Sensors shall be manufactured by EMCO or an approved equal.

F. Electric/Pneumatic Transducers

1. Electric to pneumatic transducers shall operate from either a PWM or an analog signal. E/P transducers shall be rated for 0 - 20 psi operation and accurate to 2% of full scale. E/P transducers shall have a maximum air consumption of 100 SCIM.
2. E/P transducers may be installed at the end device (damper or valve), or mounted separately in a field interface panel, or as part of the controller. All transducers will be calibrated. Panel-mounted transducers shall be Sensycon or an approved equal.

G. Electric/Pneumatic Solenoid Valves

Electric solenoid-operated pneumatic valves (EP's) shall have a three-port operation: common, normally open and normally closed. They shall be rated for 50 psig when used for 25 psig or less applications, or rated for 150 psig when used for 100 psig or less applications. The coils shall be equipped with transient suppression devices to limit transients to 150 percent of the rated coil voltage.

2.7 Control Valves

A. Provide automatic control valves suitable for the specified controlled media (steam, water or glycol). Provide valves that mate and match the material of the connected piping. Equip control valves with the actuators of required input power type and control signal type to accurately position the flow control element and provide sufficient force to achieve the required leakage specification.

B. Control valves shall meet the heating and cooling loads specified, and close off against the differential pressure conditions within the application. Valves should be sized to operate accurately and with stability from 10 to 100% of the maximum design flow.

C. Trim material shall be stainless steel for steam and high differential pressure applications.

D. Electric actuation should be provided on all terminal unit reheat applications.

2.8 Dampers

A. Automatic dampers, furnished by the Building Automation Contractor, shall be single or multiple-blade as required. Dampers are to be installed by the HVAC Contractor under the supervision of the BAS Contractor. All blank-off plates and conversions necessary to install smaller than duct size are the responsibility of the Sheet Metal Contractor.

B. Damper frames are to be constructed of 13-gauge galvanized sheet steel, mechanically joined with linkage concealed in the side channel to eliminate noise from friction. Compressible spring stainless steel side seals, and acetal or bronze bearings shall also be provided.

C. Damper blade width shall not exceed eight inches. Seals and 3/8-inch square steel zinc-plated pins are required. Blade rotation is to be parallel or opposed as shown on the schedules.

D. For high-performance applications, control dampers will meet or exceed the UL Class I leakage rating.

E. Control and smoke dampers shall be Ruskin or an approved equal.

F. Provide opposed blade dampers for modulating applications and parallel blades for two-position control.

2.9 Damper Actuators

A. Electronic Actuators – the actuator shall be directly coupled over the shaft, enabling it to be mounted directly to the damper shaft without the need for connecting linkage. The actuator shall have electronic overload circuitry to prevent damage. For power-failure/safety applications, an internal mechanical, spring return mechanism shall be built into the actuator housing. Non-spring return actuators shall have an external manual gear release to allow positioning of the damper when the actuator is not powered.

2.10 Smoke Detectors

A. Air duct smoke detectors shall be by Air Products & Controls or an approved equal. The detectors shall operate at air velocities from 300 feet per minute to 4000 feet per minute.

B. The smoke detector shall utilize a photoelectric detector head.

C. The housing shall permit mechanical installation without removal of the detector cover.

D. The detectors shall be listed by Underwriters Laboratories and meet the requirements of UL 268A.

2.11 Airflow Measuring Stations

A. Provide a thermal anemometer using instrument-grade self-heated thermistor sensors with thermistor temperature sensors.

B. The flow station shall operate over a range of 0 to 5,000 feet/min with an accuracy of +/- 2% over 500 feet/min and +/- 10 ft/min for readings less than 500 feet/min.

C. The output signal shall be linear with field selectable ranges including 0-5 VDC, 0-10VDC and 4-20 mA.

D. Furnish Ebtron Series 3000 airflow stations or approved equal.

PART 3 - EXECUTION

3.1 Contractor Responsibilities

A. General

Installation of the building automation system shall be performed by the Contractor or a subcontractor. However, all installations shall be under the personal supervision of the Contractor. The Contractor shall certify all work as proper and complete. Under no circumstances shall the design, scheduling, coordination, programming, training, and warranty requirements for the project be delegated to a subcontractor.

B. Demolition
1. Remove controls that do not remain as part of the building automation system, all associated abandoned wiring and conduit, and all associated pneumatic tubing and or wiring. The Owner will inform the Contractor of any equipment that is to be removed that will remain the property of the Owner. All other equipment that is removed will be disposed of by the Contractor.

C. Access to Site
1. Unless notified otherwise, entrance to the building is restricted. No one will be permitted to enter the building unless their names have been cleared with the Owner or the Owner's Representative.

D. Code Compliance
1. All wiring shall be installed in accordance with all applicable electrical codes and will comply with the equipment manufacturer's recommendations. Should any discrepancy be found between wiring specifications in Division 17 and Division 16, wiring requirements of Division 17 will prevail for work specified in Division 17.

E. Cleanup
1. At the completion of the work, all equipment pertinent to this contract shall be checked and thoroughly cleaned, and all other areas shall be cleaned around equipment provided under this contract.

3.2 Wiring, Conduit, and Cable

A. All wire will be copper and meet the minimum wire size and insulation class listed below:

Wire Class	Wire Size	Isolation Class
Power	12 Gauge	600 Volt
Class One	14 Gauge Std.	600 Volt
Class Two	18 Gauge Std.	300 Volt
Class Three	18 Gauge Std.	300 volt
Communications	Per Mfr.	Per Mfr.

B. Power and Class One wiring may be run in the same conduit. Class Two and Three wiring and communications wiring may be run in the same conduit.

C. Where different wiring classes terminate within the same enclosure, maintain clearances and install barriers per the National Electric Code.

D. Where wiring is required to be installed in conduit, EMT shall be used. Conduit shall be a minimum 1/2 inch galvanized EMT. Set screw fittings are acceptable for dry interior locations. Watertight compression fittings shall be used for exterior locations and interior locations subject to moisture. Provide conduit seal-off fitting where exterior conduits enter the building or between areas of high temperature/moisture differential.

E. Flexible metallic conduit (max. 3 feet) shall be used for connections to motors, actuators, controllers, and sensors mounted on vibration-producing equipment. Liquid-tight flexible conduit shall be used in exterior locations and interior locations subject to moisture.

F. Junction boxes shall be provided at all cable splices, equipment terminations, and transitions from EMT to flexible conduit. Interior dry location J-boxes shall be galvanized pressed steel, nominal four-inch square with blank cover. Exterior and damp location JH-boxes shall be cast alloy FS boxes with threaded hubs and gasketed covers.

G. Where the space above the ceiling is a supply or return air plenum, the wiring shall be plenum-rated. Teflon wiring can be run without conduit above suspended ceilings. EXCEPTION: Any wire run in suspended ceilings that is used to control outside air dampers or to connect the system to the fire management system shall be in conduit.

H. Coaxial cable shall conform to RG62 or RG59 rating. Provide plenum-rated coaxial cable when running in return air plenums.

I. Fiber optic cable shall include the following sizes: 50/125, 62.5/125 or 100/140.

J. Only glass fiber is acceptable, no plastic.

K. Fiber optic cable shall only be installed and terminated by an experienced contractor. The BAS contractor shall submit to the Engineer the name of the intended contractor of the fiber optic cable with their submittal documents.

L. Hardware Installation

3.3 Installation Practices for Wiring

A. All controllers are to be mounted vertically, per the manufacturer’s installation documentation.

B. The 120VAC power wiring to each Ethernet or Remote Site controller shall be a dedicated run, with a separate breaker. Each run will include a separate hot, neutral, and ground wire. The ground wire will terminate at the breaker panel ground. This circuit will not feed any other circuit or device.

C. A true earth ground must be available in the building. Do not use a corroded or galvanized pipe or structural steel.

D. Wires are to be attached to the building proper at regular intervals such that wiring does not droop. Wires are not to be affixed to or supported by pipes, conduit, etc.

E. Conduit in finished areas will be concealed in ceiling cavity spaces, plenums, furred spaces, and wall construction. Exception: metallic surface raceway may be used in finished areas on masonry walls. All surface raceways in finished areas must be color-matched to the existing finish within the limitations of standard manufactured colors.

F. Conduit, in non-finished areas where possible, will be concealed in ceiling cavity spaces, plenums, furred spaces, and wall construction. Exposed conduit will run parallel to or at right angles to the building structure.

G. Wires are to be kept a minimum of three (3) inches from hot water, steam, or condensate piping.

H. Where sensor wires leave the conduit system, they are to be protected by a plastic insert.

I. Wire will not be allowed to run across telephone equipment areas.

3.4 Installation Practices for Field Devices

A. Well-mounted sensors will include thermal conducting compound within the well to ensure good heat transfer to the sensor.

B. Actuators will be firmly mounted to give positive movement, and linkage will be adjusted to give smooth, continuous movement throughout 100 percent of the stroke.

C. Relay outputs will include transient suppression across all coils. Suppression devices shall limit transients to 150% of the rated coil voltage.

D. Water line-mounted sensors shall be removable without shutting down the system in which they are installed.

E. For duct static pressure sensors, the high-pressure port shall be connected to a metal static pressure probe inserted into the duct pointing upstream. The low-pressure port shall be left open to the plenum area at the point that the high-pressure port is tapped into the ductwork.

F. For building static pressure sensors, the high-pressure port shall be inserted into the space via a metal tube. Pipe the low-pressure port to the outside of the building.

3.5 Enclosures

A. For all I/O requiring field interface devices, these devices, where practical, will be mounted in a field interface panel (FIP). The Contractor shall provide an enclosure that protects the device(s) from dust, moisture, and conceals integral wiring and moving parts.

B. FIPs shall contain power supplies for sensors, interface relays and contactors, safety circuits, and I/P transducers.

C. The FIP enclosure shall be of steel construction with baked enamel finish, NEMA 1 rated with a hinged door and keyed lock. The enclosure will be sized for twenty percent spare mounting space. All locks will be keyed identically.

D. All wiring to and from the FIP will be to screw-type terminals. Analog or communications wiring may use the FIP as a raceway without terminating. The use of wire nuts within the FIP is prohibited.

E. All outside-mounted enclosures shall meet the NEMA-4 rating.

F. The wiring within all enclosures shall be run in plastic track. Wiring within controllers shall be wrapped and secured.

3.6 Identification

A. Identify all control wires with labeling tape or sleeves using either words, letters, or numbers that can be exactly cross-referenced with as-built drawings.

B. All field enclosures, other than controllers, shall be identified with a bakelite nameplate. The lettering shall be in white against a black or blue background.

C. Junction box covers will be marked to indicate that they are a part of the BAS system.

D. All I/O field devices (except space sensors) that are not mounted within FIP's shall be identified with name plates.

E. All I/O field devices inside FIP's shall be labeled.

3.7 Existing Controls.

A. Existing controls that are to be reused must each be tested and calibrated for proper operation. Existing controls that are to be reused and are found to be defective, requiring replacement, will be noted to the Owner.

B. All existing controllers, thermostats, pneumatic tubing, actuators, panels, gauges, and any device associated with equipment are to be removed completely. Remove pneumatic lines back to the wall or floor and cap airtight.

3.8 Control System Switch-over

A. Demolition of the existing control system will occur after the new temperature control system is in place, including new sensors and new field interface devices.

B. Switch-over from the existing control system to the new system will be fully coordinated with the Owner. A representative of the Owner will be on site during switch-over.

C. The Contractor shall minimize control system downtime during switch-over. Sufficient installation mechanics will be on site so that the entire switchover can be accomplished in a reasonable time frame.

3.9 Location

A. The location of sensors is per the mechanical and architectural drawings.

B. Space humidity or temperature sensors will be mounted away from machinery generating heat, direct light, and diffuser air streams.

C. Outdoor air sensors will be mounted on the north building face directly in the outside air. Install these sensors such that the effects of heat radiated from the building or sunlight are minimized.

D. Field enclosures shall be located immediately adjacent to the controller panel(s) to which it is being interfaced.

3.10 Software Installation

A. General.

The Contractor shall provide all labor necessary to install, initialize, start up, and debug all system software as described in this section. This includes any operating system software or other third-party software necessary for the successful operation of the system.

B. Database Configuration.

The Contractor will provide all labor to configure those portions of the database that are required by the points list and sequence of operation.

C. Color Graphic Slides.

Unless otherwise directed by the owner, the Contractor will provide color graphic displays as depicted in the mechanical drawings for each system and floor plan. For each system or floor plan, the display shall contain the associated points identified in the point list and allow for setpoint changes as required by the owner. Graphically represent each and every piece of equipment in the classroom building, new and existing, all input and put status points, and functional points. This shall include all new HVAC equipment.

D. Reports.

The Contractor will configure the following trend data reports for the owner.

1. Packaged roof top units
    a. Unit operating status.
    b. SA temp and set point
    c. SA static pressure and set point
    d. Room temps and set point.
    e. VAV box status/position.
    f. OA temp and set point
    g. RA temp and set point
    h. General fault alarm
2. DOAS Units
    a. Unit operating status.
    b. SA temp and set point
    c. SA static pressure and set point
    d. Room temps and set point.
    e. OA temp and set point
    f. RA temp and set point
    g. General fault alarm
3. VRF Systems
    a. Unit operating status.
    b. Room temps and set point.
    c. Heating / cooling mode status

d. Fan status
e. General fault alarms

E. Commissioning and System Startup

F. Point to Point Checkout.

Each I/O device (both field mounted as well as those located in FIPs) shall be inspected and verified for proper installation and functionality. A checkout sheet itemizing each device shall be filled out, dated, and approved by the Project Manager for submission to the owner or owner's representative.

G. Controller and Workstation Checkout.

A field checkout of all controllers and front-end equipment (computers, printers, modems, etc.) shall be conducted to verify proper operation of both hardware and software. A checkout sheet itemizing each device and a description of the associated tests shall be prepared and submitted to the owner or owner's representative by the completion of the project.

H. System Acceptance Testing

All application software will be verified and compared against the sequences of operation. Control loops will be exercised by inducing a setpoint shift of at least 10% and observing whether the system successfully returns the process variable to the setpoint. Record all test results and attach to the Test Results Sheet.

I. Test each alarm in the system and validate that the system generates the appropriate alarm message, that the message appears at all prescribed destinations (workstations or printers), and that any other related actions occur as defined (i.e., graphic panels are invoked, reports are generated, etc.). Submit a Test Results Sheet to the owner.

J. Perform an operational test of each unique graphic display and report to verify that the item exists, that the appearance and content are correct, and that any special features work as intended. Submit a Test Results Sheet to the owner.

K. Perform an operational test of each third-party interface that has been included as part of the automation system. Verify that all points are properly polled, that alarms have been configured, and that any associated graphics and reports have been completed. If the interface involves a file transfer over Ethernet, test any logic that controls the transmission of the file, and verify the content of the specified information.

END OF SECTION 230901

SECTION 230993 - SEQUENCE OF OPERATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Sequence of operation:
1. Summer winter change over
2. Boiler Plant
3. Dual temperture Variable Speed Pumping System Control.
4. Packaged Rooftop and Split System Air Conditioning Units
5. Cabinet and Unit Heater
6. Fin Tube Radiation and Radiant Panels
7. Cabinet Convectors
8. Toilet exhaust fans
9. Kitchen exhaust fan and MUA unit
10. Ductless split systems
11. Air Conditioning Condensate Pumps
12. Miscellaneous Plumbing Equipment
13. Miscellaneous.

1.02 RELATED SECTIONS

A. Section 23 0901 - Digital Control Equipment.

B. Section 230900 - Instruments and Control for HVAC.

1.03 SYSTEM DESCRIPTION

A. This Section defines the manner and method by which controls function. Requirements for each type of control system operation are specified. Equipment, devices, and system components required for control systems are specified in other Sections.

B. Provide DDC based electronic controls, panels, wiring and all accessories required to achieve the specified control sequences and establish a complete independent system for all new equipment and existing equipment. In general the equipment shall be controlled through Standalone Digital Control Units (SDCUs).

Provide the necessary quantity and types of SDCUs to meet the requirements of the project for mechanical equipment control, including air handlers, central plant control, and terminal unit control. Each SDCU will operate completely standalone, containing all of the I/O and programs to control its associated equipment.

Certain controls are specified to be furnished with the equipment. This contractor shall provide all components to communicate with factory furnished

controls and connect them to the building automation control system. This contractor shall be responsible to review equipment submittals and review and review the controls provided with all packaged equipment to insure that the equipment is ordered with eh appropriate gateways and MPTP controllers for integration to the BMS system. The contractor shall also provide all controls, wiring and auxiliaries required to operate equipment not furnished with factory controls. Work required includes, but is not limited to the following:

1. Control wiring between factory mounted unit panels and factory supplied remote panels.
2. Installation and wiring for factory supplied devices requiring field installation.
3. Panel mounted transformers and control power wiring for all controllers and control devices.
4. Control wiring to each remote device (room thermostats, outdoor air sensors, static pressure controllers, control actuators, control panels, etc.).
6. All control valves, motorized dampers thermostats, relays, sensors, etc. unless furnished as an integral part of the equipment.
7. All interlock control wiring (24 volt and 120 volt) between units, fans, etc.

C. All control and interlock wiring shall be run in EMT for indoor locations and in galvanized conduit for outdoor locations.

D. All new controllers, hardware, and accessories shall be Schneider Electric EcoStruxure

E. General System Description: The building equipment shall be controlled via a central Andover BMS system. Heating of the building will be accomplished through the central hot water boilers and associated terminal equipment, including fin tube radiators, cabinet unit heaters, and hot water coils associated with air handling units. Hot water pumps shall be variable speed and modulated via differential pressure sensors in the building. Cooling shall be accomplished primarily through seven packaged rooftop units with DX coils, and two indoor air handling units with DX coils and remote condensing units. Rooftop units serving classrooms shall be VAV type. Room control shall be through local thermostats that will modulate the associated VAV box and/or room fin tube radiator control valve. Air handling units and Rooftop units serving the cafeteria, gym, and atrium shall have demand-controlled ventilation. Refer to specific equipment sequences for detailed operation.

1.04 SUBMITTALS FOR REVIEW

A. Division 1 - Submittals: Procedures for submittals.

B. Shop Drawings: Indicate mechanical system controlled and control system components.

1. Label with settings, adjustable range of control, and limits. Include a written description of control sequence.
2. Include flow diagrams for each control system, graphically depicting control logic.
3. Include draft copies of graphic displays indicating mechanical system components, control system components, and controlled function status and value.
4. Submit a complete written sequence of operation for each and every controlled piece of equipment.

1.05 SUBMITTALS AT PROJECT CLOSEOUT

A. Operation and Maintenance Data.

B. Project Record Documents: Record actual locations of components and set-points of controls, including changes to sequences made after submission of shop drawings.

1.06 QUALITY ASSURANCE

A. Design system under direct supervision of a Professional Engineer experienced in design of this Work and licensed in the State of New York.

PART 2 PRODUCTS - Not Used

PART 3 EXECUTION

3.01 Summer/Winter Change Over

The Building Management System (BMS) shall index the hot system and cooling equipment into either summer or winter control based upon outdoor air temperature. Below 65 F, (adjustable), outside air temperature, the air conditioning shall be disabled. Above 55F, (adjustable), outside air temperature the hot water system shall disabled. Between those temperature economizers shall be used when outdoor air enthalpy permits. The system operator shall have capacity of over riding the system for manual change over. A minimum time delay, (24 hrs adjustable), between summer/winter changes over shall prevent cycling between the 2 modes. During heating mode, the DX cooling shall be locked out except for supplemental cooling systems.

3.02 Boiler Plant:

Boilers shall be operated through an application specific unitary controller that will sequence boilers, pumps dampers, valves and fans. Refer to section 235216 for all safeties and combustion control sequences. The controller shall be microprocessor-based system engineered and programmed exclusively for the operation of multiple hot water boilers.

The communications protocol for the boiler controls shall be based on ASHRA/ANSI BACNET Standard 135-1995. Provide required modules to allow open communication, integration and interoperability with other DDC system. The BMS contractor and boiler manufacturer shall coordinate their work to insure compatibility prior to installation.

The BMS system shall enable the hot water system, and change the system from cooling to heating operation based on outdoor air temperature. Set point shall be 55 degrees, adjustable for heating. The hot water primary, (HWP P-3 and P-4), circulation pumps shall be interlocked to run continuously when respective boiler is started. Furnish a flow switch in each of the primary supply water headers arranged to prevent boiler operation if flow is not proved.

The BMS shall sequence the hot water boilers to maintain the secondary hot water loop temperature set-point. The set-point shall be reset by the outdoor air temperature sensor. Reset schedule to be 180 F to 120 F hot water supply temperature as outside air varies from 10 F to 55 F. adjustable). Lead boiler selection shall be selected by the BMS according to a rotating seven-day schedule for equal running time.

The secondary pumps shall be arranged to operate when the heat plant is enabled. Refer to the Hot Water Variable Speed Pumping System Control paragraph for HW P-1 and P-2 sequence.

The glycol makeup pumps shall be arranged to automatically maintain hot water system pressure in the boiler system. The make up water pumps shall be arranged to alternate through the alternating pump controller.

BMS status and alarms;
Common failure alarm for each boiler.
High temperature
Low temperature
Fuel oil pump failure
Primary pump failure
Secondary pump failure
Make up pump failure
Low water level
High water level
Temperature out of bounds

3.03 Hot Water Variable Speed Pumping System Control (Secondary HW P1, P2)

When the heating is enabled the lead, variable speed pump will be enabled to operate at its lowest speed setting, (35% of maximum flow). If the lead variable speed drive pump fails to operate the lag variable speed pump will start and an alarm will be generated at the pump control panel and the BMS. Furnish a flow switch in the header of each secondary pump with adjustable time delay. The BMS system shall rotate the lead and lag pumps for equal running time on a weekly or daily basis, (adjustable).

Differential pressure, shall be measured across the supply and return of the two-pipe secondary system using a five-point manifold differential pressure sensor. The differential pressure will be measured at the end of the piping loop generally located in

the ceiling of the second floor. The pump will be controlled to maintain the differential pressure at (28 psi adjustable). If the differential pressure drops below set point, the pump speed shall increase proportionately, if differential pressure rises above set point, the pump speed shall be decreased proportionately. The minimum speed set point shall be determined such that the speed corresponds to 30% of the maximum flow at 28 psi differential. The actual set point shall be determined in the field when all water balancing has been completed. DP set point shall be determined when design flow is achieved at the lowest available pump speed. Furnish and install a 2 1/2" differential by pass valve on HW system in the boiler room arranged to open and allow minimum flow through the secondary pumps, if the pumps slow to minimum speed and DP is still above 28psi setpoint.

3.04 Packaged Rooftop and Split System Air Conditioning Units: RTU-1 through RTU-7, AC-1, AC-2.

The units shall be supplied with, and operated through a unit mounted DDC unitary control panel, capable of providing set-point adjustments and all programming control sequences.
The protocol shall be BacNet MSTP. Controls shall include all motorized dampers and valves, damper motors, motor starters, wiring, fans and sensors and all hardware accessories for a complete system. Furnish wall mounted room thermostats with automatic summer/winter change over, and temperature adjustments.

Units Off: The outside air intake and relief air dampers shall be closed, and the return air damper shall be full open. The automatic 2-way valve on the heating coil shall be open. Supply and return Fans shall be stopped

Summer Operation: Upon start up, the control circuits energized. The supply fan, and spill fan (RTU-2 only) shall run continuously. Return fans RF-1 and RF-2 shall run continuously. The outside air intake, and relief air dampers shall open to minimum position the return damper shall open to the maximum position.

VAV systems RTU-2, RTU-3, RTU-4 RTU-5 RTU-7 - A temperature sensor in the unit discharge duct shall be reset by a return air temperature sensor, (master-sub-master), arranged to modulate the DX coil capacity to maintain a constant discharge air temperature. Set the discharge temperature at 55°F to 60°F range (adjustable). The discharge air temperature set-point shall be determined through a comparison of the return air temperature and SA set-point, and shall be reset according or cooling demand. Hot water heating coil control valve shall be closed. VAV boxes shall operate in the summer mode.

Single zone systems AC-1, AC-2, RTU -1 and RTU-6 - A space temperature sensor shall be arranged to modulate the DX coil capacity to maintain a space temperature. Set the discharge temperature at 56°F to 60°F range (adjustable).
AC-1, AC-2, RTU -1 and RTU-6 only
The fan speed shall be reset to modulate with space load based on a comparison of return temperature. Upon a drop-in space load, (either heating or cooling) the fan speed shall be reset be reset lower. Fan speed shall be reduced no lower than 75%, (or as limited by the manufacture). Provide freeze stat on the cooling coil to override

fan speed reduction.

Winter Operation: Upon start up, the control circuits shall be energized. The supply fan and spill fan (RTU-2 only), and return fans, shall run continuously. The outside air intake, and relief air dampers shall open to minimum position the return damper shall open to the maximum position.
Single zone systems AC-1, AC-2, RTU -1 and RTU-6 - A space temperature sensor shall be arranged to modulate the heating capacity to maintain a space temperature. Set the discharge temperature maximum at 110°F .
RTU-2, RTU-3, RTU-4 RTU-5 RTU-7
The heating coil valve shall be arranged to maintain a discharge temperature at 65°F to 75°F range (adjustable). VAV boxes shall operate in the winter mode.

Economizer Operation: On a call for cooling when outdoor air conditions permit, (56 deg adjustable), and below the an enthalpy controller shall modulate the outside air intake, exhaust and return air dampers, to maintain SA temp set point. Override DCV as required. Heating coil control valve shall be closed. Control action shall be that an increase in SA temperature will cause the outside air and exhaust air dampers to modulate towards the open position and the return air damper to modulate towards the closed position. A drop in below set point temperature will cause the reverse to take place. When the outdoor air damper reaches the fully open position a further call for cooling shall cause DX system to operate. When ambient conditions are no longer suitable for economizer operation the unit controls shall revert to normal summer operation. The spill fan shall run continuously. (RTU-2 only) return fans RF-1 and RF-2 shall spill 100%.

Morning Warm-up Operation: Units shall start and operate for a predetermined period as programmed into the unit controllers. During this cycle outside intake and exhaust air dampers shall remain closed, and return air damper shall be full open. The heating valve shall modulate to maintain set point. When the zone temperature(s) comes to with in 2 degrees of set point the unit shall operate in occupied mode. The spill fan shall be off (RTU-2 only). Return fans RF-1 and RF-2 shall run, 100% RA, 0% RA.

Morning Cool-Down Operation: Unit shall start and operate for a predetermined period as programmed into the unit controllers. During this cycle outside intake and spill air dampers shall remain closed, and return air damper shall remain open. The cooling coil shall modulate to maintain discharge air temperature set point. When the zone temperature comes to with in 2 degrees of set point the unit shall operate in occupied mode. The spill fan shall be off (RTU-2 only). Return fans RF-1 and RF-2 shall run, 100% return air, 0% RA

Unoccupied Operation: Unit supply/return fans and heating coils and DX cooling shall cycle on a call for cooling or heating. During this cycle the unit shall operate with 100% re-circulated air. Unit controls shall allow complete shutdown if desired. Set point shall be 68˚ in the heating season and 85 in the cooling season. The spill fan shall be off (RTU-2 only). Return fans RF-1 and RF-2 shall run.,100% return air, 0% RA

Limit Controls: Provide a High/low limit control(s) in the supply fan discharge arranged to override temperature controls and prevent discharge temperature from dropping

below 50°F and rising above 110°F(adjustable). Provide limit control on fan speed for CV units to limit speed reduction to 75% of air flow.

Freezestat: Provide each air RTU with a manual reset type freezestat, (set at 35° adjustable),arranged to shut down the unit and sound an audio and visual alarm at the BMS operator station should the set point be reached. The freezestat element shall be the capillary type with lowest point temperature sensing. It shall be resettable from the BMS.

Static Pressure Controls VAV Units: RTU-2, RTU-3, RTU-4, RTU-5, RTU-7
Provide static pressure sensors in the supply ductwork for each ac unit located approximately two-thirds downstream of the unit in the SA duct. Sensors shall be arranged to vary the speed of the supply fan in response to supply duct static pressure. An increase in static pressure shall cause the fans to slow down a decrease shall cause the fans to speed up. The outside air dampers shall be arranged to modulate open from the minimum position proportionally as fan speed decreases. This shall be done through an air flow measuring station located in the outside air intake plenum to insure constant ventilation air rate (CFM) through the range of fan speeds. For those units that operate DCV mode during normal occupied hours this function shall be overridden by DCV control. Corresponding return or spill air fans in each RTU shall be arranged to maintain a positive pressure of .1" sp in their respective zones. On a drop-in zone pressure the fan shall be arranged to slow down, on a rise in SP above set point the fan shall be arranged to speed up. (open OAI damper)

VAV Boxes: Furnish and install electronic controllers for pressure independent operation. Room thermostats / sensors shall be heating / cooling automatic change over type with dual maximum proportional control. Winter operation; on a drop in space temperature below set point the VAV box shall modulate towards the open position, the hot water radiation control valve and, (VAV box heating coil control valve), shall modulate open proportionately to maintain set space point. On a rise in space temperature the opposite shall take place. Summer operation, the VAV box shall modulate open to increase airflow on a rise in space temperature above set point. On a drop in space temperature the box shall modulate toward the minimum position.

Demand Controlled Ventilation: (AC-1, RTU-6) Furnish combination space temperature/CO2 sensors for where shown on plans. Furnish one CO2 sensor located outdoors on the roof. The outdoor air CO2 sensor shall be used to establish a base line for outdoor CO2 levels, approximately 400 PPM. The CO2 sensors in each space shall have a set point no greater then 400 PPM above the base line, approximately 800 PPM. The air-handling unit's unitary control panel shall calculate outside air intake damper positioning in response to space CO2 levels. Control action shall be that when the space CO2 level rises to within 100 PPM of set point, the outside air intake and spill dampers shall modulate toward open and the RA damper shall modulate toward closed. Upon a drop in space CO2 levels below set point, the opposite shall take place.

The outside air intake dampers normal minimum positions shall be 20% of the design outside air rate, or shall be established based on the schedules contained on the plans, whichever is higher. When operating in demand-controlled ventilation mode

(normal occupied mode) the outside air damper position may be reset according demand with the above lower limit.

Pre-occupancy purge: Shall be automatically initiated by the building automation controls. For a period of 30 minutes prior to scheduled occupied hours, the unit shall operate under occupied mode at the full occupied outdoor air rate. After the 30 minute purge cycle the unit shall run under Demand Controlled ventilation mode.

Post-occupancy flush: Prior to entering unoccupied mode after scheduled occupied hours have elapsed, the unit shall run with the outside air damper open at minimum position until space CO2 concentrations are equal to outdoor air CO2 concentrations. When the CO2 concentrations match, the unit shall run in unoccupied mode.

Packaged Energy Recovery Units (ERV); (RTU-2, RTU-3, RTU-4, RTU-5, RTU-7)
The packaged ERV shall be energized to operate with the respective RTU. Upon start up the OAI and Spill dampers shall open. The OAI and SA fans shall start and the ERV wheel shall start.
Units shall be arranged to go into “Stop-Start-Jog” mode when the associated RTU is in Economizer cycle. The energy recovery wheel shall stop spinning to allow air to pass without energy transfer, and will spin intermittently in order to keep the wheel clean. The ERV supply fan shall be turned off and the motorized OAI economizer damper located on the associated RTU OA ductwork shall modulate open proportionately to the RTU as it modulates toward 100% OA. The spill fan in the ERV shall modulate speed proportionately to the RTU as it modulates toward 100% OA.
The units internal controls shall be arranged to prevent unit freeze up with heating coil or through wheel speed control.

Hot Gas Reheat; (RTU-1, RTU-2, RTU-3, RTU-4, RTU-5, RTU-6, RTU-7)
Provide hot gas reheat controls based on return air RH for VAV systems RTU-2, RTU-3, RTU-4, RTU-5, and RTU-7 and based on space RH for single zone systems RTU-1, and RTU-6. RH set point shall be in the range of 50%-55%. If zone temperature set point is met, or SA set point is met and the RH is above set point, the units shall be arranged to provide sub cooling of SA and energize hot gas reheat to reheat the SA to maintain space or SA set point.

Miscellaneous: Whenever units are shutdown the outside air intake, return air and exhaust air dampers shall be closed. The power exhaust fan shall be energized by a space static pressure sensor set at +.1”. The fan shall be arranged to cycle when static pressure increases above set point.

- Low temperature detection (freezestat)
- Return/exhaust fan failure
- Supply fan failure (current relay or sail switch)
- Hi discharge air temperature (temperature sensor)
- Low discharge air temperature (temperature sensor)
- Dirty filter
- Smoke detection

Purge cycle: shall be initiated manually at the unitary controller panel. During this cycle the supply fan and exhaust fan shall operate at 100% capacity. The outside air and exhaust air dampers shall be fully opened. The return air damper shall be closed.

3.05 Cabinet Heaters and Unit heaters (hot water): CUH-A, B, C and UH-A

Provide a space thermostat set at 72°F adjustable for each hot water cabinet and unit heater. Upon a drop in space temperature below set-point the unit fan shall cycle on and the hot water control valve shall open (*or the electric heating element shall be energized*). On a rise in space temperature above set point the reverse shall take place. Provide a strap-on-aquastat to prevent fan and valve operation when hot water is not detected. In summer mode the control valve shall be closed. All control valves positions shall be monitored and indicated on the BMS.

3.06 Finned Tube Radiation: Type- A and Type-B

Provide a control valve (CV) and room thermostats where indicated on plan set at 72°F for each zone of hot water fin tube radiation, upon a drop in space temperature below set-point the CV valve shall cycle open. On a rise in space temperature above set point the reverse shall take place. For those zones served by VAV boxes and FTR controls shall be arranged to operate the VAV box and FTR in sequence. All control valves positions shall be monitored and indicated on the BMS

3.07 Cabinet Convectors: Conv-A

Provide a control valve for all units and room thermostats where indicated on plan set at 72°F for each convector Upon a drop-in space temperature below set-point the CV valve shall cycle open. On a rise in space temperature above set point the reverse shall take place. For those zones served by VAV boxes with reheat coils and convectors the controls shall be arranged to operate the VAV box CV and convector CV in sequence. All control valves positions shall be monitored and indicated on the BMS

3.08 Toilet Fans and Return Fans:

Toilet exhaust fans TX-1 through TX-3 shall run as scheduled through the BMS system during occupied periods or as programmed.

Return fans RF-1 and RF -2 shall be interlocked to run with their corresponding SA fan. AC-1 and AC-2 respectively.

3.09 Kitchen Exhaust and Make up air units Systems;

KX-1, and MAU-1: KX-1 shall be manually started and stopped through a push button motor starter located in the kitchen near the hood. The starter shall have a green running light to indicate the fan is energized.
In the HAND or manual position the KX fan and MUA shall be started.
In the OFF position the KX-1 fan and MUA-1 shall be stopped.
In the Auto mode KX-1 and MUA-1 shall be interlocked to run automatically.
MAU-1 shall be interlocked to run continuously when KX-1 is energized. When the MAU is energized the OAI damper shall open. During the heating season the unit's

gas fired heating section shall be arranged modulate to maintain a discharge air temperature set point of 68 degrees adjustable. During the cooling season the heating section shall not be energized. Running status for the MAU and KX fan and SA temperature shall be annunciated at the BMS

Provide current sensing to determine if the KX fan has started. In the event of fan failure, the SA fan shall be locked out and the solenoid gas valve shall close.

Upon building fire alarm, or discharge of the Ansul system, the KX fan shall continue to run, the MAU SA fan shall stop, the outside air damper shall close, the gas solenoid valve shall close.

For all type I hoods provide a temperature sensor in the hood arranged to automatically start the exhaust fan and make up air unit upon detecting heat in the hood. The set point to start the fans shall be adjustable.

KX-2; shall be manually started and stopped through a push button motor starter located in the kitchen near the dishwasher hood. The starter shall have a green running light to indicate the fan is energized.
In the HAND or manual position, the KX -2 shall be started.
In the OFF position the KX- 2 shall be stopped.

3.10 Ductless split system: (multi zone AC systems ACC-A, ACC-B, ACC-C, ACC-D)

Shall be started and stopped through a space mounted electronic microcomputer-based room thermostat, by the equipment manufacture. The room thermostat shall be capable of providing set-point adjustments and all programming control sequences. Each evaporator shall have a separate thermostat. Each evaporator's fan and compressors shall cycle to maintain room temperature set point 75˚ when indexed to the auto mode. All condenser, and compressor operations shall be controlled by the AC unit's built in unitary controller. Provide a separate room temperature sensor provide by the BMS contractor for each evaporator. The sensor shall be arranged to report room high and low temperatures and enable an alarm at the BMS work station.

3.11 Air condition condensate pumps:

Provide connection to the overflow switch in each condensate pump tank arranged to annunciate an alarm at the BMS and shut down the respective AHU/AC unit.
Provide a secondary high level float switch in each packaged roof top unit condensate pan and each split system air handling unit condensate pan arranged to annunciate an alarm at the BMS and shut down the respective AHU/AC unit.

3.12 Miscellaneous Plumbing Equipment:

Domestic hot water pump: The BMS system shall be arranged to operate the domestic hot water recirculation pump. The pump shall be operated based on return water temperature. When return water temperature drops below setpoint (110 deg F) the pump shall be started.

Domestic hot water mixing valves: Domestic hot water mixing valves shall be 3-way mixing valves arranged to maintain the maintain domestic water to the building at 120°F maximum. (adjustable), The actual setpoint shall be 110°F. The second 3-way mixing valve shall be at the kitchen. This shall be arranged to maintain the domestic water to the pot sinks at 140°F maximum. In both cases there shall be secondary aquastats on the respective hot water pipes arranged to close a solenoid valve in each of the respective hot water lines if water temperature rises above set point. Provide monitoring and set point adjustment at the BMS work station. Alarm high temperature at the BMS.

Domestic Water Meters: domestic water make up to the boiler plant and to the domestic hot water heaters shall be metered and recorded. The BMS shall have contain a record of water usage for each meter on monthly and total annul basis. The BMS shall aggregate water usage from each separate meter on a monthly basis, and shall retain water usage data for a minimum of 1 year.

Elevator pit sump pumps: provide an interface to the sump pump control panel. The panel alarm output shall be monitored and annunciated at the BMS. The oil minder pump control panel has a discriminating alarm output for oil detection.

3.13 Miscellaneous

All safety devices shall be interlocked with “hand” and “Automatic” positions in series with motor controller holding coil circuit. Interlocking with other fans and equipment of system shall be through “Automatic” position “Hand” position shall be for maintenance only. Remote starting shall be from through “automatic” position only.

All air handling units 2,000 cfm or greater shall have a duct mounted smoke detector arranged to stop the unit and position all dampers and valves in the “unit off” sequence as described in this section, upon detecting smoke.
All air handling units, unit ventilators, cabinet unit heaters, unit heaters, fans, and fan coil units, shall be interlocked to the building fire alarm system. Upon building fire alarm all units shall shut down and damper and valves shall go to “unit off” positions.

END OF SECTION 230993

SECTION 232113 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes pipe and fitting materials and joining methods for the following:

1. Hot-water heating piping.
2. Chilled-water piping.
3. Dual-temperature heating and cooling water piping.
4. Glycol cooling-water piping.
5. Makeup-water piping.
6. Condensate-drain piping.
7. Blowdown-drain piping.
8. Air-vent piping.
9. Safety-valve-inlet and -outlet piping.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of the following:

1. Plastic pipe and fittings with solvent cement.
2. RTRP and RTRF with adhesive.
3. Pressure-seal fittings.
4. Chemical treatment.

B. Delegated-Design Submittal:

1. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides, hangers, and supports for multiple pipes, expansion joints and loops, and attachments of the same to the building structure.
2. Locations of pipe anchors, alignment guides, expansion joints, and loops.
3. Locations of and details for penetrations, including sleeves and sleeve seals for exterior walls, floors, basement, and foundation walls.
4. Locations of and details for penetration and firestopping for fire- and smoke-rated wall and floor, and ceiling assemblies.
5. For underground piping, provide the size and quantity of pipe expansion loops and thrust blocks.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Piping layout, 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. Other building services.
3. Structural members.

B. Qualification Data: For Installer.

C. Welding certificates.

D. Field quality-control reports.

E. Water Analysis: Submit a copy of the water analysis to illustrate the water quality available at the Project site.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installers of Pressure-Sealed Joints: Installers shall be certified by the pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.
2. Fiberglass Pipe and Fitting Installers: Installers of RTRF and RTRP shall be certified by the manufacturer of pipes and fittings as having been trained and qualified to join fiberglass piping with manufacturer-recommended adhesive.

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 the welding processes involved and that certification is current.

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: 150 psig at 200 deg F.
2. Chilled-Water Piping: 150 psig at 200°F.
3. Dual-Temperature Heating and Cooling Water Piping: 150 psig at 200°F.
4. Glycol Cooling-Water Piping: 150 psig at 150 deg F.
5. Makeup-Water Piping: 80 psig at 150 deg F.
6. Condensate-Drain Piping: 150 deg F.
7. Blowdown-Drain Piping: 200 deg F.
8. Air-Vent Piping: 200 deg F.
9. 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 Tubing: ASTM B 88, Type L.

B. Annealed-Temper Copper Tubing: ASTM B 88, Type K.

C. DWV Copper Tubing: ASTM B 306, Type DWV.

D. Grooved, Mechanical-Joint, Wrought-Copper Fittings: ASME B16.22.

1. Basis of Design Gruvlok
2. Grooved-End Copper Fittings: ASTM B 75, copper tube or ASTM B 584, bronze casting.
3. Grooved-End-Tube Couplings: Rigid pattern unless otherwise indicated; gasketed fitting. Ductile-iron housing with keys matching pipe and fitting grooves, pre-lubricated EPDM gasket rated for a minimum 230 deg F for use with housing, and steel bolts and nuts.

E. Copper or Bronze Pressure-Seal Fittings:

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

   a. Elkhart Products Corporation.
   b. Mueller Industries, Inc.
   c. NIBCO INC.
   d. Viega LLC.

2. Housing: Copper.
3. O-Rings and Pipe Stops: EPDM.
4. Tools: Manufacturer's special tools.
5. Minimum 200-psig working-pressure rating at 250 deg F.

F. Wrought-Copper Unions: ASME B16.22.

2.3 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, 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 A 234/A 234M, wall thickness to match adjoining pipe.

G. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

1. Material Group: 1.1.
2. End Connections: Butt welding.
3. Facings: Raised face.

H. Grooved Mechanical-Joint Fittings and Couplings:

1. Basis of design - Gruvlok
2. Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47/A 47M, Grade 32510 malleable iron; ASTM A 53/A 53M, Type F, E, or S, Grade B fabricated steel; or ASTM A 106/A 106M, 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. Steel Pipe Nipples: ASTM A 733, made of the same materials and wall thicknesses as pipe in which they are installed.

2.4 PLASTIC PIPE AND FITTINGS (NOT USED IN THIS PROJECT)

A. CPVC Plastic Pipe: ASTM F 441/F 441M, with wall thickness as indicated in "Piping Applications" Article.

1. CPVC Plastic Pipe Fittings: Socket-type pipe fittings, ASTM F 438 for Schedule 40 pipe; ASTM F 439 for Schedule 80 pipe.

B. PVC Plastic Pipe: ASTM D 1785, with wall thickness as indicated in "Piping Applications" Article.

1. PVC Plastic Pipe Fittings: Socket-type pipe fittings, ASTM D 2466 for Schedule 40 pipe; ASTM D 2467 for Schedule 80 pipe.

2.5 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for the 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. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

F. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

G. Gasket Material: Thickness, material, and type suitable for the fluid to be handled and working temperatures and pressures.

2.6 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:
1. Description:

a. Standard: ASSE 1079.
b. Pressure Rating: 150 psig 250 psig.
c. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:
   1. Description:

      a. Standard: ASSE 1079.
      b. Factory-fabricated, bolted, companion-flange assembly.
      c. Pressure Rating: 150 psig minimum at 250 deg F.
      d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:
   1. Description:

      a. Nonconducting materials for field assembly of companion flanges.
      b. Pressure Rating: 150 psig.
      c. Gasket: Neoprene or phenolic.
      d. Bolt Sleeves: Phenolic or polyethylene.
      e. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:
   1. Description:

      a. Standard: IAPMO PS 66.
      b. Electroplated steel nipple, complying with ASTM F 1545.
      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. Hydronic Piping aboveground; NPS 2 1/2 and smaller, shall be any of the following:

   1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered, brazed, pressure-seal joints.
   2. Schedule 40, Grade B, Type 96 steel pipe; Class 150, malleable-iron fittings; cast-iron flanges and flange fittings; and threaded joints.

B. Hydronic Piping aboveground; NPS 3 and larger, shall be any of the following:

   1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered, brazed joints.
   2. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
   3. Schedule 40 steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.

C. Makeup-water piping aboveground:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

D. Makeup-Water Piping Belowground and within Slabs:
1. Type K, annealed-temper copper tubing, wrought-copper fittings, and soldered joints. Use the fewest possible joints.

E. Condensate-Drain Piping:
1. Type M, Type DWV, drawn-temper copper tubing, wrought-copper fittings, and soldered joints
2. Schedule 40 PVC plastic pipe and fittings and solvent-welded joints. Only when concealed or not in a return air plenum space.

F. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.

G. Air-Vent Piping:

1. Inlet: Same as service, where installed with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer's written instructions.
2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.

H. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping:

1. Same materials and joining methods as for piping specified for the service in which the safety valve is installed, with metal-to-plastic transition fittings for plastic piping systems according to the piping manufacturer's written instructions.

3.2 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicates the general location and arrangement of piping systems. Install piping as indicated unless deviations to the 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 the 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 a 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 the direction of flow.

N. Reduce pipe sizes using an eccentric reducer fitting installed with the level side up.

O. Install branch connections to mains with tee fittings in the main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.

P. Install valves according to Section 230523.101 " Valves for HVAC Piping," Section 230523.12

Q. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

R. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

S. Install shutoff valve immediately upstream of each dielectric fitting.

T. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for identifying piping.

U. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."

V. Install escutcheons on all exposed piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

W. For piping passing through equipment room walls to occupied spaces, provide split seals for sound and vibration attenuation between rooms. Comply with section 23 21 16.

X. Install packless expansion fitting in all hydronic piping sections that are 75’ long or over.

3.3 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric nipples, or unions.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges, or nipples.

D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.4 HANGERS AND SUPPORTS

A. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hanger, support, and anchor devices. Comply with the following requirements for maximum spacing of supports and hanger rod size.

B.]Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 6 feet; minimum rod size, 1/4 inch.
2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
3. NPS 1-1/4Maximum span, 7 feet; minimum rod size, 3/8 inch.
4. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
5. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
6. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
7. NPS 3 and Larger: Maximum span, 10 feet; minimum rod size, 3/8 inch.

D. Support vertical runs at the roof, at each floor, and at 10-foot intervals between floors.

3.5 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8/A5.8M.

E. 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.

F. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install the gasket concentrically positioned. Use suitable lubricants on bolt threads.

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
3. PVC Pressure Piping: Join ASTM D 1785 schedule number, PVC pipe, and PVC socket fittings according to ASTM D 2672. Join other-than-schedule number PVC pipe and socket fittings according to ASTM D 2855.
4. PVC Non pressure Piping: Join according to ASTM D 2855.

H. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in the ends of the pipe based on the pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid, grooved-end-pipe couplings.

I. Mechanically Formed, Copper-Tube-Outlet Joints: Use manufacturer-recommended tool and procedure, and brazed joints.

J. Pressure-Sealed Joints: Use manufacturer-recommended tool and procedure. Leave insertion marks on the pipe after assembly.

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 bypass piping with shut-off valve around all control valve. If parallel control valves are installed, only one bypass is required.

D. Install ports for pressure gages and thermometers at coil inlet and outlet connections. Comply with requirements in Section 230519 "Meters and Gages for HVAC Piping."

3.7 CHEMICAL TREATMENT

A. Perform an analysis of makeup water to determine the type and quantities of chemical treatment needed to keep the 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. Revise this value if the closed system contains glycol.
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. Tolyiriazole 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 a feeder in a minimum NPS 3/4 bypass line, from the main with a full-size, full-port, ball valve in the main between bypass connections.
3. Install NPS 3/4 pipe from the chemical feeder drain to the nearest equipment drain and include a 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 the ranges noted above for the first year of operation.

E. Fill systems that have antifreeze or glycol solutions with the following concentrations:

1. All Hydronic Piping: Minimum of 30% percent propylene glycol.

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 the valve. Install blinds in flanged joints to isolate equipment.
5. Install a safety valve, set at a pressure no more than one-third higher than the test pressure, to protect against damage by expanding liquid or other source of overpressure during the test.

B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is a risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling the system, use the vents installed at high points of the system to release air. Use drains installed at low points for complete draining of the test liquid.
3. Isolate expansion tanks and determine that the 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 the maximum pressure for any vessel, pump, valve, or other component in the system under test. Verify that stress due to pressure at the bottom of vertical runs does not exceed 90 percent of the specified minimum yield strength or 1.7 times the "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
5. After the hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat the hydrostatic test until there are no leaks.
6. Prepare a 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 the required system pressure.
4. Inspect air vents at high points of the 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, and cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

END OF SECTION 232113

SECTION 232116 - HYDRONIC 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 special-duty valves and specialties for the following:

1. Hot-water heating piping.
2. Chilled-water piping.
3. Dual-temperature heating and cooling water piping.
4. Condenser-water piping.
5. Glycol cooling-water piping.
6. Makeup-water piping.
7. Condensate-drain piping.
8. Blowdown-drain piping.
9. Air-vent piping.
10. Safety-valve-inlet and -outlet piping.
11. Vibration Isolation
12. Expansion fittings for hydronic piping
13. Pipe guides and anchors
14. Chemical shot feeder

1.3 ACTION SUBMITTALS

A. Product Data: For each type of the following:

1. Valves: Include flow and pressure drop curves based on the manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
2. Air-control devices.
3. Hydronic specialties.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-control devices, hydronic specialties, and special-duty valves, to include in emergency, operation, and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Differential Pressure Meter: For each type of balancing valve and automatic flow control valve, include a flowmeter, probes, hoses, flow charts, and a carrying case.

1.6 QUALITY ASSURANCE

A. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

1. 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 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: 150 psig at 200 deg F
2. Chilled-Water Piping: 150 psig at 200 deg F.
3. Dual-Temperature Heating and Cooling Water Piping: 150 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: 80 psig at 150 deg F
7. Condensate-Drain Piping: 150 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 VALVES

A. Gate, Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Section 230523.10 "Valves for HVAC Piping."

B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Section 230923.11 "Control Valves."

2.3 BRONZE, CALIBRATED-ORIFICE, BALANCING VALVES:

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. Nexus Valve, Inc.
d. TACO Comfort Solutions, Inc.
e. Tour & Andersson; available through Victaulic Company.
f. Victaulic Company.

2. Body: Bronze, ball or globe type with calibrated orifice or venturi.

3. Ball: Brass or stainless steel.
4. Seat: PTFE.
5. End Connections: Threaded or socket.
6. Pressure Gage Connections: Integral seals for portable differential pressure meter.
7. Handle Style: Lever, with memory stop to retain set position.
8. CWP Rating: Minimum 125 psig
9. Maximum Operating Temperature: 250 deg F

B. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:

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. Nexus Valve, Inc.
d. Tour & Andersson; available through Victaulic Company.

2. Body: Cast-iron or steel body, globe pattern with calibrated orifice or venturi.

3. Ball: Brass or stainless steel.
4. Stem Seals: EPDM O-rings.
5. Disc: Glass and carbon-filled PTFE.
6. Seat: PTFE.
7. End Connections: Flanged or grooved.
8. Pressure Gage Connections: Integral seals for portable differential pressure meter.
9. Handle Style: Lever, with memory stop to retain set position.
10. CWP Rating: Minimum 125 psig
11. Maximum Operating Temperature: 250 deg F

C. 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. Armstrong Pumps, Inc.
c. Bell & Gossett; a Xylem brand.
d. Spence Engineering Company, Inc.

e. Watts; a Watts Water Technologies company.

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.

D. Diaphragm-Operated Safety Valves: ASME labeled.

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. Spence Engineering Company, Inc.
e. Watts; a Watts Water Technologies company.

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.

E. Automatic Flow-Control Valves: (NOT USED)

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

a. Flow Design, Inc.
b. Griswold Controls.
c. Nexus Valve, Inc.
d. NuTech Hydronic Specialty Products.

2. Body: Brass or ferrous metal.

3. Piston and Spring Assembly: Stainless steel, tamper-proof, self-cleaning, and removable.
4. Combination Assemblies: Include a bronze or brass-alloy ball valve.
5. Identification Tag: Marked with zone identification, valve number, and flow rate.
6. Size: Same as the pipe in which installed.
7. Performance: Maintain constant flow, plus or minus 5 percent over system pressure fluctuations.
8. Minimum CWP Rating: 175 psig
9. Maximum Operating Temperature: 200 deg F

2.4 AIR-CONTROL DEVICES

A. 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.
e. John Wood

B. Manual Air Vents:

1. Body: Bronze.

2. Internal Parts: Nonferrous.
3. Operator: Screwdriver or thumbscrew.
4. Inlet Connection: NPS 1/2
5. Discharge Connection: NPS 1/8.
6. CWP Rating: 150 psig
7. Maximum Operating Temperature: 225 deg F

C. Automatic Air Vents:
1. Body: Bronze or cast iron.
2. Internal Parts: Nonferrous.
3. Operator: Noncorrosive metal float.
4. Inlet Connection: NPS 1/2
5. Discharge Connection: NPS 1/4
6. CWP Rating: 150 psig
7. Maximum Operating Temperature: 240 deg F

D. Expansion Tanks:

1. Tank: Welded steel, rated for 125-psig working pressure and 375 deg F maximum operating temperature, with taps in the bottom of the tank for tank fitting and taps

at the end of the tank for gauge glass. Tanks shall be factory tested after taps are fabricated and shall be labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

2. Air-Control Tank Fitting: Cast-iron body, copper-plated tube, brass vent tube plug, and stainless-steel ball check, 100-gal. unit only; sized for compression-tank diameter. Provide tank fittings for 125-psig working pressure and 250 deg F maximum operating temperature.

3. Tank Drain Fitting: Brass body, nonferrous internal parts; 125-psig working pressure and 240 deg F maximum operating temperature; constructed to admit air to the compression tank, drain water, and close off the system.

4. Gage Glass: Full height with dual manual shutoff valves, 3/4-inch- diameter gage glass, and slotted-metal glass guard.

E. Diaphragm or Bladder-Type Expansion Tanks as scheduled or noted on plans:
1. Tank: Welded steel, rated for 125-psig working pressure and 375°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.
2. Diaphragm or Bladder: Securely sealed into the tank to separate air charge from system water to maintain the required expansion capacity.
3. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.

F. Tangential-Type Air Separators:
1. Tank: Welded steel; ASME constructed and labeled for 125-psig minimum working pressure and 375 deg F maximum operating temperature.
2. Air Collector Tube: Perforated stainless steel, constructed to direct released air into the expansion tank.
3. Tangential Inlet and Outlet Connections: Threaded for NPS 2 and smaller; flanged connections for NPS 2-1/2 and larger.
4. Blowdown Connection: Threaded.
5. Size: Match system flow capacity.

G. In-Line Air Separators:
1. Tank: One-piece cast iron with an integral weir constructed to decelerate system flow to maximize air separation.
2. Maximum Working Pressure: Up to 175 psig
3. Maximum Operating Temperature: Up to 300 deg F

H. Air Purgers:
1. Body: Cast iron with internal baffles that slow the water velocity to separate the air from the solution and divert it to the vent for quick removal.
2. Maximum Working Pressure: 150 psig
3. Maximum Operating Temperature: 250 deg F

2.5 HYDRONIC PIPING SPECIALTIES

A. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: Stainless-steel, 20-mesh strainer, or perforated stainless-steel basket.
4. CWP Rating: 125 psig

B. Basket Strainers:

1. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: 40-mesh startup strainer and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig

C. T-Pattern Strainers:

1. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
2. End Connections: Grooved ends.
3. Strainer Screen: 40-mesh startup strainer and perforated stainless-steel basket with 57 percent free area.
4. CWP Rating: 750 psig

D. 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 the equipment connected.
3. Performance: Capable of 3/4-inch misalignment.
4. CWP Rating: 150 psig
5. Maximum Operating Temperature: 250 deg F

E. Spherical, Rubber, Flexible Connectors:

1. Rubber flexible connections shall be peroxide-cured EPDM throughout with Kevlar tire cord reinforcement. The raised face rubber flanges must encase solid steel rings to prevent pull-out. Flexible cable wire is not acceptable. Sizes 1-1/2" through 14" shall have a ductile iron external ring between the two spheres. Sizes 3/4" through 2” may have one sphere, bolted threaded flange assemblies, and cable retention.

2. Minimum ratings shall be 250 psi at 170°F and 215 psi at 250°F. Higher published rated connectors may be used where required.

3. Safety factors shall be a minimum of 3/1. All flexible connections must be factory tested to 150% of maximum pressure for 12 minutes before shipment. The piping gap shall be equal to the length of the expansion joint under pressure. Control rods passing through 1/2" thick Neoprene washer bushings, large enough to take the thrust at 1000psi of surface area, may be used on unanchored piping where the manufacturer determines the condition exceeds the expansion joint rating without them.

4. All flexible joints shall be installed on the equipment side of the shut-off valves. Expansion joints shall be SAFEFLEX SFDEJ, SFEJ, SFDCR, or SFU and Control Rods CR as manufactured by Mason Industries, Inc
   a. Body: Fiber-reinforced rubber body.
   b. End Connections: Steel flanges drilled to align with Classes 150 and 300 steel flanges.
   c. Performance: Capable of misalignment.
   d. CWP Rating: 150 psig
   e. Maximum Operating Temperature: 250 deg F

F. Braided Pipe Flexible Connection;

1. Flexible stainless steel hose shall have stainless steel braid and carbon steel fittings. Sizes 3" and larger shall be flanged. Smaller sizes may have male nipples. Minimum sizes listed below.

Flanged (Pipe Dia x Flexible Pipe Length)		
3" x 12"	6" x 18"	12" x 24"
4" x 12"	8" x 18"	14" x 30"
5" x 18"	10" x 18"	16" x 32"

Male Nipples (Pipe Dia x Flexible Pipe Length)		
1/2" x 12"	1-1/4" x 12"	2" x 12"
3/4" x 12"	1-1/2"x 12"	2-1/2" x 18"
1" x 12"		

2. At equipment connections, hoses shall be installed on the equipment side of the shut-off valves horizontal and parallel to the equipment shafts wherever possible. Hoses shall be type FFL or type MN as manufactured by Mason Industries, Inc

G. Vibration isolation pipe hangers: pre-compressed and locked at the rated deflection by means of a resilient up-stop to keep the piping or equipment at a fixed elevation during installation. The hangers shall be designed with a release mechanism to free the spring

after the installation is complete, and the hanger is subjected to its full load. Deflection shall be clearly indicated by means of a scale. Submittals shall include a drawing of the hanger showing the 30° capability. Hangers shall be type PC30N as manufactured by Mason Industries, Inc

H. Acoustic Split Seals consist of pipe halves with a minimum 3/4" thick neoprene sponge cemented to the inner faces. The seal shall be tightened around the pipe to eliminate clearance between the inner sponge face and the piping. Grout seals to make it integral with the floor, wall, or ceiling in masonry construction. Seals shall project a minimum of 1" past the face of the wall. Where temperatures exceed 240°F, 10 lb. density fiberglass may be used in lieu of the sponge. Seals shall be Type SPS or SWS as manufactured by Mason Industries, Inc.

2.6 PACKLESS EXPANSION JOINTS

A. Metal, Compensator Packless Expansion Joints: Metraflex Model HPFF – for copper, Model HP for steel pipe

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

   a. Flexicraft Industries.
   b. Mason Industries, Inc.
   c. Metraflex Company (The).

2. Minimum Pressure Rating: 150 psig, 175 psig unless otherwise indicated.

3. Description: Totally enclosed, externally pressurized, multi-ply bellows isolated from fluid flow by an internal pipe sleeve and external housing.
4. Joint Axial Movement: 2 inches of compression and 1/2 inch of extension.
5. Configuration for Copper Tubing: Multi-ply, phosphor-bronze bellows with copper pipe ends.

   a. End Connections for Copper Tubing NPS 2 and Smaller: Solder joint or threaded.
   b. End Connections for Copper Tubing NPS 2-1/2 to NPS 4: Threaded.

6. Configuration for Steel Piping: Multi-ply, stainless-steel bellows; steel-pipe end connections; and carbon-steel shroud.

   a. End Connections for Steel Pipe NPS 2 and Smaller: Threaded.
   b. End Connections for Steel Pipe NPS 2-1/2 to NPS 4: Threaded Welded.

2.7 GROOVED-JOINT EXPANSION JOINTS

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

1. Anvil International.
2. Grinnell G-Fire by Johnson Controls Company.
3. Victaulic Company.

B. Description: Factory-assembled expansion joint made of several grooved-end pipe nipples, couplings, and grooved joints.

C. Standard: AWWA C606, for grooved joints.

D. Nipples: ASTM A 53/A 53M, Schedule 40, Type E or S, steel pipe with grooved ends.

E. Couplings: flexible type for steel-pipe dimensions. Include ferrous housing sections, Buna-N gasket suitable for diluted acid, alkaline fluids, and cold and hot water, and bolts and nuts.

2.8 ALIGNMENT GUIDES AND ANCHORS

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

   a. Advanced Thermal Systems, Inc.
   b. Flexicraft Industries.
   c. Mason Industries, Inc.
   d. Metraflex Company (The).

2. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding slider for bolting to pipe.

3. Steel Shapes and Plates: ASTM A 36/A 36M.
4. Bolts and Nuts: ASME B18.10 or ASTM A183, steel hex head.
5. Washers: ASTM F 844, steel, plain, flat washers.
6. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened concrete, with tension and shear capacities appropriate for the application. Threaded stud, expansion plug, nuts, and washers shall be zinc-coated carbon steel.

7. Chemical Fasteners: Insert-type stud, bonding-system anchor for use with hardened concrete, with tension and shear capacities appropriate for application.

   a. Bonding Material: ASTM C 881/C 881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where a fastener is to be installed.
   b. Stud: threaded stud washers and nuts shall be ASTM A 307, zinc-coated carbon steel.
   c. Alignment Guides
      1) Horizontal split spider type guide – Metraflex – Style IV

2) Slide guide - – Metraflex – model PTFE
3) Pre-insulated guide – Metraflex – model PG PRE
4) Vertical glide riser - – Metraflex – model PGQ

d. Anchors
1) Anchor clamp – Metraflex – model PA
2) Structural I Beam Anchors – Metraflex
3) Pre-insulated Anchor – Metraflex – model PAPI
4) Modular riser guide – Metraflex – modular riser with EPDM insert

2.9 BYPASS CHEMICAL FEEDER

A. Description: Welded steel construction; 150-psig working pressure; 10-gal. capacity min; with fill funnel and inlet, outlet, and drain valves.

1. Chemicals: Specially formulated, based on analysis of makeup water, to prevent accumulation of scale and corrosion in piping and connected equipment.

PART 3 - EXECUTION

3.1 VALVE APPLICATIONS

A. Install shutoff-duty valves at each branch connection to supply mains and at supply connections to each piece of equipment.

B. Install calibrated orifice, balancing valves at each branch connection to return main.

C. Install calibrated orifice, balancing valves in the return pipe of each heating or cooling terminal.

D. Install check valves at each pump discharge and elsewhere as required to control flow direction.

E. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

F. Install pressure-reducing valves at the makeup-water connection to regulate system fill pressure.

G. All valves and specialties installed in the system shall have a pressure rating that exceeds the system working pressure.

3.2 HYDRONIC SPECIALTIES INSTALLATION

A. All valves and specialties installed in the system shall have a pressure rating that exceeds the system working pressure.

B. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

C. 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.

D. Install piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward the tank.

E. Install in-line air separators in the pump suction. Install a drain valve on air separators NPS 2 and larger.

F. Install a tangential air separator in the pump suction. Install blowdown piping with a gate or full-port ball valve; extend full size to the nearest floor drain.

G. Install steel braided flexible pipe connections at all coil connections and at all piping connections to motor-driven equipment except for pumps.

H. Isolate piping from base-mounted pumps with spherical rubber flexible connections

I. Install vibration isolation hangers or supports on all piping connected to motor-driven equipment for a distance of 20’ or the first two hangers.

J. Install expansion tanks above the air separator. Install the tank fitting in the tank bottom and charge the tank. Use the manual vent for initial fill to establish the proper water level in the tank.

1. Install tank fittings that are shipped loose.
2. Support tank from floor or structure above with sufficient strength to carry the weight of tank, piping connections, fittings, plus tank full of water. Do not overload building components and structural members.

K. Install expansion tanks on the floor. Vent and purge air from the hydronic system, and ensure that the tank is properly charged with air to suit the system's Project requirements. System pressure shall be 5psi minimum residual at the top of the system.

L. Install Acoustic split seals on all hydronic piping 2” and over, penetrating mechanical equipment room walls.

M. Install Packless expansion fittings in all hydronic pipe sections, regardless of service, that are over 75’ long straight run. An alternative pipe “expansion loop” may be used if space permits. Piping layout submittal shall indicate guide and rigid mount locations.

3.3 EXPANSION JOINT INSTALLATION

A. Install expansion joints of sizes matching the sizes of piping in which they are installed.

B. Install grooved-joint expansion joints to grooved-end steel piping.

C. Grooved end pipe applications can use multiple grooved couplings installed in an arrangement as approved by the manufacturer for the specific application. The manufacturer shall recommend the number, placement, and arrangement in the piping systems. Submit to the engineer for review and approval.

3.4 PIPE LOOP AND SWING CONNECTION INSTALLATION

A. Install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during an anticipated change in temperature.

B. Connect risers and branch connections to terminal units with at least four pipe fittings, including a tee in the riser.

C. Connect mains and branch connections to terminal units with at least four pipe fittings, including a tee in the main.

3.5 ALIGNMENT-GUIDE AND ANCHOR INSTALLATION

A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.

B. Install one guide(s) on each side of pipe expansion fittings and loops. Install guides nearest to the expansion joint or loop not more than three pipe diameters from the expansion joint.

C. Attach guides to the pipe, and secure guides to the building structure.

D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

E. Anchor Attachments:

1. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24; U-bolts bolted to anchor.

F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.

1. Anchor Attachment to Steel Structural Members: Attach by welding.
2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow the fastener manufacturer's written instructions.

G. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

END OF SECTION 232116

SECTION 232123 - HYDRONIC PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Close-coupled, in-line centrifugal pumps.
2. Close-coupled, end-suction centrifugal pumps.
3. Separately coupled, horizontally mounted, in-line centrifugal pumps.
4. Separately coupled, vertically mounted, in-line centrifugal pumps.
5. Separately coupled, base-mounted, end-suction centrifugal pumps.
6. Separately coupled, base-mounted, double-suction centrifugal pumps.
7. Automatic condensate pump units.

1.3 DEFINITIONS

A. Buna-N: Nitrile rubber.

B. EPT: Ethylene propylene terpolymer.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of pump. Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate the pump's operating point on curves.

B. Shop Drawings: For each pump.

1. Show pump layout and connections.
2. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
3. Include diagrams for power, signal, and control wiring.

1.5 CLOSEOUT SUBMITTALS

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

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Mechanical Seals: One mechanical seal(s) for each pump.

PART 2 - PRODUCTS

2.1 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS

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

1. Armstrong Pumps, Inc.
2. ITT Corporation.
3. Mepco, LLC.
4. PACO Pumps; Grundfos Pumps Corporation, USA.
5. Patterson Pump Company, a Gorman-Rupp company.
6. Peerless Pump Company.
7. TACO Comfort Solutions, Inc.
8. Thrush Co. Inc.

B. 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.

C. Pump Construction:

1. Casing: Radially split, cast iron, with threaded gage tapings at inlet and outlet, replaceable bronze wear rings, and threaded or companion-flange connections.
2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to the shaft, and secured with a locking cap screw. For constant-speed pumps, trim the impeller to match the specified performance.
3. Pump Shaft: stainless steel
4. Motor shaft; carbon steel.
1. Seal: Mechanical seal consisting of a carbon rotating ring against a ceramic seat held by a stainless-steel spring, and [Buna-N] bellows and gasket. Include a water slinger on the shaft between the motor and seal.

2. Seal: 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.
3. Pump Bearings: Oil lubricated; bronze-journal or thrust type.

D. Motor: Single speed and rigidly mounted to the pump casing.

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

a. Enclosure: [Open, drip proof] [Totally enclosed, fan cooled] [Explosion proof] [Dust-ignition-proof machine].
b. Enclosure Materials: Cast iron [Rolled steel].
c. Motor Bearings: Permanently lubricated ball bearings up through 5 HP
d. Motor Bearings Grease lubricated ball bearings over 5 HP.
e. Unusual Service Conditions:

1) Ambient Temperature:104°F.
2) Altitude: 100 feet above sea level.
3) High humidity.

f. Efficiency: Premium efficiency.
g. NEMA Design: B or C
h. Service Factor: 1.15.
i. All motors used with VFDs shall be inverter-duty rated

E. Capacities and Characteristics: Refer to plans and schedules.

F. Electrical Characteristics: Refer to plans and schedules.

2.2 CLOSE-COUPLED, END-SUCTION CENTRIFUGAL PUMPS

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

1. Armstrong Pumps, Inc.
2. Aurora Pump; Pentair Ltd.
3. Buffalo Pumps, Inc.
4. ITT Corporation.
5. Mepco, LLC.
6. PACO Pumps; Grundfos Pumps Corporation, USA.
7. Patterson Pump Company, a Gorman-Rupp company.
8. Peerless Pump Company.

B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally.

C. Pump Construction:

1. Casing: Radially split, cast iron, with replaceable bronze wear rings, drain plug at bottom and air vent at top of volute, threaded gage tapings at inlet and outlet, and flanged connections.
2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to the shaft, and secured with a locking cap screw. For constant-speed pumps, trim the impeller to match the specified performance.
3. Shaft: Carbon steel.
4. Shaft sleeve; brass or stainless steel
5. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket. Include a water slinger on the shaft between the motor and the seal.
6. Pump Bearings: Permanently lubricated ball bearings.

D. Motor: Single speed and rigidly mounted to the pump casing with integral pump support.

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

    a. Enclosure: [Open, drip proof] [Totally enclosed, fan cooled] [Explosion proof] [Dust-ignition-proof machine].
    b. Enclosure Materials: Cast iron [Rolled steel].
    c. Motor Bearings: Permanently lubricated ball bearings up through 5HP
    d. Motor Bearings Grease lubricated over 5HP.
    e. Unusual Service Conditions:

        1) Ambient Temperature: 104°F.
        2) Altitude: 100 feet above sea level.
        3) High humidity.

    f. Efficiency: Premium efficiency.
    g. NEMA Design: B or C.
    h. Service Factor: 1.15.
    i. All motors used with VFDs shall be inverter-duty rated

E. Capacities and Characteristics: Refer to plans and schedules.

F. Electrical Characteristics: Refer to plans and schedules.

2.3 SEPARATELY COUPLED, HORIZONTALLY MOUNTED, IN-LINE CENTRIFUGAL PUMPS

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

1. Armstrong Pumps, Inc.
2. ITT Corporation.
3. Mapco, LLC.
4. PACO Pumps; Grundfos Pumps Corporation, USA.
5. Patterson Pump Company, a Gorman-Rupp company.
6. Peerless Pump Company.
7. TACO Comfort Solutions, Inc.
8. Thrush Co. Inc.

B. 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 horizontally.

C. Pump Construction:

1. Casing: Radially split, cast iron, with threaded gage tapings at inlet and outlet, and threaded companion-flange connections.
2. Impeller: ASTM B 584, cast bronze or brass; statically and dynamically balanced, and keyed to the shaft. For pumps not frequency-drive controlled, trim the impeller to match the specified performance.
3. Pump Shaft: Carbon Steel
4. Sleeve; Alloy Copper 110.
5. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket. Include a water slinger on the shaft between the motor and seal.)
6. Pump Bearings: permanently oil-lubricated; bronze-journal or thrust type.

D. Shaft Coupling: Molded-rubber insert with interlocking spider capable of absorbing vibration.

E. Motor: Single speed and rigidly mounted to the pump casing.

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

a. Enclosure: [Open, drip proof] [Totally enclosed, fan cooled] [Totally enclosed, air over] [Severe duty] [Explosion proof] [Dust-ignition-proof machine].

b. Enclosure Materials: Cast iron [Rolled steel].
c. Motor Bearings: Permanently lubricated ball bearings. Up to 5 hp
d. Motor Bearings: Grease-lubricated ball bearings. Over 5 hp
e. Unusual Service Conditions:

1) Ambient Temperature: 104°F.
2) Altitude: 100 feet above sea level.
3) High humidity.

f. Efficiency: Premium efficient.
g. NEMA Design: B or C
h. Service Factor: 1.15.
i. All motors used with VFDs shall be inverter-duty rated

F. Capacities and Characteristics: Refer to plans and schedules.

G. Electrical Characteristics: Refer to plans and schedules.

2.4 SEPARATELY COUPLED, VERTICALLY MOUNTED, IN-LINE CENTRIFUGAL PUMPS

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

1. Armstrong Pumps, Inc.
2. ITT Corporation.
3. Mepco, LLC.
4. PACO Pumps; Grundfos Pumps Corporation, USA.
5. Patterson Pump Company; a Gorman-Rupp company.
6. Peerless Pump Company.
7. TACO Comfort Solutions, Inc.
8. Thrush Co. Inc.

B. 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.

C. Pump Construction:

1. Casing: Radially split, cast iron, with threaded gage tapings at inlet and outlet, replaceable bronze wear rings, and threaded companion-flange or union-end connections.
2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to the shaft, and secured with a locking cap screw. For pumps not frequency-drive controlled, trim the impeller to match the specified performance.
3. Pump Shaft: Stainless steel.

4. Seal: Mechanical seal consisting of a carbon rotating ring against a ceramic seat held by a stainless-steel spring, and [Buna-N] [EPT] bellows and gasket. Include a water slinger on the shaft between the motor and seal.
5. Seal: 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: Permanently lubricated ball bearings.

D. Shaft Coupling: Axially split spacer coupling.

E. Motor: Single speed and rigidly mounted to the pump casing with a lifting eyebolt and supporting lugs in the motor enclosure.

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

a. Enclosure: [Open, drip proof] [Totally enclosed, fan cooled] [Open, externally ventilated] [Severe duty] [Explosion proof] [Dust-ignition-proof machine].
b. Enclosure Materials: Cast iron [Rolled steel].
c. Motor Bearings: Permanently lubricated ball bearing up to 5 hp
d. Motor Bearings Grease-lubricated ball bearings over 5 hp.
e. Unusual Service Conditions:

1) Ambient Temperature:104 F.
2) Altitude: 100 above sea level.
3) High humidity.

f. Efficiency: Premium efficiency.
g. NEMA Design: B or C
h. Service Factor: 1.15.
i. All motors used with VFDs shall be inverter-duty rated

F. Capacities and Characteristics: Refer to plans and schedules.

G. Electrical Characteristics: Refer to plans and schedules.

2.5 SEPARATELY COUPLED, BASE-MOUNTED, END-SUCTION CENTRIFUGAL PUMPS

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

1. Armstrong Pumps, Inc.
2. ITT Corporation.

3. Mapco, LLC.
4. PACO Pumps; Grundfos Pumps Corporation, USA.
5. Patterson Pump Company, a Gorman-Rupp company.
6. Peerless Pump Company.
7. TACO Comfort Solutions, Inc.
8. Thrush Co. Inc.

B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal.

C. Pump Construction:

1. Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gage tapings at inlet and outlet, drain plug at bottom, and air vent at top of volute, and threaded companion-flange, flanged connections. Provide an integral mount on the volute to support the casing and provide attached piping to allow removal and replacement of the impeller without disconnecting piping or requiring the realignment of the pump and motor shaft.
2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to the shaft, and secured with a locking cap screw. For pumps not frequency-drive controlled, trim the impeller to match the specified performance.
3. Pump Shaft: Stainless steel.
4. Seal: Mechanical seal consisting of a carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket.
5. Seal: 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.

D. Shaft Coupling: Molded rubber insert and interlocking spider capable of absorbing vibration. Couplings shall be drop-out type to allow disassembly and removal without removing the pump shaft or motor. EPDM coupling sleeve for variable-speed applications.

E. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.

F. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A 36/A 36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.

G. Motor: Single speed, secured to mounting frame, with adjustable alignment.

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

    a. Enclosure: [Open, drip proof] [Totally enclosed, fan cooled] [Open, externally ventilated] [Totally enclosed, nonventilated] [Explosion proof] [Dust-ignition-proof machine].
    b. Enclosure Materials: Cast iron [Rolled steel].
    c. Motor Bearings: Permanently lubricated or Grease-lubricated ball bearings.
    d. Unusual Service Conditions:

        1) Ambient Temperature: 104°F.
        2) Altitude: 100 above sea level.
        3) High humidity.

    e. Efficiency: Premium efficiency.
    f. NEMA Design: B or C
    g. Service Factor: 1.15.
    h. All motors used with VFDs shall be inverter-duty rated

H. Capacities and Characteristics: Refer to plans and schedules.

I. Electrical Characteristics: Refer to plans and schedules.

2.6 SEPARATELY COUPLED, BASE-MOUNTED, DOUBLE-SUCTION CENTRIFUGAL PUMPS

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

1. Armstrong Pumps, Inc.
2. ITT Corporation.
3. Mepco, LLC.
4. PACO Pumps; Grundfos Pumps Corporation, USA.
5. Patterson Pump Company; a Gorman-Rupp company.
6. Peerless Pump Company.
7. TACO Comfort Solutions, Inc.
8. Thrush Co. Inc.

B. Description: Factory-assembled and -tested, centrifugal, impeller-between-bearings, separately coupled, double-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal.

C. Pump Construction:

1. Casing: [Radially] [Horizontally] split, cast iron, with replaceable bronze wear rings, threaded gage tapings at inlet and outlet, drain plug at bottom, and air vent at top

of volute, and ASME B16.1, [Class 125] [Class 250] flanges. Casing supports shall allow the removal and replacement of the impeller without disconnecting piping.

2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, and keyed to the shaft. For pumps not frequency-drive controlled, trim the impeller to match the specified performance.
3. Pump Shaft: Stainless steel.
4. Seal: Mechanical seal consisting of a carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket.
5. Seal: 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.

D. Shaft Coupling: Molded rubber insert and interlocking spider capable of absorbing vibration. Couplings shall be drop-out type to allow disassembly and removal without removing the pump shaft or motor. EPDM coupling sleeve for variable-speed applications.

E. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.

F. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A 36/A 36M channels and angles. Fabricate to mount the pump casing, coupling guard, and motor.

G. Motor: Single speed, secured to mounting frame, with adjustable alignment.

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

    a. Enclosure: [Open, drip proof] [Totally enclosed, fan cooled] [Totally enclosed, air over] [Open, externally ventilated] [Totally enclosed, nonventilated] [Severe duty] [Explosion proof] [Dust-ignition-proof machine].
    b. Enclosure Materials: [Cast iron] [Rolled steel].
    c. Motor Bearings: Grease lubricated.
    d. Unusual Service Conditions:

        1) Ambient Temperature: 104°F.
        2) Altitude: 100 above sea level.
        3) High humidity.

    e. Efficiency: Premium efficiency.
    f. NEMA Design: B or C

g. Service Factor: 1.15.
h. All motors used with VFDs shall be inverter-duty rated

H. Capacities and Characteristics: Refer to plans and schedules.

I. Electrical Characteristics: Refer to plans and schedules.

2.7 AUTOMATIC CONDENSATE PUMP UNITS

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

1. Little Giant
2. Armstrong Pumps, Inc.
3. ITT Corporation.
4. Mepco, LLC.
5. PACO Pumps; Grundfos Pumps Corporation, USA.
6. Patterson Pump Company, a Gorman-Rupp company.
7. Peerless Pump Company.
8. TACO Comfort Solutions, Inc.
9. Thrush Co. Inc.

B. Description: Packaged units with corrosion-resistant pump, plastic tank with cover, and automatic controls. Include a factory- or field-installed check valve and a 72-inch minimum, electrical power cord with plug.

C. Capacities and Characteristics: Refer to plans and schedules.

D. Provide condensate overflow switch

E. Electrical Characteristics: Refer to plans and schedules.

2.8 PUMP SPECIALTY FITTINGS

A. Suction Diffuser:

1. Angle pattern.
2. [175-psig] [300-psig] pressure rating, [cast] [ductile]-iron body and end cap, pump-inlet fitting.
3. Bronze startup and bronze or stainless-steel permanent strainers.
4. Bronze or stainless-steel straightening vanes.
5. Drain plug.
6. Factory-fabricated support.

B. Triple-Duty Valve:

1. Angle or straight pattern.

2. [175-psig] [300-psig] pressure rating, [cast] [ductile]-iron body, pump-discharge fitting.
3. Drain plug and bronze-fitted shutoff, balancing, and check valve features.
4. Brass gage ports with integral check valve and orifice for flow measurement.

C. Flexible Pipe/Pump Connections.

1. Rubber flexible connections shall be peroxide-cured EPDM throughout with Kevlar tire cord reinforcement. The raised face rubber flanges must encase solid steel rings to prevent pull-out. Flexible cable wire is not acceptable. Sizes 1-1/2" through 14" shall have a ductile iron external ring between the two spheres. Sizes 3/4" through 2” may have one sphere, bolted threaded flange assemblies, and cable retention.

2. Minimum ratings shall be 250 psi at 170°F and 215 psi at 250°F. Higher published rated connectors may be used where required.

3. Safety factors shall be a minimum of 3/1. All flexible connections must be factory tested to 150% of maximum pressure for 12 minutes before shipment. The piping gap shall be equal to the length of the expansion joint under pressure. Control rods passing through 1/2" thick Neoprene washer bushings, large enough to take the thrust at 1000psi of surface area, may be used on unanchored piping where the manufacturer determines the condition exceeds the expansion joint rating without them. All flexible joints shall be installed on the equipment side of the shut-off valves. Expansion joints shall be SAFEFLEX SFDEJ, SFEJ, SFDCR, or SFU and Control Rods CR as manufactured by Mason Industries, Inc

4. All flexible joints shall be installed on the equipment side of the shut-off valves. Expansion joints shall be SAFEFLEX SFDEJ, SFEJ, SFDCR, or SFU, and Control Rods CR as manufactured by Mason Industries, Inc

   a. Body: Fiber-reinforced rubber body.
   b. End Connections: Steel flanges drilled to align with Classes 150 and 300 steel flanges.
   c. Performance: Capable of misalignment.
   d. CWP Rating: 150 psig
   e. Maximum Operating Temperature: 250 deg F

2.9 VIBRATION ISOLATION AND INERTIA BASES FOR PUMPS

A. Rectangular steel concrete pouring forms for a floating concrete inertia base. Bases for split case pumps shall be large enough to provide support for suction and discharge elbows. Bases shall be a minimum of 6” longer than the pump on all sides. The base depth need not exceed 12" unless specifically recommended by the base manufacturer for mass or rigidity. Forms shall include concrete reinforcing bars welded in place on 6” centers running both ways in a layer 1-1/2" above the bottom. Minimum reinforcing bar size shall be ½”. Forms shall be furnished with steel templates to hold the anchor bolt sleeves and anchor bolts while concrete is being poured. Height-saving spring brackets shall be used in all mounting locations to maintain a 1" clearance below the base. Wooden-formed bases leaving a concrete are not acceptable. Base shall be type BMK

as manufactured by Mason Industries, Inc. Base rails and framing shall be primed and painted in the field or factory. The concrete shall be painted grey or to match the floor.

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 are to be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PUMP INSTALLATION

A. Comply with ANSI standard HI 1.4 and HI 2.4.

B. Install pumps to provide access for periodic maintenance, including removing motors, impellers, couplings, and accessories.

C. Independently support pumps and piping so weight of piping is not supported by pumps, and the weight of pumps is not supported by piping.

D. Automatic Condensate Pump Units: Install units for collecting condensate and extend to discharge indirectly to an open drain.

E. Equipment Mounting:

1. [Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."]

2. [Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."]

3. Install base-mounted pumps on cast-in-place concrete housekeeping pads[Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete." and Section 033053 "Miscellaneous Cast-in-Place Concrete."] Concrete housekeeping pads shall be 3 ½” high and extend 6” longer on all sides than the mountings, and shall have 45° chamfered edges.

a. Pumps located above the lowest level (or when the lowest level is above grade), of the building shall be mounted on spring isolation inertia bases.

4. Install in-line pumps with continuous-thread hanger rods and elastomeric hangers, spring hangers, spring hangers with vertical-limit stop of size required to support the weight of in-line pumps as per [specification section 23 21 16 Hydronic Piping Specialties].

5. [Comply with requirements for hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."]

3.3 ALIGNMENT

A. Perform pump alignment. For pumps 20 HP or larger, engage a factory-authorized service representative to perform alignment service.

B. Comply with requirements in Hydronics Institute standards for alignment of pump and motor shaft. Add shims to the motor feet and bolt the motor to the 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 the grout has cured, fully tighten the foundation bolts.

3.4 CONNECTIONS

A. Comply with requirements for piping specified in Section 232113 "Hydronic Piping" and Section 232116 “Hydronic Piping Specialties." Drawings indicate the general arrangement of piping, fittings, and specialties.

B. When installing piping adjacent to the pump, allow space for service and maintenance.

C. Connect piping to pumps. Install valves that are the same size as the piping connected to pumps.

D. Install suction and discharge pipe sizes equal to or greater than the diameter of pump nozzles.

E. Install line size check, shutoff, and balancing valves or triple-duty valve on discharge side of pumps.

F. Install a line size Y-type strainer or suction diffuser and shutoff valve on the suction side of pumps.

G. Install flexible connectors on suction and discharge sides of base-mounted pumps between the pump casing and valves.

H. Install pressure gages on pump suction and discharge or at integral pressure-gage tapping or install a single gage with a multiple-input selector valve.

I. Install a check valve and gate or ball valve on each condensate pump unit discharge.

J. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

K. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.5 STARTUP SERVICE

A. Perform the following startup service. For motors 20 HP and over, engage a factory-authorized service representative to perform the start-up.

1. Complete installation and startup checks according to the manufacturer's written instructions.
2. Check piping connections for tightness.
3. Clean strainers on suction piping.
4. Perform the following startup checks for each pump before starting:

    a. Verify bearing lubrication.
    b. Verify that the pump is free to rotate by hand and that the pump for handling hot liquid is free to rotate with the pump hot and cold. If the pump is bound or dragging, do not operate until the cause of trouble is determined and corrected.
    c. Verify that the pump is rotating in the correct direction.

5. Prime the pump by opening suction valves and closing drains, and prepare the pump for operation.
6. Start motor.
7. Open discharge valve slowly.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps.

END OF SECTION 232123

SECTION 232513 - WATER TREATMENT FOR CLOSED-LOOP HYDRONIC 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 the following water treatment for closed-loop hydronic systems:

1. [Manual] [Automatic] chemical-feed equipment.
2. Chemicals.
3. Glycol Automatic Feed Unit

B. Related Requirements:

1. Section 232116 "Hydronic Specialties".

1.3 DEFINITIONS

A. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

B. RO: Reverse osmosis.

C. TSS: Total suspended solids are solid materials, including organic and inorganic, that are suspended in the water. These solids may include silt, plankton, and industrial wastes.

1.4 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, and furnished specialties and accessories for the following products:

1. Bypass feeders.
2. Water meters.
3. Inhibitor injection timers.
4. pH controllers.
5. TSS controllers.
6. Chemical solution tanks.
7. Injection pumps.

8. Chemical test equipment.
9. Chemical material safety data sheets.

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.

1.5 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For components, from the manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on an actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Water Analysis Provider Qualifications: Verification of experience and capability of the HVAC water-treatment service provider.

C. Field quality-control reports.

D. Other Informational Submittals:

1. Water-Treatment Program: Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in "Performance Requirements" Article.
2. Water Analysis: Illustrate the water quality available at the Project site.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For sensors, injection pumps, and controllers to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.

1.8 MAINTENANCE SERVICE

A. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions required above to inhibit corrosion and scale formation for hydronic piping and equipment. Services and chemicals shall be provided for a period of one year from date of Substantial Completion and shall include the following:

1. Initial water analysis and HVAC water-treatment recommendations.
2. Startup assistance for Contractor to flush the systems, clean with detergents, and initially fill systems with required chemical treatment prior to operation.
3. Periodic field service and consultation.
4. Customer report charts and log sheets.
5. Laboratory technical analysis.
6. Analyses and reports of all chemical items concerning safety and compliance with government regulations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Aqua-Chem, Inc.
2. Cascade Water Services, Inc.
3. Metro Group, Inc. (The).
4. Watcon, Inc.
5. Water Services Inc.

2.2 PERFORMANCE REQUIREMENTS

A. Water quality for hydronic systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of hydronic equipment without creating a hazard to operating personnel or the environment.

B. Base HVAC water treatment on the quality of water available at the Project site, hydronic system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.

C. Closed hydronic systems, including [hot-water heating] [chilled water] [dual-temperature water] [and] [glycol cooling], shall have the following water qualities:

1. pH: Maintain a value within 9.0 to 10.5.
2. "P" Alkalinity: Maintain a value within 100 to 500 ppm.
3. Boron: Maintain a value within 100 to 200 ppm.

4. Chemical Oxygen Demand: Maintain a maximum value of 100 ppm.
5. Soluble Copper: Maintain a maximum value of 0.20 ppm.
6. TSS: Maintain a maximum value of 10 ppm.
7. Ammonia: Maintain a maximum value of 20 ppm.
8. Free Caustic Alkalinity: Maintain a maximum value of 20 ppm.
9. Microbiological Limits:

    a. Total Aerobic Plate Count: Maintain a maximum value of 1000 organisms/mL.
    b. Total Anaerobic Plate Count: Maintain a maximum value of 100 organisms/mL.
    c. Nitrate Reducers: Maintain a maximum value of 100 organisms/mL.
    d. Sulfate Reducers: Maintain a maximum value of zero organisms/mL.
    e. Iron Bacteria: Maintain a maximum value of zero organisms/mL.

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 of the feeder when exposed to system pressure in the vessel.

1. Capacity: 5 gal.
2. Minimum Working Pressure: 125 psig.

2.4 AUTOMATIC CHEMICAL-FEED EQUIPMENT

A. Water Meter:

1. AWWA C700, oscillating-piston, magnetic-drive, totalization meter.
2. Body: Bronze.
3. Minimum Working-Pressure Rating: 150 psig.
4. Maximum Pressure Loss at Design Flow: 3 psig.
5. Registration: Gallons or cubic feet.
6. End Connections: Threaded.
7. Controls: Flow-control switch with normally open contacts; rated for a maximum 10 A, 250-V ac; and that will close at adjustable increments of total flow.
8. 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. Water Meter:

1. AWWA C701, turbine-type, totalization meter.
2. Body: Bronze.
3. Minimum Working-Pressure Rating: 100 psig.
4. Maximum Pressure Loss at Design Flow: 3 psig.

5. Registration: Gallons or cubic feet.
6. End Connections: Threaded.
7. Control: Low-voltage signal capable of transmitting 1000 feet.
8. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Water Meter:

1. AWWA C701, turbine-type, totalization meter.
2. Body: Bronze or Epoxy-coated cast iron.
3. Minimum Working-Pressure Rating: 150 psig.
4. Maximum Pressure Loss at Design Flow: 3 psig.
5. Registration: Gallons or cubic feet.
6. End Connections: Flanged.
7. Controls: Flow-control switch with normally open contacts; rated for maximum 10 A, 250-V ac; and that will close at adjustable increments of total flow.
8. 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.

D. Chemical Solution Tanks:

1. Chemical-resistant reservoirs fabricated from high-density opaque polyethylene with minimum 110 percent containment vessel.
2. Molded cover with recess for mounting pump.
3. Capacity: 50 gal..

E. Chemical Solution Injection Pumps:

1. Self-priming, positive displacement; rated for intended chemical with minimum 25 percent safety factor for design pressure and temperature.
2. Adjustable flow rate.
3. Metal and thermoplastic construction.
4. Built-in relief valve.
5. Fully enclosed, continuous-duty, single-phase motor. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."
6. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. Chemical Solution Tubing: Polyethylene tubing with compression fittings and joints except ASTM A 269, Type 304, stainless steel for steam boiler injection assemblies.

G. Injection Assembly:

1. Quill: Minimum NPS 1/2 with insertion length sufficient to discharge into at least 25 percent of pipe diameter.

2. Ball Valve: Two-piece, stainless steel; selected to fit quill.
3. Packing Gland: Mechanical seal on quill of sufficient length to allow quill removal during system operation.
4. Assembly Pressure/Temperature Rating: Minimum 600 psig at 200 deg F.

2.5 CHEMICALS

A. Chemicals shall be as recommended by the water-treatment system manufacturer that are compatible with piping system components and connected equipment and that can attain the water quality specified in "Performance Requirements" Article.

2.6 GLYCOL MAKE UP UNIT

A. Factory packaged and assembled simplex or duplex pump, mixing tank, and expansion tank, with level and pump controls, starters, and control wiring.

B. Reservoir
1. Industrial grade polyethylene tank
2. Suited for glycol solution or potable water
3. 55-gallon capacity
4. 2" opening on top for ventilation/fill
5. Observable fluid level with scale
6. Removable Lid
7. Y-strainer

C. Pump
1. 10 GPM capacity at 30 psi, 1/2 HP,
2. low pressure
3. 5 GPM capacity at 60 psi, 3/4 HP, high pressure
4. Operates as needed to restore system pressure with the solution contained in the unit's reservoir
5. Pump isolation valves, check and balance valve
6. Discharge pressure gauge
7. Motor contactor with pressure control
8. System HOA switch with green running light
9. Single power connection

D. Pressure Control
1. Cut off provides protection from excess pressure
2. Cut in 3-10 psi, cut out 9-30 psi for GMU30
3. Cut in 10-45 psi, cut out 20-60 psi for GMU60

E. Level Control
1. Safely shuts down the pump when the solution level is low
2. Remote alarm contact
3. Red indicator light

F. Valves
   1. Shut off
   2. Non-slam check
   3. Calibrated balance valve

PART 3 - EXECUTION

3.1 WATER ANALYSIS

A. Perform an analysis of the water supply to determine the quality of water available at the Project site.

3.2 INSTALLATION

A. Install chemical application equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so that controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to the substrate.

B. Install seismic restraints for equipment and floor-mounting accessories and anchor to building structure. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraints.

C. Install water testing equipment on the wall near the water chemical application equipment.

D. Install interconnecting control wiring for chemical treatment controls and sensors.

E. Mount sensors and injectors in piping circuits.

F. Bypass Feeders: Install in closed hydronic systems, including hot-water heating, chilled water dual-temperature water, and glycol cooling, and equipped with the following:

   1. Install bypass feeder in a bypass circuit around circulating pumps unless otherwise indicated on Drawings.
   2. Install a water meter in the makeup-water supply.
   3. Install test-coupon assembly in bypass circuit around circulating pumps unless otherwise indicated on Drawings.
   4. Install a gate or full-port ball isolation valve on the inlet, outlet, and drain below the feeder inlet.
   5. Install a swing check on the inlet after the isolation valve.

3.3 CONNECTIONS

A. When installing piping adjacent to equipment, allow space for service and maintenance.

B. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings. Comply with requirements in Section 232116 "Hydronic Piping Specialties."

C. Install shutoff valves on HVAC water-treatment equipment inlet and outlet. Metal general-duty valves are specified in Section 230523.11 "Globe Valves for HVAC Piping," Section 230523.12 "Ball Valves for HVAC Piping," Section 230523.13 "Butterfly Valves for HVAC Piping," and Section 230523.15 "Gate Valves for HVAC Piping."

D. Comply with requirements in Section 221119 "Domestic Water Piping Specialties" for backflow preventers required in make-up-water connections to potable-water systems.

E. Confirm applicable electrical requirements in the electrical Sections for connecting electrical equipment.

F. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

G. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

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

1. Inspect field-assembled components and equipment installation, including piping and electrical connections.
2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for the water-treatment system.
3. Place the HVAC water-treatment system into operation and calibrate controls during the preliminary phase of hydronic systems' startup procedures.
4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
5. Test for leaks and defects. If testing is performed in segments, submit a separate report for each test, complete with a diagram of the portion of piping tested.
6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Exposes work that has been covered or concealed before it has been tested and approved.
7. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding the pressure rating of piping system materials. Isolate

the test source and allow the test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.

8. Repair leaks and defects with new materials and retest piping until no leaks exist.

C. Equipment will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. At four-week intervals following Substantial Completion, perform separate water analyses on hydronic systems to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified in this Section. Submit written reports of water analysis advising the Owner of changes necessary to adhere to "Performance Requirements" Article.

F. Comply with ASTM D 3370 and with the following standards:

1. Silica: ASTM D 859.
2. Acidity and Alkalinity: ASTM D 1067.
3. Iron: ASTM D 1068.
4. Water Hardness: ASTM D 1126.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment.

B. Training: Provide a "how-to-use" self-contained breathing apparatus video that details exact operating procedures of equipment.

END OF SECTION 232513

SECTION 232913 - VARIABLE FREQUENCY DRIVES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Variable frequency drives.

1.02 RELATED SECTIONS

A. Section 230513 Common Motor Requirement For HAVC Equipment

1.03 REFERENCES

A. Division 1 - Reference Standards: Requirements for references and standards.

B. NEMA ICS 3.1 - Safety Standards for Construction and Guide for Selection, Installation and Operation of Adjustable-Speed Drive Systems.

C. NEMA ICS 7 - Industrial Control and Systems: Adjustable Speed Drives.

D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

E. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems (International Electrical Testing Association).

F. NFPA 70 - National Electrical Code.

1.04 SUBMITTALS FOR REVIEW

A. Division 1 - Submittals: Procedures for submittals.

B. Product Data: Provide catalog sheets showing voltage, controller size, ratings, and size of switching and overcurrent protective devices, short circuit ratings, dimensions, and enclosure details.

C. Shop Drawings: Indicate front and side views of enclosures with overall dimensions and weights shown; conduit entrance locations and requirements; and nameplate legends.

1.05 SUBMITTALS FOR INFORMATION

A. Division 1 - Submittals: Submittals for information.

B. Test Reports: Indicate field test and inspection procedures and test results.

C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by the testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

D. Manufacturer's Field Reports: Indicate start-up inspection findings.

1.06 SUBMITTALS FOR CLOSEOUT

A. Division 1 - Contract Closeout.

B. Operation Data: NEMA ICS 3.1. Include instructions for starting and operating controllers and describe operating limits that may result in hazardous conditions.

C. Maintenance Data: NEMA ICS 3.1. Include a routine preventive maintenance schedule.

D. Furnish two of each air filter.

1.07 REGULATORY REQUIREMENTS

A. Conform to the requirements of NFPA 70.

B. Products: Listed and classified by Underwriters Laboratories, Inc. as suitable for the purpose specified and indicated.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Division 1 - Material and Equipment: Transport, handle, store, and protect products.

B. Accept controllers on site in original packing. Inspect for damage.

C. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

D. Handle in accordance with the manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to components, enclosure, and finish.

1.09 MAINTENANCE SERVICE

A. Division 1 - Contract Closeout.

B. Provide service and maintenance of the controller for two years from the Date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: The Basis of design shall be Graham Danfoss series VLT. Other acceptable manufacturers, subject to compliance with the contract documents, shall be one of the following:
   1. Allen Bradley
   2. Schneider Electric
   3. Eaton

2.02 DESCRIPTION

A. Enclosed variable frequency controllers are suitable for operating the indicated loads, in conformance with the requirements of NEMA ICS 7.

B. Select unspecified features and options in accordance with NEMA ICS 3.1.

C. Furnish complete variable frequency VFDs as specified herein for the equipment designated on the drawing schedules to be variable speed. All standard and optional features shall be included within the VFD enclosure, unless otherwise specified. VFD shall be housed in a metal NEMA 1 enclosure or other NEMA type, according to the installation and operating conditions at the job site. The VFD's UL listing shall allow mounting in plenum or other air handling compartments. If a NEMA 12 enclosure is required for the plenum rating, the manufacturer must supply a NEMA 12-rated VFD. VFDs used outdoors must be in a NEMA 4x-rated enclosure.

D. The VFD shall convert incoming fixed frequency three-phase AC power into a variable frequency and voltage for controlling the speed of three-phase AC motors. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain the desired motor magnetization current suitable for centrifugal pump and fan control and to eliminate the need for motor derating.

E. With the motor's rated voltage applied to the VFD input, the VFD shall allow the motor to produce full rated power at rated amps, RMS fundamental volts, and speed without using the motor's service factor. VFDs utilizing sine weighted/coded modulation (with or without 3rd harmonic injection) must provide data verifying that the motors will not draw more than full load current during full load and full speed operation.

F. The VFD shall include an input full-wave bridge rectifier and maintain a fundamental power factor near unity regardless of speed or load.

G. The VFD and options shall be tested to ANSI/UL Standard 508. The complete VFD, including all specified options, shall be assembled by the manufacturer, which shall be UL-508 certified for the building and assembly of option panels. Assembly of the option panels by a third-party panel shop is not acceptable. The appropriate UL stickers shall be applied to both the VFD and the option panel, in the case where these are not contained in one panel. When these VFDs are to be located in Canada,

CSA or C-UL certifications shall apply. Both VFD and the option panel shall be manufactured in ISO 9001-certified facilities.

H. The VFD shall have DC link reactors on both the positive and negative rails of the DC bus to minimize power line harmonics. VFDs without DC link reactors shall provide a minimum 3% impedance line reactor.

I. The VFD's full load amp rating shall meet or exceed NEC Table 430-150. The VFD shall be able to provide full rated output current continuously, 110% of rated current for 60 seconds, and 160% of rated current for up to 0.5 seconds while starting.

J. The VFD shall be able to provide full torque at any selected frequency from 28 Hz to base speed to allow driving direct drive fans without derating.

K. An automatic energy optimization selection feature shall be provided as standard in the VFD. This feature shall automatically and continually monitor the motor's speed and load and adjust the applied voltage to maximize energy savings and provide up to an additional 3% to 10% energy savings.

L. Input and output power circuit switching shall be able to be accomplished without interlocks or damage to the VFD. Switching rate may be up to 1 time per minute on the input and unlimited on the output.

M. An automatic motor adaptation test algorithm shall measure motor stator resistance and reactance to optimize performance and efficiency. It shall not be necessary to run the motor or decouple the motor from the load to run the test.

N. Galvanic and/or optical isolation shall be provided between the VFD's power circuitry and control circuitry to ensure operator safety and to protect connected electronic control equipment from damage caused by voltage spikes, current surges, and ground loop currents. VFDs not including either galvanic or optical isolation on both analog I/O and discrete I/O shall include additional isolation modules.

O. VFD shall minimize the audible motor noise through the use of an adjustable carrier frequency. The carrier frequency shall be automatically adjusted to optimize motor and VFD efficiencies while reducing motor noise.

2.03 PROTECTIVE FEATURES

A. A minimum of Class 20 I^2t electronic motor overload protection for single motor applications and thermal-mechanical overloads for multiple motor applications shall be provided.

B. Protection against input transients, loss of AC line phase, output short circuit, output ground fault, overvoltage, under voltage, VFD over temperature, and motor over temperature. The VFD shall display all faults in plain English. Codes are not acceptable.

C. Protect VFD from sustained power or phase loss. The VFD shall provide full rated output with an input voltage as low as 90% of the nominal. The VFD will continue to operate with reduced output with an input voltage as low as 164 V AC for 208/230-volt units, and 313 V AC for 460-volt units.

D. The VFD shall incorporate a motor preheat circuit to keep the motor warm and prevent condensation buildup in the stator.

E. VFD package shall include semiconductor-rated input fuses to protect power components.

F. To prevent breakdown of the motor winding insulation, the VFD shall be designed to comply with IEC Part 34-17. Otherwise, the VFD manufacturer must ensure that inverter-rated motors are supplied.

G. VFD shall include a “signal loss detection” circuit to sense the loss of an analog input signal, such as 4 to 20 mA or 2 to 10 V DC, and shall be programmable to react as desired in such an instance.

H. VFD shall function normally when the keypad is removed while the VFD is running and continue to follow remote commands. No warnings or alarms shall be issued as a result of removing the keypad.

I. VFD shall catch a rotating motor operating forward or reverse up to full speed.

J. VFD shall be rated for 100,000 amp interrupting capacity (AIC).

K. VFD shall include current sensors on all three output phases to detect and report phase loss to the motor. The VFD will identify which of the output phases is low or lost.

L. VFD shall continue to operate without faulting until input voltage reaches 300 V AC on 208/230-volt VFDs, and 539 V AC on 460 V VFDs.

M. All three pole variable frequency controllers (VFD), either integral to equipment or field supplied, shall contain voltage fault protection specifically designed to protect all motors and all other 3-phase loads, and associated control circuits from failure or damage due to voltage unbalance, over/under voltage loss, phase loss, reversal, incorrect sequencing, and rapid short cycling.” The VFD shall be arranged to monitor critical faults, including phase loss or reversal, and when detected, de-energize the load. It shall monitor non-critical faults, including high/low voltage, voltage unbalance, and when detected, after a time delay, de-energize the load.

2.04 INTERFACE FEATURES

A. Hand/Start, Off/Stop, and Auto/Start selector switches shall be provided to start and stop the VFD and determine the speed reference.

B. The VFD shall be able to be programmed to provide a 24 V DC output signal to indicate that the VFD is in Auto/Remote mode.

C. The VFD shall provide digital manual speed control. Potentiometers are not acceptable.

D. Lockable, alphanumeric backlit display keypad can be remotely mounted up to 10 feet away using a standard 9-pin cable.

E. The keypads for all sizes of VFDs shall be identical and interchangeable.

F. To set up multiple VFDs, it shall be possible to upload all setup parameters to the VFD's keypad, place that keypad on all other VFDs in turn, and download the setup parameters to each VFD. To facilitate setting up VFDs of various sizes, it shall be possible to download from the keypad only size-independent parameters.

G. Display shall be programmable to display in 9 languages, including English, Spanish, and French.

H. The display shall have four lines, with 20 characters on three lines and eight large characters on one line.

I. A red FAULT light, a yellow WARNING light, and a green POWER-ON light shall be provided. These indications shall be visible both on the keypad and on the VFD when the keypad is removed.

J. A quick setup menu with factory preset typical HVAC parameters shall be provided on the VFD, eliminating the need for macros.

K. The VFD shall include a standard RS-485 communications port and capabilities to be connected at a future date to a Johnson Controls N2 Metasys or Siemens FLN system at no additional cost to the owner. The connection shall be software selectable by the user.

L. As a minimum, the following points shall be controlled and/or accessible:

1. VFD Start/Stop
2. Speed reference
3. Fault diagnostics
4. Meter points

a. Motor power in HP
b. Motor power in kW
c. Motor kW-hr

d. Motor current
e. Motor voltage
f. Hours run
g. Feedback signal #1
h. Feedback signal #2
i. DC link voltage
j. Thermal load on motor
k. Thermal load on VFD
l. Heat sink temperature

5. Four additional Form C 230-volt programmable relays shall be available for factory or field installation within the FD.

M. The communication protocol shall be native BACNET; LonWorks communication shall be available for factory or field installation within the VFD.

N. Two set-point control interfaces (PID control) shall be standard in the unit. VFD shall be able to look at two feedback signals, compare them with two set-points, and make various process control decisions.

O. An output signal as a start command to actuate external equipment before allowing the VFD to start.

P. The following displays shall be accessible from the control panel in actual units: Reference Signal Value in actual units, Output Frequency in Hz or percent, Output Amps, Motor HP, Motor kW, kWhr, Output Voltage, DC Bus Voltage, VFD Temperature in degrees, and Motor Speed in engineering units per application (in GPM, CFM, etc.). VFD will read out the selected engineering unit either in a linear, square, or cubed relationship to output frequency as appropriate to the unit chosen.

Q. The display shall be programmed to read in inches of water column (in-wg) for an air handler application, pressure per square inch (psi) for a pump application, and temperature deg F for a cooling tower application.

R. VFD shall be able to be programmed to sense the loss of load and signal a no-load/broken belt warning or fault.

S. If the temperature of the VFD's heat sink rises to 80 °C, the VFD shall automatically reduce its carrier frequency to reduce the heat sink temperature. If the temperature of the heat sink continues to rise, the VFD shall automatically reduce its output frequency to the motor. As the VFD's heat sink temperature returns to normal, the VFD shall automatically increase the output frequency to the motor and return the carrier frequency to its normal switching speed.

T. The VFD shall have temperature-controlled cooling fans for quiet operation and minimized losses.

U. The VFD shall store in memory the last 10 faults and related operational data.

V. Eight programmable digital inputs shall be provided for interfacing with the system's control and safety interlock circuitry.

W. Two programmable relay outputs, one Form C 240 V AC, one Form A 30 V AC, shall be provided for remote indication of VFD status.

X. Three programmable analog inputs shall be provided and shall accept a direct-or-reverse acting signal. Analog reference inputs accepted shall include two voltage (0 to 10 V DC, 2 to 10 V DC) and one current (0 to 20 mA, 4 to 20 mA) input.

Y. Two programmable 0 to 20 mA analog outputs shall be provided for indication of VFD status. These outputs shall be programmable for output speed, frequency, current, and power. They shall also be programmed to provide a selected 24 V DC status indication.

Z. Under fire mode conditions, the VFD shall be able to be programmed to automatically default to a preset speed.

2.05 ADJUSTMENTS

A. VFD shall have an adjustable carrier frequency in steps of not less than 0.1 kHz to allow tuning the VFD to the motor.

B. Sixteen preset speeds shall be provided.

C. Four acceleration and four deceleration ramps shall be provided. Accel and decal time shall be adjustable over the range from 0 to 3,600 seconds to base speed. The shape of these curves shall be automatically contoured to ensure no-trip acceleration and deceleration.

D. Four current limit settings shall be provided.

E. If the VFD trips on one of the following conditions, the VFD shall be programmable for automatic or manual reset: under voltage, over voltage, current limit, and inverter overload.

F. The number of restart attempts shall be selectable from 0 through 20 or infinitely, and the time between attempts shall be adjustable from 0 through 600 seconds.

G. An automatic “on delay” may be selected from 0 to 120 seconds.

2.06 BYPASS

A. Provide a manual 3-contact or bypass consisting of a door interlocked main fused disconnect pad lockable in the off position, a built-in motor starter, and a four-

position DRIVE/OFF/BYPASS/TEST switch controlling three contactors. In the DRIVE position, the motor is operated at an adjustable speed from the VFD. In the OFF position, the motor and VFD are disconnected. In the BYPASS position, the motor is operated at full speed from the AC power line, and power is disconnected from the VFD so that service can be performed. In the TEST position, the motor is operated at full speed from the AC line power while power is applied to the input of the VFD. This allows the VFD to be given an operational test while continuing to run the motor at full speed in bypass. In case of an external safety fault, a customer-supplied normally closed dry contact shall be able to stop the motor whether in DRIVE or BYPASS mode.

B. Service personnel shall be able to defeat the main power disconnect and open the bypass enclosure without disconnecting power. This shall be accomplished through the use of a specially designed tool and mechanism while meeting all local and national code requirements for safety.

C. Bypass shall only be required for applications where the equipment is standalone. Such as an air handling unit or rooftop AC unit. For applications where redundant pumps, fans, or other equipment, and the standby equipment utilize a VFD bypass is not required.

2.07 SERVICE CONDITIONS

A. Ambient temperature, -10 to 40°C (14 to 104°F).

B. 0 to 95% relative humidity, non-condensing.

C. Elevation to 3,300 feet without derating.

D. AC line voltage variation, -10 to +10% of nominal with full output.

E. No side clearance shall be required for the cooling of any units. All power and control wiring shall be done from the bottom.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that the surface is suitable for controller installation.

B. Do not install the controller until the building environment can be maintained within the service conditions required by the manufacturer.

C. Verify that field measurements are as indicated on shop drawings and as instructed by the manufacturer.

3.02 INSTALLATION

A. Section 01400 - Quality Control: Manufacturer's instructions.

B. Install in accordance with NEMA ICS 3.1.

C. Tighten accessible connections and mechanical fasteners after placing the controller.

D. Provide fuses in fusible switches; refer to Section 16477 for product requirements.

E. Select and install overload heater elements in motor controllers to match installed motor characteristics.

F. Provide engraved plastic nameplates; refer to Section 16195 for product requirements and location.

G. Neatly type label inside each motor controller door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating. Place it in a clear plastic holder.

3.03 FIELD QUALITY CONTROL

A. Inspect and test in accordance with NETA ATS, except Section 4.

B. Perform inspections and tests listed in NETA ATS, Section 7.16.2.

3.04 MANUFACTURER'S FIELD SERVICES

A. The manufacturer shall provide start-up commissioning of the VFD and its optional circuits by a factory-certified service technician who is experienced in start-up and repair services. Sales personnel and other agents who are not factory certified shall not be acceptable as commissioning agents. Start-up services shall include checking for verification of proper operation and installation for the VFD, its options, and its interface wiring to the building automation system.

3.05 ADJUSTING

A. Division 1 - Contract Closeout.

B. Make final adjustments to the installed controller to assure proper operation of the load system. Obtain performance requirements from the installer of driven loads.

3.06 DEMONSTRATION AND INSTRUCTIONS

A. Division 1 - Contract Closeout:

B. Demonstrate operation of controllers in automatic and manual modes. Furnish 2 (1) one-hour training sessions on the project site with the owner, by factory-authorized personnel.

END OF SECTION 232913

SECTION 233113 - METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Double-wall rectangular ducts and fittings.
3. Single-wall round and flat-oval ducts and fittings.
4. Double-wall round and flat-oval ducts and fittings.
5. Sheet metal materials.
6. Duct liner.
7. Sealants and gaskets.
8. Hangers and supports.
9. Seismic-restraint devices.

B. Related Sections:

1. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Section 233300 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.

B. Structural Performance: Duct hangers and supports and seismic restraints shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and ASCE/SEI 7. SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."

1. Seismic Hazard Level A: Seismic force to weight ratio, 0.48.
2. Seismic Hazard Level B: Seismic force to weight ratio, 0.30.
3. Seismic Hazard Level C: Seismic force to weight ratio, 0.15.

C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.
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.
13. Seismic restraints, where applicable
14. Vibration isolation.

C. Delegated-Design Submittal:

1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.
5. Design Calculations: Calculations, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation for selecting hangers and supports and seismic restraints. For seismic bracing only

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.

2. Suspended ceiling components.
3. Structural members to which the duct will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire-rated construction.
6. Items penetrating the finished ceiling, including the following:

    a. Luminaires.
    b. Air outlets and inlets.
    c. Speakers.
    d. Sprinklers.
    e. Access panels.
    f. Perimeter moldings.

B. Welding certificates.

C. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

B. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

C. Construct ductwork to NFPA 90A and NFPA 90B standards. All work, materials, and equipment shall comply with the latest requirements of NFPA 90A, standards, and the local authorities having jurisdiction.

D. All ductwork and fan, and apparatus plenums constructed and having been supported in accordance with the latest standards of the ASHRAE Guide and the Sheet Metal and Air Conditioning Contractors National Association (SMACNA).

E. Bracing, gauges, and supports indicated in SMACNA manuals are the minimum acceptable. Additional bracing or supports shall be installed to eliminate any distortion or vibration when the systems are operating or under test.

PART 2 - PRODUCTS

2.1 General

A. General: Non-combustible or conforming to requirements for Class 1 air duct materials, or UL 181.

B. Galvanized Steel Ducts: ASTM A525 and ASTM A527 galvanized steel sheet, lock-forming quality, having zinc coating of 1.25 oz per sq ft for each side in conformance with ASTM A90.

C. Dissimilar Metals: Separate connections between dissimilar metals with Dielectric Insulation. Joints between dissimilar metal duct sections to be made with Companion flanges separated by a Neoprene gasket.

D. Fasteners: Rivets, bolts, screens, and other hardware used in the sheet metal construction to be constructed of materials identical or similar to the duct material to prevent galvanic corrosion.

E. Sealant: Non-hardening, water-resistant, fire-resistant, compatible with mating materials; liquid used alone or with tape, or heavy mastic as manufactured by 3M Company EC-800.

F. Hanger Rod: Steel, galvanized; threaded both ends, threaded one end, or continuously threaded.

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 the indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 DOUBLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. Provide products from one of the following manufacturers
   1. McGill Airflow LLC
   2. Zen Industries
   3. Lindab
   4. Spiral Manufacturing Co. Inc

B. Rectangular Ducts: Fabricate ducts with the indicated dimensions for the inner duct.

C. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on the indicated static-pressure class unless otherwise indicated.

D. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

E. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

F. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard." For standard applications

1. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
2. Install spacers that position the inner duct at a uniform distance from the outer duct without compressing insulation.
3. Coat insulation with antimicrobial coating.
4. Cover insulation with polyester film complying with UL 181, Class 1.

G. Interstitial Insulation: Flexible elastomeric duct liner complying with ASTM C 534, Type II for sheet materials, and with NFPA 90A or NFPA 90B. For Humid and damp area applications, including Natatoriums and Saunas.

1. Maximum Thermal Conductivity: 0.25 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
2. Install spacers that position the inner duct at a uniform distance from the outer duct without compressing insulation.
3. Coat insulation with antimicrobial coating.
4. Cover insulation with polyester film complying with UL 181, Class 1.

H. Inner Duct: Minimum 0.028-inch perforated galvanized sheet steel having 3/32-inch-diameter perforations, with overall open area of 23 percent.

I. Formed-on Transverse Joints (Flanges): Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Traverse 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."

J. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements,

materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.4 SINGLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

B. Provide products from one of the following manufacturers
   1. McGill Airflow LLC
   2. Zen Industries
   3. Lindab
   4. Spiral Manufacturing Co. Inc

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 according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

   1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

E. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

   1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
   2. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.

F. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.5 DOUBLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

A. Provide products from one of the following manufacturers
   1. McGill Airflow LLC
   2. Zen Industries
   3. Lindab
   4. Spiral Manufacturing Co. Inc

B. 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) of the inner duct.

C. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on static-pressure class unless otherwise indicated.

1. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

    a. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

2. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

    a. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
    b. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.

3. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Inner Duct: Minimum 0.028-inch perforated galvanized sheet steel having 3/32-inch-diameter perforations, with overall open area of 23 percent.

E. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard." For standard applications.

1. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
2. Install spacers that position the inner duct at a uniform distance from the outer duct without compressing insulation.
3. Coat insulation with antimicrobial coating.
4. Cover insulation with polyester film complying with UL 181, Class 1.

F. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 534, TYPE II for sheet

materials, and with NFPA 90A or NFPA 90B. For application in damp or humid environments, including natatoriums and Saunas.

1. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
2. Install spacers that position the inner duct at a uniform distance from the outer duct without compressing insulation.
3. Coat insulation with antimicrobial coating.
4. Cover insulation with polyester film complying with UL 181, Class 1.

2.6 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G90.
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. PVC-Coated, Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G90.
2. Minimum Thickness for Factory-Applied PVC Coating: 4 mils thick on sheet metal surface of ducts and fittings exposed to corrosive conditions, and minimum 1 mil thick on the opposite surface.
3. Coating Materials: Acceptable to authorities having jurisdiction for use on ducts listed and labeled by an NRTL for compliance with UL 181, Class 1.

D. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.

E. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.

F. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-sided bright finish for duct surfaces exposed to view.

G. Factory- or Shop-Applied Antimicrobial Coating:

1. Apply to the surface of sheet metal that will form the interior surface of the duct. An untreated clear coating shall be applied to the exterior surface.
2. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
3. Coating containing the antimicrobial compound shall have a hardness of 2H, minimum, when tested according to ASTM D 3363.

4. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
5. Shop-Applied Coating Color: Black OR White.
6. Antimicrobial coating on sheet metal is not required for a duct containing a liner treated with antimicrobial coating.

H. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

I. 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.

2.7 DUCT LINER

A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

a. Maximum Thermal Conductivity:

1) Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
2) Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.

2. 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 shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
3. Solvent Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.

B. Flexible Elastomeric Duct Liner: Preformed, cellular, closed-cell, sheet materials complying with ASTM C 534, Type II, Grade 1; and with NFPA 90A or NFPA 90B.
1. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
2. Liner Adhesive: As recommended by the insulation manufacturer and complying with NFPA 90A or NFPA 90B. For application in damp or humid environments, including natatoriums and Saunas, and down stream of humidifiers

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, aluminum, or stainless steel to match ductwork; with a 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 the liner contact surface area. Attaining the indicated thickness with multiple layers of duct liner is prohibited.
2. Apply adhesive to transverse edges of the liner facing upstream that do not receive metal nosing.
3. Butt transverse joints without gaps and coat the joint with adhesive.
4. Fold and compress the liner in the 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 an air velocity of 2500 fpm.
7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:

    a. Fan discharges.
    b. Intervals of lined duct preceding unlined duct.
    c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.

9. 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.

2.8 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Two-Part Tape Sealing System:

1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form a hard, durable, airtight seal.
2. Tape Width: 4 inches.
3. Sealant: Modified styrene acrylic.
4. Water resistant.
5. Mold and mildew resistant.
6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: Minus 40 to plus 200 deg F.
9. Substrate: Compatible with galvanized sheet steel (both PVC-coated and bare), stainless steel, or aluminum.

C. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC-coated and bare), stainless steel, or aluminum sheets.

D. 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.

E. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.

F. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

G. Round Duct Joint O-Ring Seals:

1. Seal shall provide a maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for a 10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in the concave bead in the coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.9 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

2.10 SEISMIC-RESTRAINT DEVICES

A. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an evaluation service member of the ICC Evaluation Service or an agency acceptable to authorities having jurisdiction.

1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

B. Channel Support System: Shop- or field-fabricated support assembly made of slotted steel channels rated in tension, compression, and torsion forces and with accessories for attachment to a braced component at one end and to a building structure at the other end. Include matching components and corrosion-resistant coating.

C. Restraint Cables: ASTM A 603, galvanized or ASTM A 492, stainless-steel cables with end connections made of cadmium-plated steel assemblies with brackets, swivel, and bolts designed for restraining cable service; and with an automatic-locking and clamping device or double-cable clips.

D. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or Reinforcing steel angle clamped to hanger rod.

E. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type. Select anchor bolts with the required strength for the anchor and as tested according to ASTM E 488.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicates the general location and arrangement of the duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install ducts in maximum practical lengths and with the fewest possible joints

D. Install factory- or shop-fabricated fittings for changes in direction, size, and shape, and for branch connections. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 0 degrees divergence upstream of equipment and 45 degrees convergence downstream.

E. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of the building.

G. Install ducts with a clearance of 2 inches, plus allowance for insulation thickness, and with sufficient space around equipment to allow normal operating and maintenance activities. Provide easements where ductwork conflicts with piping and structure. Where easements exceed 10 percent duct area, split into two ducts, maintaining the original duct area.

H. Provide standard 45-degree lateral wye takeoffs unless otherwise indicated, where 90-degree conical tee connections may be used.

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 the same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 233300 "Air Duct Accessories" for all installations, as well as fire and smoke dampers.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

M. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with a metal can with a spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.

N. Where hanger rods must pierce ducts, provide closure plates around rods and fasten to duct using screws, rivets, or welding. Seal with sealing compound.

O. Construct T's, bends, and elbows with a radius of not less than 1-1/2 times the width of the duct on the centerline. Where it is not possible and where rectangular elbows are used, provide airfoil turning vanes. Where acoustical lining is indicated, provide turning vanes of perforated metal with glass fiber insulation.

P. Where ductwork penetrates roofs or outside walls, seal the space around ductwork air-tight with fire-rated expanding spray foam sealer similar to 3-M Fire Block Foam. This also applies to duct roof penetrations into roof curbs.

Q. All ductwork shall be inspected and pressure tested before enclosing in general construction or concealment above hung ceilings

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 a two-part tape sealing system.

C. Grind welds to provide a smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

F. Prime ductwork and paint with one coat of enamel base paint. Color as per architectural plans. All ductwork surface finish shall be treated before priming by “pickling” in accordance with industry standards and paint manufacturers' requirements.

G. All ductwork in any building that is exposed to view (except mechanical equipment rooms) shall be wall round ductwork or oval as indicated on the plan. Where ductwork is to be painted, it shall be primed. Refer to the architectural plans for where ductwork shall be painted. Submit the paint color chart for review and approval. Primer shall be specifically formulated for galvanized steel.

H. Duct sealants used on exposed ductwork of any type shall be clear.

3.3 ADDITIONAL INSTALLATION REQUIREMENTS FOR COMMERCIAL KITCHEN HOOD EXHAUST DUCT

A. No 16 USSG black steel.

B. Install commercial kitchen hood exhaust ducts without dips and traps that may hold grease and slope a minimum of 2 percent to drain grease back to the hood.

C. Install fire-rated access panel assemblies at each change in direction and at maximum intervals of 20 feet in horizontal ducts, and at every floor for vertical ducts, or as indicated on Drawings. Cleanout doors on horizontal duct shall be mounted on the side of the duct. Bottom edge shall be not less than 2 inches above the bottom of the duct. Cleanout doors at vertical ducts shall be mounted at the base. Door and frame shall be the same gauge as the duct. Hinges shall be Ventlock No. 260, extra heavy zinc plated. Latches shall be Ventlock No. 140, cast zinc. Gaskets shall be between the door and the frame. Gaskets shall be 1/8-inch double thickness rated for 2000 degree F. Cleanout door size shall be 24 inches on one side, and the other side shall be 2 inches less than duct height. Where openings are too large for side installation, the opening shall be installed on the top or bottom, in accordance with approved methods. Where duct dimensions preclude top or bottom installation, install clean outs ON THE duct face that will allow the largest opening with edges as described above.

D. Do not penetrate fire-rated assemblies except as allowed by applicable building codes and authorities having jurisdiction.

E. All seams, joints, and penetrations shall be liquid-tight tight continuous external arc welded, except where the duct stub collar of the hood is connected to the exhaust duct. Connection to the hood shall be continuous, liquid-tight tight externally arc-welded, or in accordance with the NFPA 96.

F. Angle reinforcing shall be a minimum 1 1/2-inch X 1 1/2-inch X 3/16 inch at maximum 4 ft. on centers and in accordance with SMACNA Rectangular Industrial Duct Contraction Standards shall be mounted.

G. Duct to hood joints shall be made with continuous liquid-tight external welds. Alternatively, the joint shall be made by flange. Flanges shall be 1" wide, full perimeter, fully welded. Flange connections shall have gaskets rated for 1500°f, secured by .25" Dia (minimum) bolts on 4" centers for the full perimeter secured with lock washers.

H. Duct to fan connections shall be made similarly to duct to hood connections. Where vibration isolation is required, flexible duct connections to fans shall be made with coated fabric flexible connectors listed & labeled for the application.

I. Horizontal grease ducts less than 75' long shall be installed to slope toward hoods at a rate of 3" per foot. Horizontal grease ducts of 75' or longer shall slope toward hoods at a rate of 1" per foot.

J. Commercial kitchen exhaust duct insulation: 1" fire-resistant duct wrap consisting of lightweight, non-asbestos high temperature non-organic ceramic fiber blanket encapsulated in foil/scrim having a service temperature rating of 2300º f. Wrap shall be applied in two layers to provide a two-hour-rated enclosure assembly. Bonding material shall be 304 stainless steel, ¾" wide and .015" thick. Install layers as per the manufacturer's details and specifications to achieve the required fire rating.

3.4 ADDITIONAL INSTALLATION REQUIREMENTS FOR LAUNDRY EXHAUST DUCTWORK

A. All clothes dryers shall be exhausted in accordance with manufacturer instructions.

B. Fire, smoke, combination dampers or other similar devices that will obstruct flow are prohibited in the exhaust system.

C. Provide cleanouts at the base of each vertical section and riser.

D. Ducts shall not be connected or installed with sheet metal screws or other fasteners that protrude more than 1/8" into the inside of the duct.

E. All exhaust fans shall be listed and labeled to UL 705 and installed in accordance with the manufacturer’s instructions. Fan motors shall be outside of the airstream and operate continuously. (provide standby power)

F. All duct elbows must be radius elbows; square elbows and/or turning vanes are not permitted.

G. Each riser shall be an independent system of exhaust fan, pressure sensor, motor controller, and associated wiring, supports, and specialties.

H. Refer to floor plans for riser offsets as noted; provide cleanouts at all vertical sections.

I. Provide sub-duct for each dryer connection. Re: mechanical equipment notes for make and model. Install in accordance with the manufacturer's instructions.

J. Exhaust riser shall be installed in a shaft constructed and fire-resistance rated as required by code; re: architectural plans for shaft construction.

3.5 DUCT SEALING

A. Seal ducts at a minimum to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible." Refer to the Duct Leakage and Seal Classification Table below.

Leakage and Seal Classification Table			
Duct Class	1/2"-1",2" wg	3" wg	4", 6",10"wg
Sealing Applicable	Transverse Joints Only	Transverse Joints and Seams	Joints, Seams & all Wall penetrations
Leakage Class (C_l) - CFM leakage per 100 SF @ 1" H_2O			
Rectangular Metal	24	12	6
Round Metal	12	6	3

3.6 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after the concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum interval 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.

G. Where hanger rods must pierce ducts, provide closure plates around rods and fasten to duct using screws, rivets, or welding. Seal with sealing compound.

H. Where ceiling or sheetrock has to be opened for the installation of hangers, the contractor shall patch to match the existing.

I. Where fireproofing is removed from structural members for the installation of hangers and supports, the contractor shall re-fireproof the member to match the existing material and fireproof rating.

3.7 SEISMIC-RESTRAINT-DEVICE INSTALLATION

A. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems." ASCE/SEI 7.

1. Space lateral supports a maximum of 40 feet O.C. and longitudinal supports a maximum of 80 feet OC.
2. Brace a change of direction longer than 12 feet.

B. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.

C. Install cables so they do not bend across the edges of adjacent equipment or building structure.

D. Install cable restraints on ducts that are suspended with vibration isolators.

E. Install seismic-restraint devices using methods approved by an evaluation service member of the ICC Evaluation Service or an agency acceptable to authorities having jurisdiction.

F. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.

G. Drilling for and Setting Anchors:

1. Identify the position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify the Architect if reinforcing steel or other embedded items

are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.

2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with the sleeve fully engaged in the structural element to which the anchor is to be fastened.
4. Set anchors to the manufacturer's recommended torque, using a torque wrench.
5. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

3.8 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet, and inlet, and terminal unit connections.

C. Smoke purge supply and exhaust systems and stair pressure systems. Flexible connections shall be permitted at diffusers, a maximum of 3’ long, and flexible connections are permitted at air handling equipment for vibration isolation only.

D. INSULATED FLEXIBLE DUCTS
1. UL 181, Class 0, interlocking spiral of aluminum foil; fiberglass insulation; polyethylene vapor barrier film.
2. Pressure Rating: 8 inches WG positive or negative.
3. Maximum Velocity: 5000 fpm
4. Temperature Range: -20 degrees F to 250 degrees F.

3.9 PAINTING

A. Paint the interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

3.10 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:

1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
2. Test the following systems:
    a. All Ducts with a Pressure Class equal to or Higher Than 2-inch wg: Test representative duct sections totaling no less than 25 percent of the total installed duct area for each system of the designated pressure class.

b. All smoke purge system Ducts, including supply, exhaust, and return air. All stair pressurization ductwork. Test representative duct sections totaling no less than 50 percent of the total installed duct area of each system.

3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
4. Test for leaks before applying external insulation.
5. Conduct tests at static pressures equal to the maximum design pressure of the system or section being tested. If static-pressure classes are not indicated, test the system at maximum system design pressure. Do not pressurize systems above the maximum design operating pressure.
6. Give seven days' advance notice for testing.

C. Duct System Cleanliness Tests:

1. Visually inspect the duct system to ensure that no visible contaminants are present.
2. Test sections of the metal duct system, chosen randomly by the Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."

a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

D. Duct system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.11 DUCT CLEANING

A. Clean [new] [and] [existing] duct system(s) before testing, adjusting, and balancing.

B. Use service openings for entry and inspection.

1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by the 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 the ceiling to gain access during the cleaning process.

C. Particulate Collection and Odor Control:

1. When venting the 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 the vacuuming system outdoors, use a filter to collect debris removed from the HVAC system, and locate the exhaust downwind and away from air intakes and other points of entry into the building.

D. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans, including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components, including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

E. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from the building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect the vacuum device to the downstream end of duct sections so that areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging the 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 the fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans according to NADCA 1992. Keep the drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to the manufacturer's written instructions after removal of surface deposits and debris.

3.12 SMOKE AND HEAT DETECTOR INSTALLATION

A. Duct-mounted smoke and heat detectors will be supplied under the Electrical Division. This Contractor to coordinate duct sizes and provide labor to install sensing probes into ductwork.

3.13 DUCTWORK PROTECTION

A. Duct work under construction or alteration shall not be left open-ended during dust-producing construction. All new and existing ductwork systems in the area of alteration or under construction shall be protected during construction. Open-ended ducts shall be sealed with sheet metal or as approved.

B. For unenclosed buildings, ductwork shall be kept dry and water tight. Seal open ends water-tight during construction to prevent water infiltration. Keep all acoustical lining dry during construction. Lining that has become we shall be replaced. All incomplete ductwork being used to condition spaces in phase I or phase II that will be completed under a later phase must be protected from being internally contaminated by construction dust. All return openings must have filters placed over them to prevent dust from being returned to the unit.

3.14 DUCT SCHEDULE

A. Fabricate ducts using the following material.

1. Underground Ducts: Concrete-encased PVC-coated galvanized steel, or Concrete-encased stainless steel, or fiberglass.
2. Natatorium ductwork – PVC-coated galvanized steel.
3. Kitchen exhaust – welded stainless steel or black steel
4. Smoke purge ductwork - welded stainless steel or black steel.
5. Shower room exhaust – aluminum
6. Dryer exhaust – aluminum
7. Outside air intake plenum and ductwork - Aluminum
8. Above ground in MER, conditioned space or unconditioned spaces – galvanized steel

B. Duct Pressure Class.

1. All duct systems shall be constructed to have a pressure classification based on the maximum static pressure (positive or negative) developed by the air handling apparatus connected to the ductwork system. Unless otherwise noted below, refer to the equipment schedules and equipment notes for the design operating pressure of each system. Systems with operating pressures between pressure classes shall be constructed to the next higher-pressure class.

Pressure Classification Table						
System operating pressure (OP) in wc	OP≤1"	1"≥OP<2"	2"≥OP<3"	3"≥OP<4"	4"≥OP<6"	6"≥OP<10"
SMACNA Construction classification	1"	2"	3"	4"	6"	10"

2. All ductwork shall be constructed in accordance with the leakage and seal classification. Note that the leakage and seal classification required by the current code is more stringent than SMACNA requirements.

Leakage and Seal Classification Table			
System operating pressure in wc	<2" low	2"≥med<3"	High≥3"
Seal Class	C	B	A
Sealing	Transverse joints	Transverse joints and seams	Transverse joints and seams and all wall penetrations
Leakage class CL factor - Rectangular me	24	12	4
Leakage class CL factor - round metal	12	6	3

C. Supply Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, unit ventilators and Terminal Units: (supply, return, OA intake)

   a. Pressure Class: Positive [1-inch wg] [2-inch wg].
   b. Minimum SMACNA Seal Class: [A] [B] [C].
   c. SMACNA Leakage Class for Rectangular: [12] [24].
   d. SMACNA Leakage Class for Round and Flat Oval: [12] [24].

2. Ducts Connected to Constant-Volume Air-Handling Units and packaged roof top units: (supply, return, OA intake)

   a. Pressure Class: Positive [2-inch wg] [3-inch wg].
   b. Minimum SMACNA Seal Class: [A] [B].
   c. SMACNA Leakage Class for Rectangular: [6] [12] [24].
   d. SMACNA Leakage Class for Round and Flat Oval: [6] [12] [24].

3. Ducts Connected to Variable-Air-Volume Air-Handling Units, and packaged roof top units up to terminal units SA and RA: (OAI ducts shall be the same as CV units)

   a. Pressure Class: Positive [3-inch wg] [4-inch wg].
   b. Minimum SMACNA Seal Class: [A] [B].
   c. SMACNA Leakage Class for Rectangular: [3] [6].
   d. SMACNA Leakage Class for Round and Flat Oval: [3] [6].

4. Ducts Connected to Smoke Purge and Stair Pressurization Systems:

   a. Pressure Class: Positive [2-inch wg] [3-inch wg] [4-inch wg].
   b. Minimum SMACNA Seal Class: [A] [B].
   c. SMACNA Leakage Class for Rectangular: [3] [6] [12].
   d. SMACNA Leakage Class for Round and Flat Oval: [3] [6] [12].

D. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:

    a. Pressure Class: Negative [1-inch wg] [2-inch wg] [3-inch wg].
    b. Minimum SMACNA Seal Class: [A] [B] [C] if negative pressure, and A if positive pressure.
    c. SMACNA Leakage Class for Rectangular: [12] [24].
    d. SMACNA Leakage Class for Round and Flat Oval: [6] [12] [24].

2. Ducts Connected to Air-Handling Units:

    a. Pressure Class: Positive or negative [2-inch wg] [3-inch wg].
    b. Minimum SMACNA Seal Class: [A] [B] if negative pressure, and A if positive pressure.
    c. SMACNA Leakage Class for Rectangular: [6] [12] [24].
    d. SMACNA Leakage Class for Round and Flat Oval: [3] [6] [12] [24].

3. Ducts Connected to Commercial Kitchen Hoods: Comply with NFPA 96.

    a. Exposed to View: Type 304, stainless-steel sheet, No. 4 finish.
    b. Concealed: Type 304, stainless-steel sheet, No. 2D finish or Carbon-steel sheet.
    c. Welded seams and joints.
    d. Pressure Class: Positive or negative [2-inch wg] [3-inch wg] [4-inch wg].
    e. Airtight/Watertight.

4. Ducts Connected to Dishwasher Hoods:

    a. Type 304, stainless-steel sheet.
    b. Exposed to View: No. 4 Insert finish
    c. Concealed: No. 2D finish. Or aluminum
    d. Welded seams and flanged joints with watertight EPDM gaskets.
    e. Pressure Class: Positive or negative [2-inch wg] [3-inch wg].
    f. Airtight/Watertight.

5. Ducts Connected to Fans Exhausting Laboratory and Process air (ASHRAE 62.1, Class 3 and 4).

    a. Type 316, stainless-steel sheet.

        1) Exposed to View: No. 4 finish.
        2) Concealed: No. 2B finish.

    b. PVC-coated, galvanized sheet steel with thicker coating on duct interior.
    c. Pressure Class: Positive or negative [3-inch wg] [4-inch wg] [6-inch wg].
    d. Minimum SMACNA Seal Class: A Welded seams and joints.
    e. SMACNA Leakage Class 3.
    f. Airtight/Watertight.

6. Ducts Connected to Equipment Smoke Purge:

a. Pressure Class: Positive or negative [2-inch wg] [3-inch wg] [4-inch wg].
b. Minimum SMACNA Seal Class: [A] [B] if negative pressure, and A if positive pressure.
c. SMACNA Leakage Class for Rectangular: [6] [12] [24].
d. SMACNA Leakage Class for Round and Flat Oval: [3] [6] [12] [24].

E. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Unit Ventilators:

a. Pressure Class: Positive or negative [1-inch wg] [2-inch wg].
b. Minimum SMACNA Seal Class: [A] [B] [C].
c. SMACNA Leakage Class for Rectangular: [12] [24].
d. SMACNA Leakage Class for Round and Flat Oval: [6] [12] [24].

2. Ducts Connected to Air-Handling Units, packaged roof top units constant volume or VAV.

a. Pressure Class: Positive or negative [2-inch wg] [3-inch wg].
b. Minimum SMACNA Seal Class: [A] [B].
c. SMACNA Leakage Class for Rectangular: [6] [12] [24].
d. SMACNA Leakage Class for Round and Flat Oval: [3] [6] [12] [24].

3. Ducts Connected to Equipment Not Listed Above:

a. Pressure Class: Positive or negative [2-inch wg] [3-inch wg] [4-inch wg].
b. Minimum SMACNA Seal Class: [A] [B].
c. SMACNA Leakage Class for Rectangular: [3] [6] [12].
d. SMACNA Leakage Class for Round and Flat Oval: [3] [6] [12].

F. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel.
2. PVC-Coated Ducts:

a. Exposed to Airstream: Match duct material.
b. Not Exposed to Airstream: Match duct material.

3. Stainless-Steel Ducts:

a. Exposed to Airstream: Match duct material.
b. Not Exposed to Airstream: Match duct material.

4. Aluminum Ducts: Aluminum or galvanized sheet steel coated with zinc chromate.

G. Liner for sound attenuation:

1. Supply, Return, and exhaust air ducts: ½” inches thick.
2. Supply and return fan Plenums: 1 inch thick.

3. Transfer Ducts: 1 inch thick.
4. Ductwork downstream from VAV boxes for 10’
5. At the inlet and discharge of all fans for a distance of 20’
6.

H. Double-Wall Duct Interstitial Insulation:

1. Supply, Return, Exhaust Air Ducts: 1” inch thick. (when ducts are exposed in the conditions space)
2. Supply, Return, Exhaust Air Ducts: 1 1/2” inches thick. (when ducts are concealed in plenums or are located in unconditioned spaces)

I. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

   a. Velocity 1000 fpm or Lower:

      1) Radius Type RE 1 with a 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 a minimum 1.0 radius-to-diameter ratio.
      2) Radius Type RE 3 with a minimum 0.5 radius-to-diameter ratio and two vanes.
      3) Mitered Type RE 2 with turning 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 a minimum 1.5 radius-to-diameter ratio.
      2) Radius Type RE 3 with a minimum 1.0 radius-to-diameter ratio and two vanes.
      3) Mitered Type RE 2 with turning vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

   a. Radius Type RE 1 with a minimum 1.5 radius-to-diameter ratio.
   b. Radius Type RE 3 with a minimum 1.0 radius-to-diameter ratio and two vanes.
   c. Mitered Type RE 2 with turning 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 a 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 a 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:
    c. Round Elbows, 14 Inches and Larger in Diameter:

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: 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 the 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.

3.15 DUCTWORK PRESSURE TESTING

A. All high-pressure ductwork designed or operated at 3wc or greater shall be pressure tested in accordance with specification section 23 05 93 Testing, Adjusting and Balancing.

B. The contractor reviews the test report results and repairs or replaces any sections of ductwork with an air leakage rate over 4.0

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. Barometric relief dampers.
3. Manual volume dampers.
4. Control dampers.
5. Fire dampers.
6. Ceiling radiation dampers.
7. Smoke dampers.
8. Combination fire and smoke dampers.
9. Control dampers.
10. Flange connectors.
11. Duct silencers.
12. Turning vanes.
13. Remote damper operators.
14. Duct-mounted access doors.
15. Flexible connectors.
16. Duct accessory hardware.
17. Duct Roof Supports

B. Related Requirements:

1. Section 233113 Metal Ducts
2. Section 233346 "Flexible Ducts" for insulated and non-insulated flexible ducts.
3. Section 233723 "HVAC Gravity Ventilators" for roof-mounted ventilator caps.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For duct silencers, they include pressure drop and dynamic insertion loss 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 the 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. Duct security bars.
    f. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.

B. Source quality-control reports.

1.5 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 the amount installed.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 MATERIALS

A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G90.
2. Exposed-Surface Finish: Mill phosphatized.

B. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and have a No. 2 finish for concealed ducts and a finish for exposed ducts.

C. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

D. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.

E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 BACKDRAFT AND PRESSURE RELIEF DAMPERS

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

1. Greenheck Fan Corporation.
2. Nailor Industries Inc.
3. Pottorff.
4. Ruskin Company.
5. Buckley

B. Description: Gravity balanced.

C. Maximum Air Velocity: 1000 fpm.

D. Maximum System Pressure: up to 6”wc.

E. Frame: Hat-shaped, 0.094-inch-thick, galvanized sheet steel, or 0.063-inch-thick extruded aluminum, or 0.03-inch-thick stainless steel, with welded corners or mechanically attached and mounting flange.

F. Blades: Multiple single-piece blades, center pivoted, or off-center pivoted, maximum 6-inch width, 0.025-inch-thick, roll-formed aluminum or 0.050-inch-thick aluminum sheet noncombustible, tear-resistant, neoprene-coated fiberglass with sealed edges.

G. Blade Action: Parallel.

H. Blade Seals: Neoprene, mechanically locked.

I. Blade Axles:

1. Material: Galvanized, steel, Stainless steel, or Aluminum.
2. Diameter: 0.20-inch min.

J. Tie Bars and Brackets: Aluminum or Galvanized steel.

K. Return Spring: Adjustable tension.

L. Bearings: Steel ball or synthetic pivot bushings.

M. Accessories:

1. Adjustment device to permit setting for varying differential static pressure.
2. Counterweights and spring-assist kits for vertical airflow installations.
3. Electric actuators.
4. Chain pulls.
5. Screen Mounting: Front-mounted in sleeve.
    a. Sleeve Thickness: 20 gauge minimum.
    b. Sleeve Length: 6 inches minimum.
6. Screen Mounting: Rear-mounted.
7. Screen Material: Galvanized steel or Aluminum.
8. Screen Type: Bird. ½ x ½ max opening
9. 90-degree stops.

2.4 BAROMETRIC RELIEF DAMPERS

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

1. Greenheck Fan Corporation.
2. Nailor Industries Inc.
3. Pottorff.
4. Ruskin Company.
5. Buckley

B. Suitable for horizontal or vertical mounting.

C. Maximum Air Velocity: 1000 fpm.

D. Maximum System Pressure: up to 6-inch wg.

E. Frame: Hat-shaped, 0.094-inch-thick, galvanized sheet steel, or 0.063-inch-thick extruded aluminum, or 0.03-inch-thick stainless steel, with welded corners or mechanically attached and mounting flange.

F. Blades:

1. Multiple, 0.025-inch-thick, roll-formed aluminum or 0.050-inch-thick aluminum sheet.
2. Maximum Width: 6 inches.
3. Action: Parallel.
4. Balance: Gravity.
5. Eccentrically pivoted or Off-center pivoted.

G. Blade Seals: Neoprene.

H. Blade Axles: Galvanized steel, aluminum, or Stainless steel.

I. Tie Bars and Brackets:

1. Material: Aluminum or galvanized steel.
2. Rattle-free with a 90-degree stop.

J. Return Spring: Adjustable tension.

K. Bearings: Synthetic, Stainless steel, Bronze.

L. Accessories:

1. Flange on intake.
2. Adjustment device to permit setting for varying differential static pressures.

2.5 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:

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

a. Flex-Tek Group.
b. McGill AirFlow LLC.
c. Nailor Industries Inc.
d. Pottorff.
e. Ruskin Company.
f. Vent Products Co., Inc.
g. Buckley

2. Standard leakage rating, with linkage outside airstream.

3. Suitable for horizontal or vertical applications.
4. Frames:

    a. Frame: Hat-shaped, 0.094-inch-thick, galvanized sheet steel or 0.05-inch-thick stainless 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 or Stainless-steel, 0.064 inch thick.

6. Blade Axles: Galvanized steel, Stainless steel, Nonferrous metal.
7. Bearings:

    a. Oil-impregnated bronze, molded synthetic, Oil-impregnated stainless-steel sleeve.
    b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles the full length of damper blades and bearings at both ends of the operating shaft.

8. Tie Bars and Brackets: Galvanized steel.

B. Standard, Aluminum, Manual Volume Dampers:

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

    a. McGill AirFlow LLC.
    b. Nailor Industries Inc.
    c. Pottorff.
    d. Ruskin Company.
    e. Vent Products Co., Inc.

2. Standard leakage rating, with linkage outside airstream.

3. Suitable for horizontal or vertical applications.
4. Frames: Hat-shaped, 0.10-inch-thick, aluminum sheet channels; frames with 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 or Stainless steel.
7. Bearings:

a. Oil-impregnated bronze, molded synthetic, or Stainless-steel sleeve.
b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles the full length of damper blades and bearings at both ends of the operating shaft.

8. Tie Bars and Brackets: Aluminum.

C. Low-Leakage, Steel, Manual Volume Dampers:

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

a. McGill AirFlow LLC.
b. Nailor Industries Inc.
c. Pottorff.
d. Ruskin Company.
e. Vent Products Co., Inc.

2. Comply with AMCA 500-D testing for damper rating.
3. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
4. Suitable for horizontal or vertical applications.
5. Frames:

a. U or Angle shaped.
b. 0.094-inch-thick, galvanized sheet steel or 0.05-inch-thick stainless steel.
c. Mitered and welded corners.
d. Flanges for attaching to walls and flangeless frames for installing in ducts.

6. Blades:

a. Multiple or single blade.
b. Parallel- or opposed-blade design.
c. Stiffen damper blades for stability.
d. Galvanized or Stainless, roll-formed steel, 0.064 inch thick.

7. Blade Axles: Galvanized steel or Stainless steel.
8. Bearings:

a. Oil-impregnated bronze, Molded synthetic, Oil-impregnated stainless-steel sleeve, Stainless-steel sleeve.

b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles the full length of damper blades and bearings at both ends of the operating shaft.

9. Blade Seals: Neoprene.
10. Jamb Seals: Cambered stainless steel or aluminum.
11. Tie Bars and Brackets: Galvanized steel or Aluminum.
12. Accessories:

a. Include a locking device to hold single-blade dampers 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. McGill AirFlow LLC.
b. Nailor Industries Inc.
c. Pottorff.
d. Ruskin Company.
e. Vent Products Co., Inc.

2. Comply with AMCA 500-D testing for damper rating.
3. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
4. Suitable for horizontal or vertical applications.
5. Frames: U or Angle-shaped, 0.10-inch-thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.
6. Blades:

a. Multiple or single blade.
b. Parallel- or opposed-blade design.
c. Roll-Formed Aluminum Blades: 0.10-inch-thick aluminum sheet.
d. Extruded-Aluminum Blades: 0.050-inch-thick extruded aluminum.

7. Blade Axles: Galvanized steel, Stainless steel.
8. Bearings:

a. Oil-impregnated bronze, Molded synthetic, Oil-impregnated stainless-steel sleeve, Stainless-steel sleeve.
b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles the full length of damper blades and bearings at both ends of the operating shaft.

9. Blade Seals: Neoprene.
10. Jamb Seals: Cambered stainless steel, aluminum.
11. Tie Bars and Brackets: Galvanized steel, Aluminum.

12. Accessories:

    a. Include a locking device to hold single-blade dampers in a fixed position without vibration.

E. Jackshaft:

1. Size: 0.5-inch diameter min.
2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
3. Length and Number of Mountings: As required to connect the linkage of each damper in a 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 a center hole to suit the damper operating-rod size.
3. Include an elevated platform for insulated duct mounting.

2.6 CONTROL DAMPERS

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

1. Arrow United Industries.
2. Greenheck Fan Corporation.
3. McGill AirFlow LLC.
4. Nailor Industries Inc.
5. Pottorff.
6. Ruskin Company.

B. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.

C. Frames:

1. U or Angle shaped.
2. 0.094-inch-thick, galvanized sheet steel or 0.05-inch-thick stainless steel.
3. Mitered and welded corners.

D. Blades:

1. Multiple blades with a maximum blade width of 6 inches.
2. Parallel blade for non-modulating application
3. Opposed-blade design for all modulating applications
4. Galvanized steel, Stainless steel, Aluminum.

5. 0.064-inch-thick single skin or 0.0747-inch-thick dual skin.
6. Blade Edging: Closed-cell neoprene.
7. Blade Edging: Inflatable seal blade edging or replaceable rubber seals.

E. Blade Axles: 1/2-inch-diameter; galvanized steel, or stainless steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.

1. Operating Temperature Range: From minus 40 to plus 200 deg F.

F. Bearings:

1. Oil-impregnated bronze, Molded synthetic, Oil-impregnated, stainless-steel sleeve, or Stainless-steel sleeve.
2. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles the full length of the damper blades and bearings at both ends of the operating shaft.
3. Thrust bearings at each end of every blade.

2.7 FIRE DAMPERS

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

1. Arrow United Industries.
2. Greenheck Fan Corporation.
3. Nailor Industries Inc.
4. Pottorff.
5. Ruskin Company.
6. Ward Industries; a brand of Hart & Cooley, Inc.

B. Type: Dynamic; rated and labeled according to UL 555 by an NRTL.

C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity.

D. Fire Rating: 1-1/2 and 3 hours.

E. Frame: Curtain type with blades inside the airstream for application in ducts over 24” in height. Curtain type with blades outside the airstream for ducts 24” or less in height. Multiple-blade type; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.

F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.

1. Minimum Thickness: 0.138 inch up to 4 SF, 0.39 over 4 SF inch thick, as indicated, and of length to suit application.

2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.

G. Mounting Orientation: Vertical or horizontal as indicated.

H. Blades: Roll-formed, interlocking, 0.034-inch-thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch-thick, galvanized-steel blade connectors.

I. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

J. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

2.8 CEILING RADIATION DAMPERS

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

1. Aire Technologies.
2. Nailor Industries Inc.
3. Pottorff.
4. Prefco.
5. Ruskin Company.

B. General Requirements:

1. Labeled according to UL 555C by an NRTL.
2. Comply with construction details for tested floor- and roof-ceiling assemblies as indicated in UL's "Fire Resistance Directory."

C. Frame: Galvanized sheet steel, round or rectangular, style to suit ceiling construction.

D. Blades: Galvanized sheet steel with refractory insulation.

E. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

F. Fire Rating: 1hr for applications in assemblies up to 1 ½ hr. rating. 2hr for application in assemblies of up to 3hr

2.9 SMOKE DAMPERS

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

1. Greenheck Fan Corporation.
2. Nailor Industries Inc.
3. Pottorff.

4. Ruskin Company.

B. General Requirements: Label according to UL 555S by an NRTL.

C. Smoke Detector: Integral, factory wired for single-point connection. Except for NYC, a smoke detector shall be provided by the fire alarm contractor.

D. Frame: Hat-shaped, 0.094-inch-thick, galvanized sheet steel, with welded or mechanically attached corners and mounting flange.

E. Blades: Roll-formed, horizontal, overlapping, 0.063-inch-thick, galvanized sheet steel.

F. Leakage: Class I.

G. Rated pressure and velocity to exceed design airflow conditions.

H. Mounting Sleeve: Factory-installed, 0.05-inch-thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking.

I. Damper Motors: Modulating or two-position action.

J. 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, a large enough driven load will not require the motor to operate in a service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."
3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
4. Spring-Return Motors: Equipped with an integral spiral-spring mechanism where indicated. Enclose the entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.
5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
6. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.
7. Electrical Connection: [115 V, single phase, 60 Hz]

K. Accessories:

1. Auxiliary switches for signaling, fan control, and position indication.
2. Test and reset switches, damper or remote-mounted.

3. Manual damper testing by physically depressing the low-temperature thermal disc from the inside of the damper sleeve and resetting the sensor from the exterior side of the damper sleeve.
4. Dual-position blade indicator switch package shall connect directly to the blade axle for positive annunciation (interconnecting arms, wire-forms, or brackets shall not be accepted) and provide full open and full closed blade indication to a remote location.
5. Dual Position Indicator Switch Package: Shall connect directly to the blade axle for positive annunciation (interconnecting arms, wire-forms, or brackets shall not be accepted) and provide full open and full closed blade indication to a remote location.
6. Duct Smoke Detector: Factory-mounted in the damper sleeve with interconnecting wiring from the damper actuator to the smoke detector, enabling a single power connection point for easy field wiring.

2.10 COMBINATION FIRE AND SMOKE DAMPERS

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

1. Greenheck Fan Corporation.
2. Pottorff.
3. Ruskin Company.

B. Type: Dynamic; rated and labeled according to UL 555 and UL 555S 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 for assemblies up to 2 hours and 3 hr rating for assemblies over 1 1/2hours.

E. Frame: Hat-shaped, 0.094-inch-thick, galvanized sheet steel, with welded corners and mounting flange.

F. Primary heat-responsive device set at 285 deg F, resettable.

G. Secondary heat closure device, set at 350 deg F, resettable.

H. Smoke Detector: Integral, factory wired for single-point connection.

I. Blades: Roll-formed, horizontal, interlocking, 0.063-inch-thick, galvanized sheet steel.

J. Leakage: Class I.

K. Rated pressure and velocity to exceed design airflow conditions.

L. Mounting Sleeve: Factory-installed, 0.039-inch-thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking.

M. Master control panel for use in dynamic smoke-management systems.

N. Damper Motors: Modulating or two-position action.

O. 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, a large enough driven load will not require the motor to operate in a service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."
3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
4. Spring-Return Motors: Equipped with an integral spiral-spring mechanism where indicated. Enclose the entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.
5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
6. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.
7. Electrical Connection: 115 V, single phase, 60 Hz.

P. Accessories:

A. DRS-30 Two-Temperature Fire Closure Device:

1. UL classified a two-temperature device permits the damper to be reopened after initial temperature closure, allowing the damper to remain operable for smoke management purposes until the high temperature limit is reached.

2. Manual damper testing is permitted by physically depressing the low-temperature thermal disc from the inside of the damper sleeve and resetting the sensor from the exterior side of the damper sleeve.

3. Dual position blade indicator switch package shall connect directly to the blade axle for positive annunciation (interconnecting arms, wire-forms, or brackets shall not be accepted) and provide full open and full closed blade indication to a remote location.

B. PI-50 Dual Position Indicator Switch Package: Shall connect directly to the blade axle for positive annunciation (interconnecting arms, wire-forms, or brackets shall not be accepted) and provide full open and full closed blade indication to a remote location.

C. Duct Smoke Detector: Factory mounted in the damper sleeve with interconnecting wiring from the damper actuator to the smoke detector, enabling a single power connection point for easy field wiring.

2.11 FLANGE CONNECTORS

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

1. CL WARD & Family Inc.
2. Ductmate Industries, Inc.
3. Hardcast, Inc.
4. Ward Industries; a brand of Hart & Cooley, Inc.

B. Description: Add-on or roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

C. Material: Galvanized steel.

D. Gage and Shape: Match connecting ductwork.

2.12 DUCT SILENCERS

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

1. Industrial Noise Control, Inc.
2. McGill AirFlow LLC.
3. Ruskin Company.
4. Vibro-Acoustics.
5. Industrial Acoustics

B. General Requirements:

1. Factory fabricated.
2. Fire-Performance Characteristics: Adhesives, sealants, packing materials, and accessory materials shall have a flame-spread index not exceeding 25 and a smoke-developed index not exceeding 50 when tested according to ASTM E 84.
3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

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 A 653/A 653M, G90, galvanized sheet steel, 0.040 inch thick.

E. Round Silencer Outer Casing: ASTM A 653/A 653M, G90, galvanized sheet steel.

1. Sheet Metal Thickness for Units up to 24 Inches in Diameter: 0.034 inch thick.
2. Sheet Metal Thickness for Units 26 through 40 Inches in Diameter: 0.040 inch thick.
3. Sheet Metal Thickness for Units 42 through 52 Inches in Diameter: 0.05 inch thick.
4. Sheet Metal Thickness for Units 54 through 60 Inches in Diameter: 0.064 inch thick.

F. Inner Casing and Baffles: ASTM A 653/A 653M, G60 galvanized sheet metal, 0.034 inch thick, and with 1/8-inch-diameter perforations.

G. Special Construction:

1. Suitable for outdoor use.
2. High transmission loss to achieve STC 45.

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 or Film-lined type with fill material.

a. Fill Material: Inert and vermin-proof fibrous material, packed under not less than 15 percent compression, and Moisture-proof nonfibrous material.
b. Erosion Barrier: Polymer bag enclosing fill, and 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 continuously welded or flanged connections.
2. Suspended Units: Factory-installed suspension hooks or lugs attached to the frame in quantities and spaced to prevent deflection or distortion.
3. Reinforcement: Cross or trapeze angles for rigid suspension.

K. Accessories:

1. Integral 1-1/2 3-hour fire damper with access door. Access door to have a high transmission loss to match the silencer.
2. Factory-installed end caps to prevent contamination during shipping.
3. Removable splitters.
4. Airflow measuring devices.

L. Source Quality Control: Test according to ASTM E 477.

1. Testing to be witnessed by the Engineer.
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 the associated fan static pressure or 6-inch wg static pressure, whichever is greater.

M. Capacities and Characteristics:

1. Configuration: Straight or 90-degree elbow as indicated on the plan
2. Shape: Rectangular or Round as indicated on the plan
3. Attenuation Mechanism: Acoustical glass fiber with protective film liner.
4. Maximum Pressure Drop: 0.25-inch wg.
5. Casing:

    a. Attenuation: Standard.
    b. Outer Material: Galvanized steel.
    c. Inner Material: Galvanized steel.

6. Velocity Range: 500 fpm max.
7. End Connection: 1-inch slip joint or Flange.
8. Length: as per plan
9. Face Dimension:

    a. Width: as per plan
    b. Height: as per plan

10. Face Velocity: as per plan
11. Dynamic Insertion Loss: as per plan
12. Generated Noise: as per plan
13. Accessories:

    a. Access door.
    b. Birdscreen.

2.13 TURNING VANES

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

1. Aero-Dyne Sound Control Co.
2. CL WARD & Family Inc.
3. Ductmate Industries, Inc.
4. Duro Dyne Inc.
5. METALAIRE, Inc.
6. Ward Industries; a brand of Hart & Cooley, Inc.

B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

C. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

D. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."

E. Vane Construction: Single wall for ducts up to 48 inches wide and double wall for larger dimensions.

2.14 REMOTE DAMPER OPERATORS

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

1. Pottorff.
2. Ventfabrics, Inc.
3. Young Regulator Company.

B. Description: Cable system designed for remote manual damper adjustment.

C. Tubing: Copper or Aluminum.

D. Cable: Steel.

E. Wall-Box Mounting: Recessed.

F. Wall-Box Cover-Plate Material: Stainless steel.

2.15 DUCT-MOUNTED ACCESS DOORS

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

1. CL WARD & Family Inc.
2. Ductmate Industries, Inc.
3. Greenheck Fan Corporation.
4. McGill AirFlow LLC.
5. Nailor Industries Inc.
6. Pottorff.

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."

1. Door:

   a. Double wall, rectangular.
   b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
   c. Vision panel.
   d. Hinges and Latches: 1-by-1-inchbutt or piano hinge and cam latches.
   e. Fabricate doors airtight and suitable for duct pressure class.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Number of Hinges and Locks:

   a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
   b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.
   c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches with outside and inside handles for plenum applications.
   d. Access Doors Larger Than 24 by 48 Inches: Four hinges or Continuous and two compression latches with outside and inside handles.

C. Pressure Relief Access Door:

1. Door and Frame Material: Galvanized sheet steel.
2. Door: Double wall with insulation filled with metal thickness applicable for duct pressure class.
3. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.
4. Factory set at 3.0- to 8.0-inch wg.
5. Doors close when pressures are within the set-point range.
6. Hinge: Continuous piano.
7. Latches: Cam.
8. Seal: Neoprene or foam rubber.
9. Insulation Fill: 1-inch-thick, fibrous-glass or polystyrene-foam board.

2.16 DUCT ACCESS PANEL ASSEMBLIES

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

1. 3M.
2. Ductmate Industries, Inc.
3. Flame Gard, Inc.

B. Labeled according to UL 1978 by an NRTL.

C. Panel and Frame: Minimum thickness 0.0528-inch carbon steel.

D. Fasteners: Carbon steel. Panel fasteners shall not penetrate the duct wall.

E. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for a minimum 2000 deg F.

F. Minimum Pressure Rating: 10-inch wg, positive or negative.

2.17 FLEXIBLE CONNECTORS

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.

B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.

D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches or 5-3/4 inches wide attached to two strips of 2-3/4-inch-wide, 0.028-inch-thick, galvanized sheet steel or 0.032-inch-thick aluminum sheets. Provide metal compatible with connected ducts.

E. Indoor System, Flexible Connector Fabric: Glass fabric double-coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd..
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F.

F. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.

1. Minimum Weight: 24 oz./sq. yd..
2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
3. Service Temperature: Minus 50 to plus 250 deg F.

G. High-Temperature System, Flexible Connectors: Glass fabric coated with silicone rubber.

1. Minimum Weight: 16 oz./sq. yd.
2. Tensile Strength: 285 lbf/inch in the warp and 185 lbf/inch in the filling.
3. Service Temperature: Minus 67 to plus 500 deg F.

H. High-Corrosive-Environment System, Flexible Connectors: Glass fabric with chemical-resistant coating.

1. Minimum Weight: 14 oz./sq. yd.
2. Tensile Strength: 450 lbf/inch in the warp and 340 lbf/inch in the filling.
3. Service Temperature: Minus 67 to plus 500 deg F.

I. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.

1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
2. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent rated vertical stiffness.
5. Overload Capacity: Support 200 percent of the rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

2.18 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High-strength, quick-setting, neoprene-based, waterproof, and resistant to gasoline and grease.

2.19 DUCT ROOF SUPPORTS

A. Ductwork shall be supported a minimum of 12” above the roof with an “H” stand manufactured by RTS. Roof support systems. All parts shall be manufactured from hot-dipped galvanized steel 1 5/8” channels. All fasteners shall be hot-dipped galvanized steel or nickel-plated. All channels that are filed cut shall be finished with cold galvanizing at all unfinished edges. All stands shall have two lateral horizontal cross members

B. “H” stands shall use double base. Gusseted 2”x2” square receiver base plate mounted on 14.5”x17.5” x2” thick neoprene pad model RTSF21G.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Compliance with ASHRAE/IESNA 90.1-2004 includes Section 6.4.3.3.3 - "Shutoff Damper Controls," which restricts the use of backdraft dampers and requires control dampers for certain applications. Install backdraft dampers at the inlet of exhaust fans or exhaust ducts as close as possible to the exhaust fan unless otherwise indicated.

D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of the same depth as the liner, and terminate the liner with nosing at the hat channel.

1. Install steel volume dampers in steel ducts.
2. Install aluminum volume dampers in aluminum ducts.
3. Install stainless steel volume dampers in stainless steel ducts.

E. Set dampers to the fully open position before testing, adjusting, and balancing.

F. Install test holes at fan inlets and outlets and elsewhere as indicated.

G. Install fire and smoke dampers according to UL listing.

H. Connect ducts to duct silencers rigidly.

I. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:

1. On both sides of the duct coils.
2. Upstream from duct filters.
3. At outdoor-air intakes and mixed-air plenums.
4. At drain pans and seals.
5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
7. At each change in direction and at maximum 50-foot spacing, and at the bottom of all risers in Laundry exhaust ducts.
8. Upstream from turning vanes.
9. Upstream or downstream from duct silencers.
10. Control devices requiring inspection.
11. Elsewhere as indicated.

J. Install access doors with swing against duct static pressure.

K. Access Door Sizes:

1. One-Hand or Inspection Access: 8 by 5 inches.
2. Two-Hand Access: 12 by 6 inches.
3. Head and Hand Access: 18 by 10 inches.
4. Head and Shoulders Access: 21 by 14 inches.
5. Body Access: 25 by 14 inches.
6. Body plus Ladder Access: 25 by 17 inches.

L. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of the access door.

M. Install flexible connectors to connect ducts to equipment.

N. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with a loaded vinyl sheet held in place with metal straps.

O. Connect terminal units to supply ducts with a maximum 12-inch length of flexible duct. Do not use flexible ducts to change directions.

P. Connect diffusers or light troffer boots to ducts with a maximum 30-inch length of flexible duct clamped or strapped in place.

Q. Connect flexible ducts to metal ducts with draw bands.

R. Install duct test holes where required for testing and balancing purposes.

S. Install thrust limits at the centerline of thrust, symmetrical on both sides of the equipment. Attach thrust limits at the centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

T. Install remote volume damper operators for all volume dampers that are concealed and not accessible after the construction is complete.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify the full range of movement.
2. Inspect the locations of access doors and verify that the purpose of the access door can be performed.
3. Operate fire, smoke, and combination fire and smoke dampers to verify the full range of movement and verify that a proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.
5. Operate remote damper operators to verify the full range of movement of the operator and damper.

END OF SECTION 233300

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. Utility set fans.
2. Centrifugal roof ventilators.
3. Axial roof ventilators.
4. Centrifugal wall ventilators.
5. Ceiling-mounted ventilators.
6. In-line centrifugal fans.
7. Propeller fans.
8. Vibration isolation.

1.3 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan-performance ratings on sea level.

B. Operating Limits: Classify according to AMCA 99.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Also include the following:

1. Certified fan performance curves with system operating conditions indicated.
2. Certified fan sound-power ratings.
3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
4. Material thickness and finishes, including color charts.
5. Dampers, including housings, linkages, and operators.
6. Roof curbs.
7. Fan speed controllers.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.

C. Delegated-Design Submittal: For unit hangars and supports 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. 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.
2. Design Calculations: Calculate requirements for selecting vibration isolatorsand for designing vibration isolation bases.

D. Coordination Drawings: 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. Roof framing and support members related to duct penetrations.
2. Ceiling suspension assembly members.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items, including light fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

E. Field quality-control reports.

F. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.

C. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use in restaurant kitchen exhaust shall also comply with UL 762.

1.6 COORDINATION

A. Coordinate the size and location of structural-steel support members.

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

C. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.7 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Belts: 2 set(s) for each belt-driven unit.

PART 2 - PRODUCTS

2.1 UTILITY SET FANS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ACME Company.
2. Loren Cook Company.
3. New York Blower Company
4. PennBarry.
5. Greenheck.

B. Housing: Fabricated of galvanized steel with side sheets fastened with a deep lock seam or welded to scroll sheets.

1. Housing Discharge Arrangement: Adjustable to eight standard positions.

C. Fan Wheels: Single-width, single inlet; welded to cast-iron or cast-steel hub and spun-steel inlet cone, with hub keyed to shaft.

1. Blade Materials: Steel or Aluminum.
2. Blade Type: Backward inclined or Forward curved, or Airfoil. As scheduled
3. Spark-Resistant Construction: AMCA 99, Type A

D. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.

E. Shaft Bearings: Prelubricated and sealed, self-aligning, pillow-block-type ball bearings with ABMA 9, L_{50} of 200,000 hours.

1. Extend the grease fitting to an accessible location outside of the unit.

F. Belt Drives:

1. Factory-mounted, with final alignment and belt adjustment made after installation
2. Service Factor Based on Fan Motor Size: 1.5

3. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select a pulley so that pitch adjustment is at the middle of the adjustment range at fan design conditions.
4. Belts: Oil-resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
5. Belt Guards: Fabrication of steel for motors mounted on the outside of the fan cabinet.

G. Accessories:

1. Inlet and Outlet: Flanged.
2. Companion Flanges: Rolled flanges for duct connections of the same material as the housing.
3. Backdraft Dampers: Gravity actuated with counterweight and interlocking aluminum blades with felt edges in a steel frame installed on fan discharge.
4. Access Door: Gasketed door in scroll with latch-type handles.
5. Scroll Dampers: Single-blade damper installed at fan scroll top with adjustable linkage.
6. Inlet Screens: Removable wire mesh.
7. Drain Connections: NPS 3/4 threaded coupling drain connection installed at the lowest point of housing.
8. Weather Hoods: Weather-resistant with stamped vents over the motor and drive compartment.
9. Discharge Dampers: Assembly with opposed blades constructed of two plates formed around and to the shaft, channel frame, sealed ball bearings, with blades linked outside of the airstream to a single control lever of the same material as housing.
10. Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
11. Disconnect switch - Nonfusible type, with thermal-overload protection. Externally mounted outdoor disconnects shall be NEMA 3R

2.2 CENTRIFUGAL ROOF VENTILATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ACME Company.
2. Central Blower Company.
3. Greenheck Fan Corporation.
4. Loren Cook Company.
5. PennBarry.

B. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone.

1. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains and grease collector (for kitchen hood applications).
2. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.

C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

D. Belt Drives:

1. Resiliently mounted to housing.
2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
4. Pulleys: Cast-iron, adjustable-pitch motor pulley.
5. Fan and motor are isolated from the exhaust airstream.

E. Accessories:

1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside or outside fan housing, factory wired through an internal aluminum conduit.
3. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
4. Barometric 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 the curb base with an electric actuator; wired to close when the fan stops.
6. Refer to plans for damper type

F. Special Considerations for Kitchen Hood Exhaust Applications:
   a. No back draft discharge damper for kitchen hood exhaust applications
   b. Minimum curb Height: 8”. Coordinate the exact curb height in the field so that the top of the fan is a minimum of 40” above the roof.
   c. Roof curb shall be vented without insulation.
   d. Provide grease drain line and cup
   e. Provide hinged
   f. NEMA 3R external unit-mounted disconnect switch.
   g. Bird screen with heat baffle
   h. Fan shall be hinge-mounted to the curb for access to the wheel and ductwork
   i. UL 762 rated for continuous operation up to 300 deg F.

G. 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 the roof opening and fan base.

1. Configuration: Self-flashing without a cant strip, with mounting flange.

2. Minimum Height: 18 inches. For Kitchen exhaust applications, coordinate the curb height in the field so that the top of the fan is a minimum of 40” above the roof.
3. Sound Curb: Curb with sound-absorbing insulation.
4. Pitch Mounting: Manufacture a curb for the roof slope.
5. Metal Liner: Galvanized steel.
6. Burglar Bars: 1/2-inch- thick steel bars welded in place to form 6-inch squares. (Not required unless scheduled)
7. Mounting Pedestal: Galvanized steel with removable access panel.
8. Vented Curb: Unlined with louvered vents in vertical sides. (for kitchen hood exhaust applications)

2.3 AXIAL ROOF VENTILATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ACME Company.
2. Greenheck Fan Corporation.
3. Hartzell Fan Incorporated.
4. Loren Cook Company.
5. New York Blower Company
6. PennBarry.

B. Housing: Heavy-gage, removable, spun-aluminum, dome top and outlet baffle; square, one-piece, hinged, aluminum base.

1. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.

C. Fan Wheel: Aluminum or Steel hub and blades.

D. Belt Drives:

1. Resiliently mounted to housing.
2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
4. Pulleys: Cast-iron, adjustable-pitch motor pulley.

E. Accessories:

1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside or outside fan housing, factory wired through an internal aluminum conduit. Externally mounted disconnects shall be NEMA 3R
2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
3. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.

4. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.

F. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch- thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood Nailer. Size as required to suit the roof opening and fan base.

1. Configuration: Self-flashing without a cant strip, with mounting flange.
2. Minimum Height: 18 inches.
3. Sound Curb: Curb with sound-absorbing insulation.
4. Pitch Mounting: Manufacture a curb for the roof slope.
5. Metal Liner: Galvanized steel.
6. Burglar Bars: 1/2-inch- thick steel bars welded in place to form 6-inch squares.(required where specifically scheduled)
7. Mounting Pedestal: Galvanized steel with removable access panel.

2.4 CENTRIFUGAL WALL VENTILATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Carnes Company.
2. Greenheck Fan Corporation.
3. ACME Fan Incorporated.
4. Loren Cook Company.
5. PennBarry.

B. Housing: Heavy-gauge, removable, spun-aluminum, dome top and outlet baffle; venturi inlet cone.

C. Fan Wheel: Aluminum hub and wheel with backward-inclined blades.

D. Belt Drives:

1. Resiliently mounted to housing.
2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
4. Pulleys: Cast-iron, adjustable-pitch motor pulley.
5. Fan and motor are isolated from the exhaust airstream.

E. Accessories:

1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through internal aluminum conduit.
3. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.

4. Wall Grille: Ring type for flush mounting.
5. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in wall sleeve; factory set to close when fan stops.
6. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.

2.5 CEILING-MOUNTED VENTILATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Carnes Company.
   2. Greenheck Fan Corporation.
   3. Loren Cook Company.
   4. PennBarry.

B. Housing: Steel, lined with acoustical insulation. Housing shall be field adaptable for inline installation.

C. Fan Wheel: Centrifugal wheels are directly mounted on the motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.

D. Grille: Aluminum or painted aluminum, louvered grille with flange on intake and thumbscrew attachment to fan housing.

E. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.

F. Accessories:

   1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
   2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through internal aluminum conduit. Externally mounted disconnects shall be NEMA 3R
   3. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
   4. Wall Grille: Ring type for flush mounting.
   5. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in wall sleeve; factory set to close when fan stops.
   6. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.

2.6 IN-LINE CENTRIFUGAL FANS

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

2. Greenheck Fan Corporation.
3. ACME Fan Incorporated.
4. Loren Cook Company.
5. PennBarry.

B. Housing: Split, spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.

C. Direct-Drive Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing.

D. Belt-Driven Units: Motor mounted on an adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.

E. Fan Wheels: Aluminum, airfoil blades welded to an aluminum hub.

F. Accessories:

1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent. (where scheduled or indicated on plan)
2. Volume-Control Damper: Manually operated with quadrant lock, located in the fan outlet.
3. Companion Flanges: For inlet and outlet duct connections.
4. Fan Guards: 1/2- by 1-inch mesh of galvanized steel in a removable frame. Provide a guard for the inlet or outlet for units not connected to ductwork.
5. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.
6. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside or outside fan housing, factory wired through an internal aluminum conduit

2.7 PROPELLER FANS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Carnes Company.
2. Chicago Blower Corporation.
3. Loren Cook Company.
4. ACME
5. PennBarry.

B. Housing: Galvanized-steel sheet with flanged edges and integral orifice ring with baked-enamel finish coat applied after assembly.

C. Steel Fan Wheels: Formed-steel blades riveted to heavy-gauge steel spider bolted to cast-iron hub.

D. Fan Wheel: Replaceable, cast or extruded-aluminum, airfoil blades fastened to a cast-aluminum hub; factory set pitch angle of blades.

E. Fan Drive: Motor mounted in the airstream, factory wired to a disconnect switch located on the outside of the fan housing.

F. Fan Drive:

1. Resiliently mounted to housing.
2. Statically and dynamically balanced.
3. Selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
4. Extend the grease fitting to an accessible location outside of the unit.
5. Service Factor Based on Fan Motor Size: 1.4.
6. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
7. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.

    a. Ball-Bearing Rating Life: ABMA 9, L_{10} of 100,000 hours.

8. Pulleys: Cast iron with split, tapered bushing; dynamically balanced at the factory.
9. Motor Pulleys: Adjustable pitch for use with motors through 3 hp; fixed pitch for use with larger motors. Select a pulley so that pitch adjustment is at the middle of the adjustment range at fan design conditions.
10. Belts: Oil-resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
11. Belt Guards: Fabrication of steel for motors mounted on the outside of the fan cabinet.

G. Accessories:

1. Gravity Shutters: Aluminum blades in an aluminum frame; interlocked blades with nylon bearings.
2. Motor-Side Back Guard: Galvanized steel, complying with OSHA specifications, removable for maintenance.
3. Wall Sleeve: Galvanized steel to match fan and accessory size.
4. Weathershield Hood: Galvanized steel to match fan and accessory size.
5. Weathershield Front Guard: Galvanized steel with expanded metal screen.
6. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
7. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.

2.8 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 15 Section "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, a large enough driven load will not require the motor to operate in a service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.

B. Enclosure Type: Totally enclosed, fan-cooled.

2.9 VIBRATION ISOLATORS FOR HANGING and DUNNAGE-MOUNTED EQUIPMENT

A. Spring isolators shall be free-standing and laterally stable without any housing and complete with a molded neoprene cup or 1/4" neoprene acoustical friction pad between the baseplate and the support. All mountings shall have leveling bolts that must be rigidly bolted to the equipment. Installed and operating heights shall be equal. The ratio of the spring diameter divided by the compressed spring height shall be no less than 0.8. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Submittals shall include spring diameters, deflection, compressed spring height, and solid spring height. Mountings shall be type SLF, as manufactured by Mason Industries, Inc

B. All dunnage-mounted fans shall be mounted to the dunnage using spring isolators at all support points. Spring isolators shall be free-standing and laterally stable without any housing and complete with a molded neoprene cup or 1/4" neoprene acoustical friction pad between the baseplate and the support. All mountings shall have leveling bolts that must be rigidly bolted to the equipment. Installed and operating heights shall be equal. The ratio of the spring diameter divided by the compressed spring height shall be no less than 0.8. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Submittals shall include spring diameters, deflection, compressed spring height, and solid spring height.

C. Isolators shall include a neoprene acoustical pad within a rigid-sided housing that includes vertical limit stops to prevent spring extension when weight is removed and temporary steel spacers between the upper and lower housings. Housings shall serve as blocking during erection. When the equipment is at full operating weight, the springs shall be adjusted to assume the weight and the spacers removed, without changing the installed and operating heights. All restraining bolts shall have large rubber grommets to provide cushioning in the vertical as well as horizontal modes. The hole through the bushing shall be a minimum of 0.75" larger in diameter than the restraining bolt. Horizontal clearance on the sides between the spring assembly and the housing shall be a minimum of 0.5" to avoid bumping and interfering with the spring action. Vertical limit stops shall be out of contact during normal operation. Housings and springs shall

be powder-coated and hardware electro-galvanized. Mountings shall be SLR as manufactured by Mason Industries, Inc.

2.10 SOURCE QUALITY CONTROL

A. Certify sound-power level ratings according to AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Certify fan performance ratings, including flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating." Label fans with the AMCA-Certified Ratings Seal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install power ventilators level and plumb.

B. Support units using spring isolators or restrained spring isolators for projects with seismic requirements having a static deflection of 1 inch. Vibration- and seismic-control devices are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

1. Secure vibration and seismic controls to concrete bases using anchor bolts cast in concrete base.

C. Install floor-mounted units on concrete bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."

D. Secure roof-mounted fans to roof curbs with cadmium-plated hardware. Ceiling Units: Suspend units from structure; use steel wire or metal straps.

E. Support suspended units from structure using threaded steel rods and elastomeric hangers or spring hangers with vertical-limit stops having a static deflection of 1 inch.

F. Install units with clearances for service and maintenance.

G. Label units according to requirements specified in Division 23 Section "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS

A. Duct installation and connection requirements are specified in other Sections. Drawings indicate the general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Section "Air Duct Accessories."

B. Kitchen exhaust hood fans shall not have flexible connections or back-draft dampers.

C. Install ducts adjacent to power ventilators to allow service and maintenance.

D. Prove flexible duct connections for all fans except Kitchen exhaust fans.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that the unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Disconnect the fan drive from the motor, verify proper motor rotation direction, and verify the fan wheel's free rotation and smooth bearing operation. Reconnect the fan drive system, align and adjust belts, and install belt guards.
5. Adjust belt tension.
6. Adjust damper linkages for proper damper operation.
7. Verify lubrication for bearings and other moving parts.
8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in the fully open position.
9. Disable automatic temperature-control operators, energize the motor, and adjust the fan to the indicated rpm, and measure and record motor voltage and amperage.
10. Shut the unit down and reconnect the automatic temperature-control operators.
11. Remove and replace malfunctioning units and retest as specified above.

C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Prepare test and inspection reports.

3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Lubricate bearings.

D. Comply with requirements in "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.

E. Mechanical schedules and equipment notes indicate estimated static pressures and resultant RPM. If, during balancing, it is determined that the sheaves supplied with a fan or air handling unit have reached the maximum adjustment and design static pressure, and or CFM cannot be obtained, then it shall be the mechanical contractor's responsibility to remove and change the drive as required to reach design conditions. And it shall be the balancer's responsibility to rebalance the system as appropriate to achieve design conditions after the drives have been changed.

END OF SECTION 233423

SECTION 235123 – LISTED SPECIAL GAS VENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings 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. LISTED TYPE B AND BW VENTS
2. LISTED TYPE L VENTS
3. LISTED SPECIAL GAS VENTS
4.

B. Related Requirements:

1. Section 235216.11 "Condensing Boilers”

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the product.

B. Shop Drawings: For vents and stacks. Include plans, elevations, sections, details, and attachments to other work.

1. The contractor shall detail equipment assemblies and indicate dimensions, required clearances, methods of field assembly, components, hangers, and seismic restraints, and the location and size of each field connection.
2. The contractor shall include in the submittal package all of the following for review and approval by the engineer;
   a. Detailed scaled drawing of the boiler room equipment or the equipment to be vented. It shall contain a scale drawing of the breeching and chimney liner, including all fittings and terminations.
   b. Vent support details, methods, and locations.
   c. The inner diameter of the flue system shall be verified by the manufacturer’s venting computations to determine the system's available draft. The draft computations shall follow ASHRAE calculation methods. The draft

calculation shall be based on the actual field-verified breaching/liner layout for this project.

d. Flue gas velocity shall not exceed the manufacturer's maximum requirement or 1000 ft/min. The required draft shall be .1” min at the farthest appliance connected.

1.4 The manufacturer shall provide “to scale” drawings depicting the actual layout. The prefabricated flue system shall be installed as designed by the manufacturer and in accordance with the terms of the manufacturer’s warranty and in conjunction with sound engineering practices

1.5 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Sample Warranty: For special warranty.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
2. AWS D9.1/D9.1M, "Sheet Metal Welding Code," for shop and field welding of joints and seams in vents.

B. Certified Sizing Calculations: Manufacturer shall certify venting system sizing calculations.

PART 2 - PRODUCTS

2.1 LISTED TYPE B AND BW VENTS (NOT USED)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Heatfab Saf-T Vent.
2. Enervex
3. Security Chimneys International.
4. Selkirk Corporation.

B. Description: Double-wall metal vents tested according to UL 441 and rated for 480 deg F continuously for Type B or 550 deg F continuously for Type BW; with neutral or negative flue pressure complying with NFPA 211.

C. Construction: Inner shell and outer jacket separated by at least a 1-inch insulation

D. Inner Shell: ASTM A666, Type 430 stainless steel.

E. Outer Jacket: Galvanized or 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.

1. Termination: Stack cap designed to exclude a minimum 90 percent of rainfall.

2.2 LISTED TYPE L VENTS – (NOT USED)

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

1. Heatfab Saf-T Vent.
2. Security Chimneys International.
3. Selkirk Corporation.
4. Enervex

B. Description: Double-wall metal vents tested according to UL 641 and rated for 570 deg F continuously or 1700 deg F for 10 minutes; with neutral or negative flue pressure complying with NFPA 211.

C. Construction: Inner shell and outer jacket separated by at least a 1-inch airspace filled with high-temperature, ceramic-fiber or mineral-wool insulation.

D. Inner Shell: ASTM A666, Type 316 stainless steel.

E. Outer Jacket: Galvanized, or Aluminized or Stainless 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.
1. Termination: Round chimney top designed to exclude 98 percent of rainfall.

2.3 LISTED SPECIAL GAS VENTS - CONDENSING BOILERS AND HOT WATER HEATERS

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

1. Heatfab Saf-T Vent.
2. Metal-Fab, Inc.
3. Security Chimneys International.
4. Selkirk Corporation.

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 a 1" interstitial space filled with high-temperature, ceramic-fiber or mineral-wool insulation.

D. Inner Shell: ASTM A959, Type 29-4C stainless steel.

E. Outer Jacket: Aluminized steel, galvanized steel, or Stainless 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 the same assembly.
1. Termination: Round chimney top designed to exclude a minimum 98 percent of rainfall.

2.4 COMBUSTION OUTSIDE AIR INTAKE DUCTWORK FOR BOILERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Spot – Spiral pipe.
2. United McGill
3. R.L. Craig Company
4. US Duct.

B. Outside air intake ductwork and fittings for all gas- fired direct venting condensing & non-condensing appliances shall be single-wall spiral round galvanized steel. All ductwork and accessories shall be 4-ply spiral lock seam meeting ASTM A-653. All duct connections shall be made with a double-legged EPDM gasket creating an airtight connection meeting ASTM A-653. Single-wall duct gauge shall be selected for positive or negative pressure SMACNA leak class 3, and up to 10" WC with a minimum gauge of 24. The product is rated for zero clearance to combustibles. Provide straight sections, elbows, offsets, connection adapters, wall sleeves, and screened terminations.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting the performance of work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATION

A. Listed Type B and BW Vents: Vents for certified gas appliances.

B. Listed Type L Vent: Vents for low-heat appliances.

C. Listed Special Gas Vent: Condensing gas appliances.

3.3 INSTALLATION OF LISTED VENTS

A. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 077200 "Roof Accessories."

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 the manufacturer's written installation instructions, using sealants recommended by the manufacturer.

D. Support vents at intervals recommended by the manufacturer to support the weight of vents and all accessories, without exceeding appliance loading.

E. Lap joints in the direction of flow.

3.4 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes.

END OF SECTION 235123

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 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 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. Delegated-Design Submittal: For each boiler.

1. Design calculations and vibration isolation base details, signed and sealed by a qualified professional engineer.

    a. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
    b. 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. Seismic Qualification Data: Certificates, for boiler, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Source quality-control reports.

C. Field quality-control reports.

D. Sample Warranty: For special warranty.

E. Product Certificates:

1. ASME Stamp Certification and Report: Submit "A," "S," or "PP" stamp certificate of authorization, as required by authorities having jurisdiction, and document hydrostatic testing of piping external to the boiler.
2. CSA B51 pressure vessel Canadian Registration Number (CRN).

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For boilers to include in emergency, operation, and maintenance manuals.

1.6 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within the specified warranty period.

1. Warranty Period for Fire-Tube Condensing Boilers:

a. Leakage and Materials: 10 years from the date of Substantial Completion.
b. Heat Exchanger Damaged by Thermal Stress and Corrosion: Nonprorated for five 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 the 2023 ASME Boiler and Pressure Vessel Code.

C. ASHRAE/IES 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."

D. DOE Compliance: Minimum efficiency shall comply with 10 CFR 430, Subpart B, Appendix N.

E. UL Compliance: Test boilers for compliance with UL 795. Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

F. CSA Compliance: Test boilers for compliance with CSA B51.

G. Mounting Base: For securing the boiler to a concrete base.

1. Seismic Fabrication Requirements: Fabricate mounting base and attachment to boiler pressure vessel, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC" when the mounting base is anchored to building structure.

2.2 WATER JACKETED 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. Bosch Thermotechnology Corp.
3. Camus.
4. Cleaver-Brooks.
5. Fulton.
6. Lochinvar.

B. Description: Factory-fabricated, assembled, and tested, fire-tube 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. Water-heating service only.

C. Heat Exchanger: Stainless-steel primary and secondary combustion chamber.

D. Pressure Vessel: Carbon steel with welded heads and tube connections where not in contact with combustion or flue gases.

E. Burner: Natural gas, forced draft; swing-open front and burner observation port.

F. Blower: Centrifugal fan to operate during each burner firing sequence and to pre-purge and post-purge the combustion chamber.

1. Motors: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

a. Motor Sizes: Minimum size as indicated; if not indicated, large enough so the driven load will not require the motor to operate in a service factor range above 1.0.

G. Gas Train: Combination gas valve with manual shutoff and pressure regulator. Include a 100 percent safety shutoff with electronic flame supervision.

H. Ignition: Spark ignition with 100 percent main-valve shutoff with electronic flame supervision.

I. Casing:

1. Jacket: Sheet metal, with snap-in or interlocking closures.
2. Control Compartment Enclosures: NEMA 250, Type 1A.
3. Finish: Baked-enamel or Powder-coated protective finish.
4. Insulation: Minimum 4-inch-thick, mineral-fiber insulation surrounding the heat exchanger.
5. Combustion-Air Connections: Inlet and vent duct collars.

J. Capacities and Characteristics:
1. Refer to plans and schedules for capacities

2. Heat Retain "Minimum Efficiency AFUE," "Minimum Thermal Efficiency," or "Minimum Combustion Efficiency" Subparagraph below. Specify a standing or intermittent pilot with minimum AFUE. Sustainable design systems require compliance with ASHRAE/IES 90.1 and may require efficiency in excess of the minimum efficiency required by ASHRAE/IES 90.1.
3. Minimum Thermal Efficiency: 94.6 percent.
4. Minimum Combustion Efficiency: 97.1 percent.

2.3 TRIM

A. Include devices sized to comply with ASME B31.9.

B. Aquastat Controllers: Operating, firing rate, and high limit.

C. Safety (pressure) Relief Valve: ASME rated.

D. Pressure and Temperature Gage: Minimum 3-1/2-inch-diameter, combination water-pressure and temperature gage. Gages shall have operating-pressure and -temperature ranges, so the normal operating range is about 50 percent of the full range.

E. Boiler Air Vent: Automatic.

F. Drain Valve: Minimum NPS 3/4 hose-end drain valve.

G. Circulation Pump: Non-overloading, in-line pump with split-capacitor motor having thermal-overload protection and lubricated bearings; designed to operate at specified boiler pressures and temperatures.

H. Condensate neutralization and drain kit with marble chips.

I. BACNet MSTP communications card.

J. High and low gas pressure switches with manual reset.

K. Low water cut off with manual reset and test.

L. 30 PSI pressure relief

2.4 CONTROLS

A. Refer to Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC."

B. Boiler operating controls shall be direct digital and fully self-contained. The operating control panel shall be mounted on the boiler front panel and shall be fully installed and programmed with a factory-packed controller by the boiler manufacturer. The controller shall have an LCD screen for user or operator interface.

C. Boiler operating controls shall include the following devices and features:

1. Control transformer.
2. Set-Point Adjust: Set points shall be adjustable.
3. Operating Pressure Control: Factory wired and mounted to the cycle burner.
4. Low-Water Cutoff and Pump Control: Cycle feedwater pump(s) for makeup water control.

5. Sequence of Operation: Electric, factory-fabricated, and OR field-installed panel to control burner firing rate to reset supply-water temperature inversely with outside-air temperature. At 0 deg F outside-air temperature, set supply-water temperature at 180 deg F; at 50 deg F outside-air temperature, set supply-water temperature at 140 deg F.

a. Include an automatic, alternating-firing sequence for multiple boilers to ensure maximum system efficiency throughout the load range and to provide equal runtime for boilers.

D. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.

1. High Cutoff: Manual reset stops the burner if operating conditions rise above the maximum boiler design temperature.
2. Low-Water Cutoff Switch: (1) Electronic AND (1) Float and electronic probe shall prevent burner operation on low water. Cutoff switch shall be (1) manual AND (1) automatic-reset type.
3. Blocked Inlet Safety Switch: Manual-reset pressure switch field-mounted on boiler combustion-air inlet.
4. Audible Alarm: Factory mounted on the control panel with a silence switch; shall sound alarm for the above conditions.

E. Building Automation System Interface: Factory install hardware and software to enable the 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. The communication interface with the building automation system shall enable the building automation system operator to remotely control and monitor the boiler from an operator workstation. Control features available, and monitoring points displayed locally at the boiler control panel, shall be available through the building automation system.

2.5 ELECTRICAL POWER

A. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in electrical Sections.

B. Single-Point Field Power Connection: Factory-installed and wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to the boiler.

1. House in NEMA 250, Type 1 enclosure.
2. Wiring shall be numbered and color-coded to match the wiring diagram.
3. Install factory wiring outside of an enclosure in a metal raceway.
4. Field power interface shall be to a nonfused disconnect switch.
5. Provide a branch power circuit to each motor and to controls with a disconnect switch. Provide each motor with overcurrent protection.

2.6 VENTING KITS

A. Provide full boiler venting and OAI ducting. Refer to Section 235123 "Gas Vents." For full requirements. The following paragraphs are the minimum requirements.

B. ASTM A 959, Type 29-4C stainless steel, pipe, vent terminal, thimble, indoor plate, vent adapter, condensate trap, dilution tank, and sealant.
   1. Provide all specialty fittings, including offsets, elbows, roof thimble, wall thimble screens, and caps from boiler flue to termination point outdoors. Refer to the plans for duct arrangement. Boiler vent piping shall be double-walled with 2” of insulation and an aluminum jacket. Vertical vent piping located inside existing masonry chimneys shall be single-walled.

C. Combustion-Air Intake: Complete system, stainless steel pipe, vent terminal with screen, inlet air coupling, and sealant.
   1. Provide all specialty fittings, including offsets, elbows, and screens for CA intake from boiler to OAI louver or termination point outdoors. Refer to the plans for duct arrangement.

2.7 SOURCE QUALITY CONTROL

A. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.

B. Test and inspect factory-assembled boilers before shipping, according to the 2010 ASME Boiler and Pressure Vessel Code.

C. Allow Owner access to source quality-control testing of boilers. Notify the engineer 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 boilers on cast-in-place concrete housekeeping pads. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete," and Section 033053 "Miscellaneous Cast-in-Place Concrete." Concrete housekeeping pads shall be 5 ½" high and extend 6" longer on all sides than the mountings and shall have 45° chamfered edges.
   a. Pumps located above the lowest level (or when the lowest level is above grade) of the building shall be mounted on spring isolation inertia bases.
   b. Grout between the boiler base and the house keep pad.

B. Install gas-fired boilers according to NFPA 54.

C. Assemble and install boiler trim.

D. Install electrical devices furnished with the boiler but not specified to be factory-mounted.

E. Install control wiring to field-mounted electrical devices.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate the general arrangement of piping, fittings, and specialties. Install all piping in accordance with manufactures recommendations.

B. Install piping adjacent to the boiler to allow service and maintenance.

C. Install piping from the acid neutralizing device/equipment drain connection to discharge indirectly to the nearest floor drain. Piping shall be at least the full size of the connection. Provide an isolation valve if required by the manufacturer. Drain piping shall be PVC.

D. Connect piping to boilers, except safety relief valve connections, with flexible connectors of materials suitable for service. Flexible connectors and their installation are specified in Section 232116 "Hydronic Piping Specialties."

E. Safety relief valves shall be hard piped, with the full size of the relief valve outlet. Pipe down to within 18" of the floor or to the nearest floor drain. Discharge at the floor drain shall be an indirect connection.

F. Connect gas piping to boiler gas-train inlet with a union and shut-off valve. Piping shall be at least the full size of the gas-train connection. Provide a reducer if required. Provide a plug valve for shut off and a 6" drip leg.

G. Connect hot-water piping to supply and return boiler tappings with a shutoff valve and union or flange at each connection.

H. Install piping from safety valves to the drip-pan elbow and to the nearest floor drain.

I. Boiler Venting:

1. Install flue venting kit and combustion-air intake.
2. Connect full-size to boiler connections. Comply with requirements in Section 235123 "Gas Vents."

J. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

K. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

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

1. Perform installation and startup checks according to the 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 the air-fuel ratio and combustion.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

    a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level, and water temperature.
    b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

D. Boiler will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

F. Occupancy Adjustments: When requested within 12 months of the date of Substantial Completion, provide on-site assistance in adjusting the system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

G. Performance Tests:

1. Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
2. Boilers shall comply with the performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment to comply.
3. Perform field performance tests to determine the capacity and efficiency of boilers.

    a. Test for full capacity.
    b. Test for boiler efficiency at low fire 20, 40, 60, 80, 100, 80, 60, 40, and 20 percent of full capacity. Determine efficiency at each test point.

4. Repeat tests until results comply with the requirements indicated.
5. Provide the analysis equipment required to determine performance.
6. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are inadequate.
7. Notify the engineer 48 hours minimum in advance of test dates.
8. Document test results in a report and submit to the engineer.

3.5 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain boilers. Refer to Section 017900 "Demonstration and Training."

END OF SECTION 235216

SECTION 236200 - PACKAGED COMPRESSOR AND CONDENSER 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 packaged, refrigerant compressor and condenser units.

1.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Compressor and condenser units shall withstand the effects of earthquake motions determined according to ASCE/SEI 7

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

1.4 ACTION SUBMITTALS

A. Product Data: For each compressor and condenser unit. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include equipment dimensions, weights and structural loads, required clearances, method of field assembly, components, and location and size of each field connection.

B. Sustainable Design Submittals:

1. Product Data: For energy performance.
2. Product Data for EA Prerequisite "Fundamental Refrigerant Management": For refrigerants, indicating compliance with refrigerant management practices.

C. Shop Drawings: For compressor and condenser units. Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: For power, signal, and control wiring.

D. Delegated-Design Submittal: For compressor and condenser units 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. 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.
2. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Structural members to which compressor and condenser units will be attached.
2. Liquid and vapor pipe sizes.
3. Refrigerant specialties.
4. Piping including connections, oil traps, and double risers.
5. Compressors.
6. Evaporators.

B. Seismic Qualification Certification: For compressor and condenser units, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

D. Warranty: Sample of special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For compressor and condenser units to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Fabricate and label refrigeration system according to ASHRAE 15, "Safety Standard for Refrigeration Systems."

C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6, "Heating, Ventilating, and Air-Conditioning."

D. ASME Compliance: Fabricate and label water-cooled compressor and condenser units to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

1.8 COORDINATION

A. Coordinate sizes and locations of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Section 033000 "Cast-In-Place Concrete" and Section 033053 "Miscellaneous Cast-In-Place Concrete."

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 077200 "Roof Accessories."

C. Coordinate location of piping and electrical rough-ins.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of compressor and condenser units that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Compressor failure.
b. Condenser coil leak.

2. Warranty Period: Five years from date of Substantial Completion all parts.

PART 2 - PRODUCTS

2.1 COMPRESSOR AND CONDENSER UNITS, AIR COOLED, 1 TO 5 TONS

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

1. Carrier Corporation; a unit of United Technologies Corp.
2. Johnsons Controls
3. Daikin
4. Aaon

B. Description: Factory assembled and tested; consisting of compressor, condenser coil, fan, motors, refrigerant reservoir, and operating controls.

C. Compressor: Scroll, hermetically sealed, with rubber vibration isolators.

1. Motor: Two speed, and includes thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
2. Two-Speed Compressor: Include manual-reset, high-pressure switch and automatic-reset, low-pressure switch.
3. Accumulator: Suction tube.

D. Refrigerant: R-410A.

E. Condenser Coil: Seamless copper-tube, aluminum-fin coil; circuited for integral liquid subcooler, with removable drain pan and brass service valves with service ports.

F. Condenser Fan: Direct-drive, aluminum propeller fan; with permanently lubricated, totally enclosed fan motor with thermal-overload protection.

G. Accessories:
1. Cycle Protector: Automatic-reset timer to prevent rapid compressor cycling.
2. Evaporator Freeze Thermostat: Temperature-actuated switch that stops unit when evaporator reaches freezing temperature.
3. Filter-dryer.
4. High-Pressure Switch: Automatic-reset switch cycles compressor off on high refrigerant pressure.
5. Liquid-line solenoid.
6. Low-Ambient Controller: Cycles condenser fan to permit operation down to 0 deg F. (supplemental units only)
7. Low-Pressure Switch: Automatic-reset switch cycles compressor off on low refrigerant pressure.
8. PE mounting base.
9. Precharged and insulated suction and liquid tubing.
10. Sound Hood: Wraps around sound attenuation cover for compressor. (AC-1 AND AC-2)
11. Thermostatic expansion valve.
12. Reversing valve.

H. Unit Casing: Galvanized steel, finished with baked enamel; with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Mount service valves, fittings, and gage ports on exterior of casing.

I. Capacities and Characteristics:

1. Refer to schedules:

2.2 COMPRESSOR AND CONDENSER UNITS, AIR COOLED, 6 TO 120 TONS

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

1. Carrier Corporation; a unit of United Technologies Corp.

2. Johnsons Controls
3. Daikin
4. Aaon
5. ADDISON

B. Description: Factory assembled and tested, air cooled; consisting of casing, compressors, condenser coils, condenser fans and motors, and unit controls.

C. Compressor: Hermetic scroll compressor designed for service with crankcase sight glass, crankcase heater, and back-seating service access valves on suction and discharge ports.

1. Capacity Control: Hot-gas bypass.

D. Compressor: Hermetic or semi-hermetic rotary screw compressor designed for service with crankcase sight glass, crankcase heater, and back-seating service access valves on suction and discharge ports.

1. Capacity Control: Variable-frequency controller or Hot-gas bypass.

E. Refrigerant: R-410A.

F. Condenser Coil: Seamless copper-tube, aluminum-fin coil, including subcooling circuit and back-seating liquid-line service access valve. Factory pressure test coils, then dehydrate by drawing a vacuum and fill with a holding charge of nitrogen or refrigerant.

G. Condenser Fans: Propeller-type vertical discharge; either directly or belt driven. Include the following:

1. Permanently lubricated, ball-bearing totally enclosed motors.
2. Separate motor for each fan.
3. Dynamically and statically balanced fan assemblies.

H. Operating and safety controls include the following:

1. Manual-reset, high-pressure cutout switches.
2. Automatic-reset, low-pressure cutout switches.
3. Low-oil-pressure cutout switch.
4. Compressor-winding thermostat cutout switch.
5. Three-leg, compressor-overload protection.
6. Control transformer.
7. Magnetic contactors for compressor and condenser fan motors.
8. Timer to prevent excessive compressor cycling.

I. Accessories:
1. Gage Panel: Package with refrigerant circuit suction and discharge gages.
2. Hot-gas bypass kit.
3. Part-winding-start timing relay, circuit breakers, and contactors.

J. Unit Casings: Designed for outdoor installation with weather protection for components and controls and with removable panels for required access to compressors, controls, condenser fans, motors, and drives. Additional features include the following:

1. Steel, galvanized or zinc coated, for exposed casing surfaces; treated and finished with manufacturer's standard paint coating.
2. Perimeter base rail with forklift slots and lifting holes to facilitate rigging.
3. Gasketed control panel door.
4. Nonfused disconnect switch, factory mounted and wired, for single external electrical power connection.
5. Condenser coil grille.

K. Capacities and Characteristics: Refer to Schedule

2.3 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2.4 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate compressor and condenser units according to ARI 206/110 ARI 306/110.

B. Energy Efficiency: Equal to or greater than prescribed by ASHRAE/IESNA 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings," Section 6, "Heating, Ventilating, and Air-Conditioning."

C. Test and inspect shell and tube condensers according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

D. Testing Requirements: Factory test sound-power-level ratings according to ARI 270.

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 compressor and condenser units.

B. Examine roughing-in for refrigerant piping systems to verify actual locations of piping connections before equipment installation.

C. Examine walls, floors, and roofs for suitable conditions where compressor and condenser units will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install units level and plumb, firmly anchored in locations indicated.

B. Install roof-mounting units on equipment supports specified in Section 077200 "Roof Accessories."

C. Equipment Mounting:

1. Condensing units installed on grade shall be installed on a concreate housekeeping pad 3 ½” thick and 6” longer and wider than unit mounts. Set pad level, slope soil away from pad. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

2. Condensing units installed on steel dunnage or roof curbs shall be installed on neoprene pads between the unit frame and the dunnage. Fasten condensing unit to dunnage of curb galvanized steel fasteners. Set units level with shims. Vibration isolators shall be mason industries model MBSW or super WSW.

D. Maintain manufacturer's recommended clearances for service and maintenance.

E. Loose Components: Install electrical components, devices, and accessories that are not factory mounted.

3.3 CONNECTIONS

A. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

B. Connect pre-charged refrigerant tubing to unit's quick-connect fittings. Install tubing so it does not interfere with access to unit. Install furnished accessories.

C. Connect refrigerant piping to air-cooled compressor and condenser units; maintain required access to unit. Install furnished field-mounted accessories. Refrigerant piping and specialties are specified in Section 232300 "Refrigerant Piping."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test. Certify compliance with test parameters.
2. Leak Test: After installation, charge system with refrigerant and oil and test for leaks. Repair leaks, replace lost refrigerant and oil, and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor operation and unit operation, product capability, and compliance with requirements.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
5. Verify proper airflow over coils.

C. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.

D. Compressor and condenser units will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.5 STARTUP SERVICE

1. Complete installation and startup checks according to manufacturer's written instructions and perform the following:

a. Inspect for physical damage to unit casing.
b. Verify that access doors move freely and are weathertight.
c. Clean units and inspect for construction debris.
d. Verify that all bolts and screws are tight.
e. Adjust vibration isolation and flexible connections.
f. Verify that controls are connected and operational.

B. Lubricate bearings on fan motors.

C. Verify that fan wheel is rotating in the correct direction and is not vibrating or binding.

D. Start unit according to manufacturer's written instructions and complete manufacturer's startup checklist.

E. Measure and record airflow and air temperature rise over coils.

F. Verify proper operation of condenser capacity control device.

G. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.

H. After startup and performance test, lubricate bearings.

3.6 DEMONSTRATION

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

END OF SECTION 236200

SECTION 236611 - PACKAGED OUTDOOR AIR TO WATER HEAT PUMP 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 design, performance criteria, refrigerants, controls, and installation requirements for a fully inverter air-cooled scroll heat pump chiller. The packaged heat pump shall be provided as specified on the drawings. The packaged heat pump shall meet the standards referenced in this specification and meet all local codes in effect.

1.3 ACTION SUBMITTALS

A. Submit shops drawings and product data in accordance with the specifications.

B. Submittals shall include the following:
   1. Total Model Selection Summary for the chiller.
   2. Combined System Performance Information (certification is not in scope of AHRI 550-590):
      a) Ambient Temperature Cooling and Heating (°F)
      b) Cooling and Heating Capacity (Ton and MBH)
      c) Power for Cooling and Heating (kW)
      d) EER and COP (Btu/Whr and W/W)
      e) NPLV (Cooling Only Btu/Whr)
      f) Water Temperature Cooling and Heating (in/out °F)
      g) Fluid Flow Rate Cooling and Heating (GPM)
      h) Pressure Drop Cooling and Heating (ftAq)
   3. Individual Chiller Specifications to include:
      a) Dimensions (width, height, and length)
      b) Weight (lb.)
      c) Refrigerant Type, # of circuits and amount required per circuit.
      d) Sound Data in accordance with AHRI Standard 370-2015
         i. Sound Power Cooling and Heating
         ii. Sound Pressure Cooling and Heating (5 feet and 30 feet)
      e) Compressor Type and Quantity
      f) Oil Type and Oil Charge (oz)

g) Evaporator Type, Flow Rate Cooling and Heating, Connection (Size/ Type) and Pressure Drop (ftAq)
h) Fan Motor Type, Flow (CFM) and Power (W)

4. Dimensioned plan and elevation view drawings and location water connections size and type.
5. Electrical Specifications to include Model, Voltage, Phase, Maximum Fuse Amps (MFA) or Maximum Circuit Breaker Amps, Minimum Circuit Amps (MCA), Running Load Amps (RLA), Minimum Start Current (MSC) and Quantity of Independent Circuits.
6. Enhance Sound Information for Cooling and Heating tested in accordance with AHRI Standard 370-2015 (data based on individual unit installation). Sound Pressure Values shall be provided based on Q=2 (180 degree) profile using formula: Lp =Lw – 10 log [Q / ($4\pi^2$)]
7. In the Heating mode only 100% overall data is to be provided.
8. Single-line schematic diagram of line voltage and control system indicating points for field interface/connection.
9. AHRI 550-590 Cooling Performance Data Page to include:
    a) Unit information
        i. Model
        ii. Power Supply (phase, # of wires and volts)
        iii. Refrigerant Type
        iv. Cooling Capacity (Ton)
        v. Quantity of Compressors
        vi. Dimensions (length inch, height inch and width inch)
        vii. Operating Weight (lb)
        viii. Shipping Weight (lb)
        ix. Refrigerant Charge (lb)
        x. Sound Pressure (AHRI Standard 370-2015 5 Feet and 30 Feet)
    b) Cooling Performance Data
        i. System KW (W/O Pump)
        ii. EER (Btu/Whr)
        iii. Full Load Power Input per Ton (kW/usRT)
        iv. NPLV (Btu/Whr)
        v. 100% EER (Btu/Whr)
        vi. 75% EER (Btu/Whr)
        vii. 50% EER (Btu/Whr)
        viii. 25% EER (Btu/Whr)
    c) Evaporator Data
        i. Heat Exchanger Structure
        ii. Fluid Type and % of Glycol
        iii. Water Connection (Size and Type)
        iv. Fouling Factor (h·ft²·°F/Btu)
        v. Entering Water Temp (°F)

vi. Leaving Water Temp (°F)
vii. Flow-rate (GPM)
viii. Pressure Drop (ftAq)

d) Condenser Data
i. Heat Exchanger Structure
ii. Refrigerant Type
iii. Altitude (ft above sea level)
iv. Number of Fans
v. Total Air Flow Each (CFM)
vi. Entering Air Temperature (DBT °F)

10. Heating Performance (Tested in accordance with AHRI 550-590 Procedure- not in certification scope of standard)
a) Unit information
i. Model
ii. Power Supply (phase, # of wires and volts)
iii. Refrigerant Type
iv. Heating Capacity (MBH)
v. Quantity of Compressors
vi. Dimensions (length inch, height inch and width inch)
vii. Operating Weight (lb.)
viii. Shipping Weight (lb.)
ix. Refrigerant Charge (lb.)
x. Sound Pressure (AHRI Standard 370-2015 5 Feet and 30 Feet)

b) Heating Performance Data
i. System KW (W/O Pump)
ii. COP (W/W)

c) Evaporator Data
i. Heat Exchanger Structure
ii. Fluid Type and % of Glycol
iii. Water Connection (Size and Type)
iv. Fouling Factor ($h \cdot ft^2 \cdot °F/Btu$)
v. Entering Water Temp (°F)
vi. Leaving Water Temp (°F)
vii. Flow-rate (GPM)
viii. Pressure Drop (ftAq)

d) Condenser Data
i. Heat Exchanger Structure
ii. Refrigerant Type
iii. Altitude (ft above sea level)
iv. Number of Fans
v. Total Air Flow Each (CFM)
vi. Entering Air Temperature (DBT °F)

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Structural members to which compressor and condenser units will be attached.
2. Liquid and vapor pipe sizes.
3. Refrigerant specialties.
4. Piping including connections, oil traps, and double risers.
5. Compressors.
6. Evaporators.

B. Field quality-control reports.

C. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For compressor and condenser units to include in emergency, operation, and maintenance manuals.

B. Spare Parts List: Recommended spare parts list with quantity for each.

C. Touchup Paint Description: Detailed description of paint used in application of finish coat to allow for procurement of a matching paint.

D. Instructional Videos: Including those that are prerecorded and those that are recorded during training.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Fabricate and label refrigeration system according to ASHRAE 15, "Safety Standard for Refrigeration Systems."

C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6, "Heating, Ventilating, and Air-Conditioning."

1.7 COORDINATION

A. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 077200 "Roof Accessories."

B. Coordinate location of piping and electrical rough-ins.

1.8 WARRANTY

A. One-Year Parts Only Limited Warranty for a Qualified Product: Part(s), including the compressor, are warranted for a period of twelve (12) months starting on the date of initial start-up, or if the start-up date is not available, the Limited Warranty Period will begin twelve (12) months from the date of manufacture (the “Standard Parts Limited Warranty Period”).

B. Standard Additional Two (2) Year Compressor Limited Part Only Warranty: The compressor is to be warranted for an additional two (2) year period after the end of the applicable Standard Parts Limited Warranty Period (the “Compressor Limited Warranty Period”).

C. The limited parts only warranty period, including all parts and the compressor, shall be extended to a total of (60) months by the purchase of additional warranty period increments, which shall be purchased at the time of the original chiller equipment purchase.

PART 2 - PRODUCTS

2.1 INVERTER SCROLL HEAT PUMP CHILLER

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

1. LG
2. York
3. Multistack
4. Carrier

B. Provide and install as detailed on plans Factory-assembled, single-piece air-cooled variable refrigerant flow liquid heat pump chiller(s) in the quantity required. Contained within the unit cabinet shall be all factory wiring, piping, controls, refrigerant charge (R32), and special features prior to field start up.

C. The heat pump chiller shall be functionally evaluated at the factory to ensure components including sensors, wiring, electronics, and microprocessor controls operate properly per the needed value and function.

D. Chiller shall be reverse cycle air cooled heat pump and provide both hot and cold water. Remote mode change, start stop, leaving water set point, demand limiting, and remote trouble stop hard wire contacts shall be provided as standard.

E. Each outdoor unit refrigeration circuit shall include, but not limited to the following components:
1. Refrigerant strainer(s)
2. Check valve(s)

3. Inverter driven, medium pressure vapor injection, high pressure shell compressors.
4. Oil separator(s)
5. Accumulator /controlled volume receiver(s)
6. 4-way reversing valve(s)
7. Vapor injection valve(s)
8. Oil Level sensor(s)
9. Electronic expansion valve(s)
10. Sub-cooler (s)
11. Vapor Injection Valve(s)
12. High and low side Schrader valve service ports with caps
13. Shared brazed plate water to refrigerant heat exchanger with (4) refrigerant connections and (2) water connections, 316 stainless steel construction with (2) refrigerant circuits and a single water circuit, heat exchanger refrigerant circuits shall be rated to 650 PSIG, water circuit rated to 340 PSIG.

F. Capacities and Characteristics:

1. Refer to schedules:

2.2 HEAT PUMP CHILLER COMPONENTS

A. MATERIALS OF CONSTRUCTION

1. Chiller shall be capable of capturing all condenser water created in the heating mode with water collected in drain pans with condensate lines attached that exit the bottom of the chiller allowing for proper collection and drainage if desired or required by local code.
2. The casing shall be constructed so that it is easy to disassemble and assemble during maintenance/repair. It shall be insulated to prevent condensation, and structurally sound to prevent vibration and/or abnormal noise.
3. Exterior panels shall have an epoxy coat with a salt spray rating of up to 500 hours.

B. COMPRESSOR/COMPRESSOR COMPONENTS AND SEQUENCE OF OPERATION

1. The R32 Compressor shall be a hermetic, high-side shell (HSS), commercial grade, compliant scroll direct-drive design. The compressor shall be designed and assembled by the INVERTER chiller-heat pump manufacturer specifically for use in the air source INVERTER chiller-heat pump product line. Third party manufactured, branded, or designed to the INVERTER chiller-heat pump system's OEM specifications by a third-party manufacturer shall not be acceptable.
2. Compressor Design: The compressor design shall be of the high-pressure shell scroll type where the internal pressure below the scroll plates of the compressor shall be at the same high pressure and high temperature. The motor shall be cooled by high pressure gas at temperatures above saturation conditions and minimize the mixing of refrigerant liquid with oil in the sump. The system shall employ a high-pressure oil return method returning recovered oil from the oil separator directly into the oil sump of the compressor; oil shall not be allowed to

return via the suction line. Bearing surfaces are continually coated with oil. The compressor shall employ an Aero-bearing constructed with high lubricity materials increasing operation time in case of low sump oil level. The fixed and oscillating compressor scroll components shall be made of high grade (GC25) or denser steel material. All scrolls shall be heat treated and tempered. The oscillating scroll shall be finely machined and polished. PVE refrigerant oil shall be used as the sole liquid used to maintain a seal between the high and low sides of the compression chamber. Compressors that require any mechanical or wearable sealant material between the moving surfaces of the compression chamber are NOT ACCEPTABLE.

3. Single frame systems will have 2 inverter compressors, Double Frame systems will have 4 inverter compressors and Triple Frame systems will have 6 compressors. Each compressor has a nominal capacity of 10 tons.
4. Each refrigeration circuit shall employ a single inverter compressor with a maximum refrigerant charge not to exceed 10.4 lbs.
5. All compressors shall employ high pressure oil return directly into the compressor oil sump. Oil-return via the suction line shall not be permitted.
6. All compressors shall provide, during off cycle, a trickle charge to the windings to keep oil warm. External crankcase heaters shall not be permitted.
7. All inverter-driven compressors within a frame are to operate in unison at the same level. Staging of compressors shall not be permitted within a frame.
8. Compressor shall soft start via inverter and shall load only to the required load. Compressors start current for 208-230V the minimum start current shall not exceed 25% of MCA and the 460V the minimum start current shall not exceed 20% of MCA.
9. The system design is to have a shared evaporator between 2 compressors. System is designed to run on any active compressor that is not offline from an error code. External human interface shall not be acceptable if required for emergency operation. Compressor Error messages are available from Main PCB for BMS interface. Local HMI or Chiller Control shall also keep record of compressor error codes as a redundant feature.
10. Vibration prevention isolation rubber grommets shall be installed to isolate compressor from base frame.
11. Inverter Compressor Control and Sequence: Each compressor shall be equipped with a dedicated inverter compressor drive. The control of multiple compressors using a single drive shall not be acceptable. The frequency variable boundary of inverter scroll compressor shall be minimum 30Hz and maximum 127Hz. The inverter driver controller shall be matched with the physical properties of the compressor. The drive shall be manufactured by the INVERTER chiller-heat pump unit manufacturer. The inverter drive and matching compressor shall have been thoroughly evaluated as a matched pair. The inverter drive shall be programmed to avoid operating the compressor at any speed that results in harmonic vibration, nuisance noise, or mechanical damage to either the driver or the compressor with power provided that is within the tolerance specification. The compressor inverter drive assembly and software must be designed, manufactured, and supplied by the INVERTER chiller-heat pump product manufacturer. Third party branded inverter driver hardware and/or driver software or inverter driver hardware and/or software provided by a third-party manufacturer to meet OEM specifications shall not be allowed. All inverter drive hardware or software manufactured in, is a

product of, or sourced from China, or using a broker or third-party provider as an intermediary that obtains the product from CHINA shall not be acceptable.

12. Hot Gas Bypass: Includes factory-mounted hot gas bypass valve, solenoid valve, for each circuit.
13. Inverter Compressor Refrigerant Flow Control Requirements: An active refrigerant -in-circulation control system consisting of a refrigerant storage container, interconnecting refrigerant piping control valves, pressure transducers, microprocessor control, and software to continuously monitor necessary refrigeration cycle operating parameters to maintain stable cycle operation between minus (-)22°F and 125°F ambient conditions. The refrigerant system operating conditions shall be checked by the algorithm at three-minute intervals and if needed automatically and dynamically remove and store refrigerant to the storage tank or inject refrigerant from the tank into the refrigerant circuit. The algorithm shall adjust the needed refrigerant with input:
    a. As the outdoor air temperature changes.
    b. System mode of operation changes.
    c. The path of refrigerant flow through the outdoor coil is modified.
    d. The system's target suction and head pressure control values are adjusted.
14. Maximum Hz operation shall be set at local control or external connection to Unit Main PCB. When reduced capacity and or load shedding is desired.
15. In an event of low load application, below 20% of full rated capacity, an alternating operation should allow for uniform average operation time for each compressor.
16. Oil Management: The system shall utilize a high-pressure oil return system to ensure a consistent film of oil on all moving compressor parts at all points of operation. Oil is returned to compressor through a separate high pressure oil injection pipe directly into the oil sump. Oil returned to the compressor via the suction port of the compressor shall not be allowed. Each compressor shall be provided with a high efficiency independent centrifugal cyclone type oil separator, designed to extract oil from the oil/refrigerant gas stream leaving the compressor. The system shall have an oil level sensor in the compressor to provide direct oil level sensing data to the main controller. The sensor shall provide data to main outdoor unit PCB to start oil return mode. The system shall only initiate an oil return cycle if the sensed oil level is below oil level target values as determined by the microprocessor. The system shall display an error if the oil sensor signals low oil level for a period of 130 minutes or longer. A default oil return algorithm shall automatically initiate the oil return mode if the system detects a failure of the oil sump sensor. A fault code shall be reported by the system. Timed oil return operations or systems that do not directly monitor compressor oil level shall not be permitted.
17. Vapor Injection Requirement and Description: System shall have a medium pressure gas vapor injection function employed in the heating and cooling modes to increase system capacity when the outdoor ambient temperatures are low and to lower compressor lift when temperatures are high. The compressor vapor injection flow amount shall be controlled by the vapor injection sub-cooling algorithm reset by discharge gas temperatures of the compressor. Pressure differential design shall draw oil from the compressor sump reservoir, pressurize the oil and inject the oil directly to the crankshaft journals maintaining a consistent film of oil between all moving parts. Auxiliary, indirect, or electronically driven oil pumps are not acceptable. The viscosity property of the PVE oil in the compressor

sump shall be maintained regardless of compressor operation and the surrounding ambient temperature. The compressor shall be equipped with control to automatically supply the compressor windings with a trickle charge of electricity enough to maintain the oil temperature above the refrigerant boiling temperature that is automatically activated only when the ambient temperature is below 40F, and the compressor is not running. The addition of external crank case heaters shall not be allowed. Low side shell (LSS) type compressors that use suction vapor to cool the compressor motor shall not be allowed.

18. Vapor Injection Sub-cooler: Each compressor circuit shall a factory provided and mounted sub-cooler assembly consisting of a brazed plate type sub-cooling heat exchanger and EEV providing refrigerant sub-cooling modulation control by fuzzy logic of EEV and by mode of operation to provide capacity and efficiency as required. Brazed plate shell & tube heat exchangers shall not be allowed for this function.
19. Internal Compressor Cooling Requirements and Description: The motor winding insulation shall be designed to operate continuously at a minimum temperature of 180°F without deterioration. The motor cooling system shall be designed to always maintain an acceptable operational temperature and, in all conditions, using high pressure, hot refrigerant vapor as motor coolant. Low side shell (LSS) and compressors that use low pressure, low temperature refrigerant gas to cool the motor shall not be allowed.
20. Active Refrigerant Volume Management: The INVERTER chiller-heat pump system shall be able to operate at all published conditions in cooling or heating mode without the need to add or remove refrigerant from the system. The air source unit shall be provided with an isolated vessel, interconnecting piping, valves, and sensors to store refrigerant and actively pass refrigerant to (or from) the refrigerant circuit in real time as necessary to maintain stable refrigeration cycle operation. The air source unit microprocessor shall be provided with an algorithm that monitors the INVERTER chiller-heat pump system head pressure, suction pressure, sub-cooling, superheat, compressor speed, high and low side temperatures, chilled water temperatures, hot water temperatures, status of water flow and the load on the system at three minute intervals and if needed, automatically and dynamically remove and store refrigerant to the storage tank or inject refrigerant from the tank into the refrigerant circuit. INVERTER chiller-heat pump systems that cannot perform active refrigerant control are not acceptable.
21. Compressors are designed to operate independently. Unless the error code interrupts control power the error of compressor will be broadcasted to BMS front end, and the remaining compressors normal operation is not interrupted.
22. SCCR: Short Circuit Current Rating for the heat pump chiller shall be 56 kA at 208V, 62 kA at 230V and 65 kA at 460V. All kA (kilo Amperes) values are tested and provided as RMS (root mean square) symmetrical current values.

C. FLUID HEAT EXCHANGERS
1. The fluid heat exchanger shall be a 316 stainless-steel plate and frame type heat exchanger.
2. As standard, the fluid heat exchanger shell and fluid piping in the heat pump chiller shall be insulated with rigid poly styrene, 1 1/4” thickness and black color.

3. The maximum volume per independent refrigerant circuit shall not exceed .25 cubic ft. feet of volume.
4. The maximum number of water to refrigerant circuits shall not exceed a single water circuit and two independent refrigerant circuits as a 1 to 2 ratio per the internal design of the heat exchanger.

D. AIR COOLED HEAT EXCHANGER

1. The air-cooled heat exchange arrangement shall be 3-row, 14 FPI (fins per inch), 48 rows. Use wide louvered aluminum fin. The coil(s) shall be sized to provide full heat rejection at a maximum 125°F or -22F minimum ambient temperature for 460V chiller heat pumps and 122°F or -22F for 208-230V chiller heat pumps both at sea level.
2. The coil(s) shall be factory tested to a minimum 600 psig.
3. Air Cooled heat exchanger shall include “black fin II” coating, a heavy anti-corrosion treatment protecting the heat exchanger from high salinity, humidity, and pollution. The coating is applied to the fin stock only and the corrosion performance is compliant to meet a 10,000-hour rated salt spray performance test that is conducted in accordance with ASTM B117 standard.
4. ISO 21207 Salt Spray Test Method B – 10,000 hours performance compliant.
5. ASTM B-117 Acid Salt Test – 900 hours performance compliant.
6. The Black Fin II coating shall be certified by Underwriters Laboratories and per ISO 21207.
7. Air Cooled heat exchanger shall be used with 99.9% purity or above phosphorus deoxidized copper without joint and it shall be constructed with Pre-Coated Aluminum fins that are mechanically bonded to increase the thermal transfer surface area. (Cross fin and tube type).
8. Fan(s) shall be connected directly to driving motor. Motor shall be BLDC type that can increase efficiency. The fan motors shall vary speed to maintain refrigeration head pressure.
9. Fan design at rated cooling capacity shall not exceed 90% of full or maximum RPM/Hz.
10. The system is capable of low noise operation and can reduce sound by up to 3 db.

E. ELECTRONIC EXPANSION VALVES

1. EEV’s shall be used during the adiabatic-expansion process within the refrigerant cycle to expand high pressure liquid refrigerant at both the Air-cooled heat exchanger and the fluid heat exchanger exit thereby converting to low temperature/low pressure state.
2. LEV’s (linear expansion valves) shall be activated to adjust refrigerant amount according to fluid heat exchanger load during cooling operation.
3. Based on data from various sensors installed in the chiller heat pump, the microprocessor shall be able to analyze the operation status of the system and compressor shall control the optimum refrigerant amount linearly.
4. By applying electric pulse signal (up to 2,000 pulses) to the stepping motor, it shall be able to adjust refrigerant flow and superheat and sub-cooling.

F. CONTROL SYSTEM

1. Controller shall operate to control the overall system at optimal condition with a micro-computer unit installed in the chiller heat pump, and be able to control electronic expansion valve and inverter driven compressor(s) based on the 4 measured values: suction gas pressure, discharge gas pressure, discharge gas temperature, and heat exchanger refrigerant temperature
2. Control system shall include sensor(s) functionality connected to the heat pump chiller and the varying operation mode status.
3. Heat Pump Chiller shall be equipped with self-protection devices and system protection functionality.
4. Internal flow switch is included as standard, installed, and wired.
5. External contact closure indicating pump operation is required and is to be hard wired to heat pump chiller main PCB.
6. Continued heat operation during defrost is required on systems that are at or above 33 tons or double and triple frame modules.
7. Target Evaporator temperature is set based on leaving water temperature allowing for energy savings as leaving water temps settings can change with the application and time of day.
8. If the unit is off and not running due to error the service tool provided by the manufacturer shall be capable of downloading the last 180 seconds of operational time the chiller was running, helping to diagnose field service issues that may arise.

G. HEAT PUMP CHILLER UNIT CONTROLLER AND DISPLAY (HMI- HUMAN MACHINE INTERFACE)

1. The HMI control interface can be applied for simple product control. Relocation & re-installation of HMI controller shall be possible.
2. The HMI may be relocated up to 1500 wire feet away from chiller heat pump.
3. Black box function shall retain the last 180 seconds of operational data prior to a failure.
4. Scheduled operation shall be possible via the HMI.
5. High ambient control box for operation in ambient temperatures to 125°F (52°C).
6. The controller shall be equipped with a cycle indication display to directly monitor refrigerant pressure conditions for refrigerant cycle and high-pressure gas safety management.
7. Chiller heat pump optional interface controller/HMI shall be capable of networking up to 5 chiller heat pump modules and control & monitor up to five (5) chiller heat pumps as one system if desired. For systems larger than five modules parallel networks of up to 99 modules may be installed and controlled via BMS.
8. Optional Heat Pump Chiller Control BACnet Gateway. The Control Gateway shall include Niagara4.7 or later based hardware, with a minimum 512 MB DDR SDRAM, 2GB total eMMC flash storage with user space set at 1GB, 1 RS485 port, 2 10/100 MB Ethernet ports, with BACnet and Modbus network protocol capability. Standard interface is BACnet/IP. BACnet/MSTP is an optional solution and should be specified if needed.

H. WATER PIPING AND FLOW REQUIREMENTS:

1. The heat pump chiller is to be capable of a minimum flow is at a 20-degree delta between entering and leaving water and maximum flow capable of a 4-degree delta between entering and leaving water temperatures.
2. The heat pump chiller is provided with a factory installed flow switch that is prewired as a required safety circuit for operation.
3. A strainer (50 Mesh or above) shall be provided, by others, and installed in the supply fluid piping to each module to prevent solid bodies or particles from entering the fluid heat exchanger. Strainer shall be installed on leveled pipe and shall be serviceable by individual manual isolation valves, by others permitting each strainer to be removed and allowing the remaining modules to continue to operate.
4. Flexible joints shall be installed at the inlet and outlet pipes of each module.
5. Fluid piping and needed insulation shall be properly specified by the engineer and be compliant per local code for both process and comfort cooling applications.
6. Piping is to be installed and service valves provided so that each heat pump chiller module shall have service valves and the isolation of an independent module in the array shall not affect the flow and operation of the additional heat pump chiller modules that work together to create the heat pump chiller plant. On a four-pipe system this is required for both hot and cold water.
7. The maximum water pressure design for the system is 300 psi.
8. All water piping and accessories to be independently supported from the equipment and the dead weight of the pipe or accessories is not transmitted or supported by the equipment in any way.
9. The following fluid specification shall be maintained; Water- PH 7-9, total dissolved solids less than 1000PPM, hardness (CaCo3) 30-500 PPM, alkalinity (CaCo3) 0-500 PPM, chlorides less than 200 PPM, sulfates less than 200 PPM. Water with 25% glycol- PH 7-9, total dissolved solids 1000 -10,000 PPM, conductivity 1000-5000 PPM, hardness (CaCo3) 30-500 PPM, alkalinity (CaCo3) more than 500 PPM, chlorides less than 200 PPM, sulfides less than 200 PPM. Other fluid conditions shall be as defined in specifications provided elsewhere.

2.3 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2.4 SOURCE QUALITY CONTROL

A. Energy Efficiency: Equal to or greater than prescribed by ASHRAE/IESNA 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings," Section 6, "Heating, Ventilating, and Air-Conditioning."

B. Testing Requirements: Factory test sound-power-level ratings according to ARI 270.

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 equipment.

B. Examine roughing-in for refrigerant piping systems to verify actual locations of piping connections before equipment installation.

C. Examine walls, floors, and roofs for suitable conditions where equipment will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install units level and plumb, firmly anchored in locations indicated.

B. Install roof-mounting units on equipment supports specified in Section 077200 "Roof Accessories."

C. Equipment Mounting:

1. Units installed on steel dunnage or roof curbs shall be installed on neoprene pads between the unit frame and the dunnage. Fasten condensing unit to dunnage of curb galvanized steel fasteners. Set units level with shims. Vibration isolators shall be mason industries model MBSW or super WSW.

D. Maintain manufacturer's recommended clearances for service and maintenance.

E. Loose Components: Install electrical components, devices, and accessories that are not factory mounted.

3.3 CONNECTIONS

A. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

B. Install control and electrical power wiring to field-mounted control devices.

C. Connect control wiring between chillers and other equipment to interlock operation as required to provide a complete and functioning system.

D. Connect control wiring between chiller control interface and DDC system for remote monitoring and control of chillers. Comply with requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC."

E. Provide nameplate on face of chiller control panel indicating control equipment designation serving chiller and the I/O point designation for each control connection. Nameplate shall be laminated phenolic layers of black with engraved white letters at least 1/2 inch high.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test. Certify compliance with test parameters.
2. Leak Test: After installation, charge system with refrigerant and oil and test for leaks. Repair leaks, replace lost refrigerant and oil, and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor operation and unit operation, product capability, and compliance with requirements.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
5. Verify proper airflow over coils.

C. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.

D. Equipment will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assemblies, installations, and connections.

C. Complete installation and startup checks according to manufacturer's written instructions and perform the following:

1. Verify that refrigerant charge is sufficient and water chiller has been leak tested.
2. Verify that pumps are installed and functional.
3. Verify that thermometers and gages are installed.
4. Operate water chiller for run-in period.
5. Check bearing lubrication and oil levels.

6. Verify that refrigerant pressure relief device for chillers installed indoors is vented outside.
7. Verify proper motor rotation.
8. Verify static deflection of vibration isolators, including deflection during water chiller startup and shutdown.

D. Lubricate bearings on fan motors.

E. Verify that fan wheel is rotating in the correct direction and is not vibrating or binding.

F. Start unit according to manufacturer's written instructions and complete manufacturer's startup checklist.

G. Measure and record airflow and air temperature rise over coils.

H. Verify proper operation of condenser capacity control device.

I. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.

J. After startup and performance test, lubricate bearings.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain heat pump chillers. Video record the training sessions and provide electronic copy to Owner.

1. Instructor shall be factory trained and certified.
2. Provide not less than eight 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 236611

SECTION 237223.13 - PACKAGED INDOOR HEAT WHEEL ENERGY RECOVERY UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Packaged, indoor, heat wheel energy-recovery units.

B. Related Requirements:

1. Section 237313.16 "Indoor, Semi-Custom Air-Handling Units" for indoor, semi-custom air-handling units if they also include coils, other than electric coils for frost control, in addition to heat wheels.
2. Section 237313.19 "Indoor, Custom Air-Handling Units" for indoor, custom air-handling units if they also include coils, other than electric coils for frost control, in addition to heat wheels.
3. Section 237343.16 "Outdoor, Semi-Custom Air-Handling Units" for outdoor, semi-custom air-handling units if they also include coils, other than electric coils for frost control, in addition to heat wheels.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include packaged, indoor, heat wheel, energy-recovery-unit rated capacities, operating characteristics, furnished specialties, and accessories.
2. Fans:

a. Certified fan-performance curves with system operating conditions indicated.
b. Certified fan-sound power ratings.
c. Fan construction and accessories.
d. Motor ratings, electrical characteristics, and motor accessories.

B. Shop Drawings: For air-to-air energy-recovery equipment.

1. Include plans, elevations, sections, details, 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.

C. Delegated Design Submittal: For air-to-air energy-recovery equipment 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 air-to-air energy-recovery equipment.
2. 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.
3. Design Calculations: Calculate requirements for selecting vibration isolators[and seismic restraints] and for designing vibration-isolation bases.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, elevations, and other details, drawn to scale and coordinated with each other, using input from installers of the items involved.

B. Seismic Qualification Data: Certificates, for air-to-air energy-recovery equipment, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-to-air energy-recovery equipment 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. Filters: [One] set(s) of each type of filter specified.
2. Fan Belts: [One] set(s) of belts for each belt-driven fan in energy-recovery units.
3. Wheel Belts: [One] set(s) of belts for each heat wheel.

1.6 COORDINATION

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

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of packaged, indoor, heat wheel energy-recovery units that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Packaged Energy-Recovery Units: [Two] years.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.

B. ASHRAE Compliance:

1. Applicable requirements in ASHRAE 62.1.
2. Capacity ratings for air-to-air energy-recovery equipment shall comply with ASHRAE 84.

C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1.

D. UL Compliance:

1. Packaged heat-recovery ventilators shall comply with requirements in UL 1812 or UL 1815.
2. Electric coils shall comply with requirements in UL 1995.

E. Comply with [ASTM E84].

F. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design vibration-isolation controls[and seismic restraints], including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

2.2 PACKAGED, INDOOR, HEAT WHEEL ENERGY-RECOVERY UNITS

A. Source Limitations: Obtain packaged, indoor, heat wheel energy-recovery units from single manufacturer.

B. Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

C. Housing: Manufacturer's standard construction with corrosion-protection coating and exterior finish, [gasketed] [hinged access doors] with neoprene gaskets for inspection

and access to internal parts, minimum 1-inch thick, R-6 thermal insulation, knockouts for electrical connections, exterior drain connection, and lifting lugs.

D. Heat Wheel:

1. Casing:

   a. Manufacturer's standard construction with standard factory finish.
   b. Slide-in, slide-out cassette style for easy access.

2. Rotor:

   a. Aluminum or polymer segmented wheel, strengthened with radial spokes.
   b. Aluminum or polymer segmented wheel, strengthened with radial spokes, with nontoxic, noncorrosive, silica-gel coating.
   c. Aluminum, metallic, or polymer segmented wheel, strengthened with radial spokes impregnated with nonmigrating, water-selective, four-angstrom, molecular-sieve desiccant coating.

3. Drive: Fractional horsepower motor and gear reducer, with speed changed by variable-frequency motor controller and self-adjusting multilink belt around outside of rotor.

   a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."
   b. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

E. Supply and Exhaust Fans: Forward-curved, centrifugal fan with spring isolators.

1. Motor and Drive: Direct driven, with speed changed by variable-frequency motor controller.
2. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."
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.

F. Filters:

1. Description: Flat, Pleated factory-fabricated, self-supported, disposable air filters with holding frames.
2. UL Compliance: Comply with UL 900.
3. Media: Interlaced glass fibers sprayed with nonflammable adhesive
4. Filter-Mounting Frames: Arranged with access doors or panels on both sides of unit. Filters shall be removable from one side or lift out from access plenum.

G. Wiring: Fabricate units with space within housing for electrical conduits. Wire motors and controls, so only external connections are required during installation.

1. Indoor Enclosure: NEMA 250, Type 12 enclosure contains relays, starters, and terminal strip.
2. Include nonfused disconnect switches.

H. Controls:

1. Control Panel: Solid-state, programmable, microprocessor-based control unit for [wall mounting]. Integrate to BACnet, LonWorks, or Modbus, as specified in Section 230923 "Direct Digital Control (DDC) System for HVAC".
2. Starting relay, factory mounted and wired, and manual motor starter for field wiring.
3. Frost Control: Variable rotor speed.
4. Motion (Occupancy) Sensor: Passive infrared sensor for [wall] [ceiling] mounting, with adjustable time-off delay of up to 30 minutes to energize unit.
5. Carbon Dioxide Sensor: Adjustable control from 600 to 2000 ppm for [wall] [duct] mounting, with digital display and computer/building management system interface to energize unit.
6. Economizer Control:

    a. Stop wheel rotation or modulate wheel rotation when conditions are favorable for economizer operation.
    b. Heat wheel airflow bypass. See Section 230923 "Direct Digital Control (DDC) System for HVAC" for control sequence.

7. Enthalpy sensor.
8. Rotation sensor and alarm.
9. Dirty filter switch.
10. Low-Voltage Transformer: Integral transformer to provide control voltage to unit from primary incoming electrical service.
11. Electric Coil Controls:

    a. Factory-mounted sensor in outside-air intake with sensor adjustment located in control panel to control electric coil and maintain minimum entering temperature, to avoid frost formation.

12. Variable-frequency motor controller complies with Section 262923 "Variable-Frequency Motor Controllers."
13. Variable-Frequency Motor Controller: Serving wheel rotation motor.

    a. Manufactured Units: Pulse-width modulated variable torque for inverter-duty motors.
    b. Output Rating: Three phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.
    c. Unit Operating Requirements:

1) Internal Adjustability:

a) Minimum Speed: 5 to 25 percent of maximum rpm.
b) Maximum Speed: 80 to 100 percent of maximum rpm.
c) Acceleration: [0.1 to 999.9] seconds.
d) Deceleration: [0.1 to 999.9] seconds.
e) Current Limit: 30 to minimum of 150 percent of maximum rating.

2) Self-Protection and Reliability Features:

a) Surge suppression.
b) Loss of input signal protection.
c) Under- and overvoltage trips.
d) Variable-frequency motor controller and motor-overload/overtemperature protection.
e) Critical frequency rejection.
f) Loss-of-phase protection.
g) Reverse-phase protection.
h) Motor-overtemperature fault.

3) Bidirectional autospeed search.
4) Torque boost.
5) Motor temperature compensation at slow speeds.

a) Panel-mounted operator station.
b) Historical logging information and displays.
c) Digital indicating devices.

6) Control Signal Interface: Electric.
7) Proportional integral derivative (PID) control interface.
8) DDC System for HVAC Protocols for Network Communications: [ASHRAE 135].

d. Line Conditioning:

1) Input line conditioning.
2) Output filtering.
3) EMI/RFI filtering.

14. Variable-Speed Control:

a. Factory mounted and wired, permitting input of field-connected, 4-20 mA or 1-10-V control signal.
b. Factory mounted and wired, with exhaust-air sensor to vary rotor speed and maintain exhaust temperature above freezing.
c. Factory mounted and wired, with exhaust- and outdoor-air sensors, automatic changeover thermostat, and set-point adjuster, to vary rotor

speed and maintain[exhaust temperature above freezing and] air differential temperature above set point. Rotor speed shall increase to maximum when exhaust-air temperature is less than outdoor-air temperature.

d. <Insert features>.

15. <Insert additional control features>.

2.3 SOURCE QUALITY CONTROL

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended application.

B. AHRI Compliance: Capacity ratings for air-to-air energy-recovery equipment certified as complying with AHRI 1060 (AHRI 1061).

C. Fan Performance Rating: Comply with AMCA 211 and label fans with AMCA-certified rating seal. Factory test fan performance for airflow, pressure, power, air density, rotation speed, and efficiency according to AMCA 210/ASHRAE 51.

D. Fan Sound Rating: Comply with AMCA 301 or AHRI 260 (IP). Air-handling unit fan sound ratings shall comply with AMCA 301 or AHRI 260 (IP).

E. UL Compliance:

1. Packaged heat recovery ventilators shall comply with requirements in UL 1812 or UL 1815.
2. Electric Coils: Comply with UL 1995.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine casing insulation materials and filter media before packaged, indoor, heat wheel energy-recovery unit installation. Replace with new insulation materials any filter media that are wet, moisture damaged, or mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF PACKAGED, INDOOR, HEAT WHEEL ENERGY-RECOVERY UNITS

A. Install packaged, indoor, heat wheel energy-recovery units, so supply and exhaust airstreams flow in opposite directions, and rotation is away from exhaust side to purge section to supply side.

1. Install access doors in both supply and exhaust ducts, both upstream and downstream, for access to wheel surfaces, drive motor, and seals.
2. Install removable panels or access doors between supply and exhaust ducts on building side for bypass during startup.
3. Access doors and panels are specified in Section 233300 "Air Duct Accessories."

B. Equipment Mounting:
1. Comply with requirements for vibration-isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."
2. Suspended Units: Suspend[and brace] units from structural-steel support frame, using threaded steel rods and spring hangers.

C. Install units with clearances for service and maintenance.

D. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing with new, clean filters.

3.3 DUCTWORK CONNECTIONS

A. Comply with requirements for ductwork according to Section 233113 "Metal Ducts."

B. Connect duct to units with flexible connections. Comply with requirements in Section 233300 "Air Duct Accessories."

C. Isolation Dampers: Install isolation dampers according to Section 230923.12 "Control Dampers."

3.4 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. Where installing piping adjacent to unit, allow service and maintenance.

C. Connect piping to units mounted on vibration isolators with flexible connectors.

D. Condensate Drain Piping: See Section 232113 "Hydronic Piping" for pipe type. Pipe drains from drain pans to nearest floor drain, same size as condensate drain connection.

1. Construct deep trap at connection to drain pan, and install cleanouts at changes in direction.

3.5 ELECTRICAL CONNECTIONS

A. Install electrical devices furnished with units but not factory mounted.

B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

D. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

E. 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, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch (13 mm) high.

3.6 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring according to Section 260523 "Control-Voltage Electrical Power Cables."

3.7 FIELD QUALITY CONTROL

A. Testing Agency:

1. Owner will engage a qualified testing agency to perform tests and inspections.
2. Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections[with the assistance of a factory-authorized service representative].

D. Tests and Inspections:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Packaged, indoor, heat wheel energy-recovery equipment will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

3.8 STARTUP SERVICE

A. [Engage a factory-authorized service representative to perform] [Perform] startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. <Insert startup steps if any>.

3.9 ADJUSTING

A. Adjust moving parts to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust initial temperature and humidity set points.

C. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-to-air energy-recovery units.

END OF SECTION 237223.13

SECTION 237313.16 – INDOOR AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes insulated, double-wall-casing, indoor, semi-custom air-handling units that are factory assembled using multiple section components.

1.3 ACTION SUBMITTALS

A. Product Data: For each air-handling unit.

1. Unit dimensions and weight.
2. Cabinet material, metal thickness, finishes, insulation, and accessories.
3. Fans:

    a. Certified fan-performance curves with system operating conditions indicated.
    b. Certified fan-sound power ratings.
    c. Fan construction and accessories.
    d. Motor ratings, electrical characteristics, and motor accessories.

4. Vibration isolation product data with performance ratings. Uniquely identify and include information for each different isolator type and indicate for each air-handling unit where each isolator type is being used.
5. Include certified coil-performance ratings with system operating conditions indicated. Product data to include dimensions, dry and operating weight, volume of fluid contained, materials of construction, and performance ratings with system operating conditions indicated.
6. Casing insulation product data and performance ratings.
7. Access door and access panel product data and performance ratings.
8. Paint product data and performance ratings.
9. Electrical product data and performance ratings.
10. Metal grating product data and performance ratings.
11. Dampers product data, including housings, linkages, and operators with performance ratings.
12. Filters product data with performance characteristics.
13. Heat wheels product data with performance ratings.
14. Duct silencers product data with performance ratings.

B. Sustainable Design Submittals:

1. Product data showing compliance with ASHRAE 62.1.
2. Product data showing compliance with ASHRAE 90.1.
3. Product Data: For air filtration performance.
4. Product Data: For adhesives, mastics, and sealants, indicating VOC content.
5. Laboratory Test Reports: For adhesives, mastics, and sealants, indicating compliance with requirements for low-emitting materials.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor 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. Mechanical-room layout and relationships between components and adjacent structural and mechanical elements.
2. Support location, type, and weight.
3. Field measurements.

B. Source quality-control reports:

C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-handling units to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: One set(s) for each air-handling unit.
2. Gaskets: One set(s) for each access door.
3. Fan Belts: One set(s) for each air-handling unit fan.

1.7 COORDINATION

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

B. Coordinate sizes and locations of structural-steel support members, if any, with actual equipment provided.

1.8 DELIVERY, STORAGE, HANDLING

A. Deliver air-handling units with factory-installed shipping skids and lifting lugs; pack small components in factory-fabricated protective containers. Cover units with heat-shrinkable plastic sheeting suitable for shipping from point of manufacture to Project.

B. Handle air-handling units carefully to avoid damage to components, casing, and finish. Do not install damaged components; replace and return damaged components to air-handling unit manufacturer.

C. Store air-handling units in a clean dry place and protect them from weather and construction activities.

D. Keep air-handling units fully covered and protected during construction. Remove dirt and debris and clean units to a factory-cleaned condition.

E. Comply with manufacturer's written rigging and installation instructions for unloading air-handling units and moving them to their final locations.

1.9 WARRANTY

A. Warranty: Manufacturer agrees to repair or replace components of air-handling units that fails in materials or workmanship within specified warranty period.

1. Warranty Period: 1 year(s) from date of Substantial Completion.

B. Extended warranties include, but are not limited to, the following:

1. Complete Air-Handling Unit: Two years from date of Substantial Completion for entire air-handling unit and longer where indicated for individual components.
2. Air-Handling Unit Casing: 25 years from date of Substantial Completion.
3. Motors: Two years from date of Substantial Completion.
4. Heat Wheels: Five 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. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.

C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

E. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design vibration isolation, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

F. Structural Performance: Casing panels shall be self-supporting and capable of withstanding positive/negative 8-inch wg of internal static pressure, without exceeding a midpoint deflection of 0.0042 inch/inch of panel span.

G. Casing Leakage Performance: ASHRAE 111, Class 6 leakage or better at plus or minus 8 inch wg.

2.2 CAPACITIES AND CHARACTERISTICS

A. Refer to plans and schedules

2.3 INDOOR/OUTDOOR, SEMI-CUSTOM AIR-HANDLING UNIT MANUFACTURERS

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

1. Buffalo Air Handling.
2. Carrier Corporation; a unit of United Technologies Corp.
3. Daikin Applied.
4. Dunham-Bush, Inc.
5. YORK; a Johnson Controls company.

2.4 UNIT CASINGS

A. Frame: Modular and providing overall structural integrity without reliance on casing panels for structural support.

B. Base Rail: The air-handling unit shall be provided with a full perimeter base rail channel.
1. The base rail channel shall be formed of 16-gage minimum galvanized steel
2. Height: 6 inches.

C. Casing Joints: Hermetically sealed at each corner and around entire perimeter.

D. Outside Casing Wall: shall be one of the following:

1. Material: G90 Galvanized steel, minimum 16gauge thick.
2. Material: Aluminum, minimum 14 gauge thick.
3. Material: Stainless steel, minimum 16 gauge thick.
4. Factory Finish: prime coat and acrylic polyurethane shall be applied.
5. Outdoor units - The finished unit shall exceed 500-hour salt spray solution (5%) without any sign of red rust when tested in accordance with ASTM B-117.

E. Inside Casing Wall: shall be one of the following three:

1. Material: G 90 Galvanized steel, solid, minimum 16 gauge thick. solid
2. Material: Aluminum, solid, minimum 14 gauge thick. perforated
3. Material: Stainless steel, solid, minimum 16 gauge thick. Solid

4. Antimicrobial Coating: Applied during the manufacturing process. EPA approved and NSF approved.

F. Floor Plate:
1. Floor panels shall be double wall construction, designed to provide at most L/240 deflection based on 300 lb. concentrated load at mid-span. The interior liner of the floor panels shall be a solid lining of minimum 20 gage galvanized or 304 stainless steel.
2. Material: G90 Galvanized steel, minimum 16 gauge thick.
3. Material: Stainless steel, minimum 16 gauge thick.
4. Antimicrobial Coating: Applied during the manufacturing process. EPA approved NSF approved.
5. Where units are large enough to walk inside, provide an additional 0.125" aluminum diamond tread plate liner shall be provided as a walk-on surface in unit access areas.

G. Static-Pressure Classifications:

1. For Unit Sections Upstream of Fans: Minus 3-inch wg.
2. For Unit Sections Downstream and Including Fans: 3-inch wg.

H. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

I. Casing Insulation:

1. Materials: Glass-fiber insulation layered over injected foam in perforated interior casing sections to meet specified acoustic requirements.
2. Casing Panel R-Value: Minimum R-12.5(Hr-Ft2-°F/BTU).
3. Insulation Thickness: 2 inches.
4. Thermal Break: Provide continuity of insulation with no through-casing metal in casing walls, floors, or roofs of air-handling unit.
5. Insulation application shall conform to NFPA 90A requirements.
6. Panels with perforated panel liner shall utilize a triple-wall construction, joining a matte-faced fiberglass insulated panel with a foam insulated panel

J. Panels, Doors, and Windows:

1. Doors:
   a. Provide access doors on both sides, in all sections, of the air-handling unit.

   b. Fabrication: Formed and reinforced, double-wall and insulated panels of same materials and thicknesses as casing.
   c. Hinges: A minimum of two ball-bearing hinges or stainless-steel piano hinge and two wedge-lever latches, operable from inside and outside. Arrange doors to be opened against airflow. Provide safety latch retainers on doors so that doors do not open uncontrollably.

d. Gasket: Neoprene, applied around entire perimeters of panel frames.
e. Size: Large enough to allow for unobstructed access for inspection and maintenance of air-handling unit's internal components. At least 24 inches wide by full height of unit casing up to a maximum height of 60 inches.

2. Panels;
a. Provide removable access panels, on both side of the air handling, whenever access doors are not available ,will not fit or there is insufficient space for door swing.

b. Fabrication: Formed and reinforced, double-wall and insulated panels of same materials and thicknesses as casing.
c. Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels to be opened against airflow
d. Gasket: Neoprene, applied around entire perimeters of panel frames.
e. Size: Large enough to allow unobstructed access for inspection and maintenance of air-handling unit's internal components. Full width by full height of unit casing section.

3. Windows: (not required)

4. Service Lights: 75 watt LED, when available vaporproof luminaire with individual switched junction box located outside, adjacent to each access door and panel.

a. Locations: all sections with motors and drives.

5. Convenience Outlets: One 20-A duplex GFCI receptacle per location with junction box located on outside casing wall.

a. Locations: exterior of unit. One per unit when located out doors.

K. Condensate Drain Pans:
1. Provide auxiliary drain pans in segments as required.
a. The auxiliary pans shall be double sloped, positive draining with galvanized steel liner and double wall construction with drain connection of like material, draining to one side of the unit.
b. Coat auxiliary drain pans with a anti- microbial coating.
c. Drain connection shall be welded to the drain pan. If threaded screw-type joint is used, all joints must be easily accessible for inspection and service.

2. Construction:
a. Drain pan design and application shall comply fully with the stated intent of ASHRAE 62-2001.

b. Single-wall, 20 gage galvanized-steel or noncorrosive polymer OR 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 ¼".

4. Slope: Minimum 0.125-in./ft. slope, to comply with ASHRAE 62.1, 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 but no less than 6".
6. Width: Entire width of water producing device.
7. Depth: A minimum of 2 inches deep.
8. Formed sections.
9. Pan-Top Surface Coating for Galvanized-Steel Drain Pans: Asphaltic waterproofing compound.
10. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

2.5 FAN, DRIVE, AND MOTOR SECTION

A. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.

1. Shafts: With field-adjustable alignment.

a. Turned, ground, and polished hot-rolled steel with keyway. Ship with a protective coating of lubricating oil.
b. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

B. Centrifugal Fan Housings: Formed- and reinforced-steel panels to form curved scroll housings with shaped cutoff and spun-metal inlet bell.

1. Bracing: Steel angle or channel supports for mounting and supporting fan scroll, wheel, motor, and accessories.
2. Horizontal-Flanged, Split Housing: Bolted construction.
3. Housing for Supply Fan: Attach housing to fan-section casing with metal-edged flexible duct connector.
4. Flexible Connector: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4 inches wide 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.

1) Fabric Minimum Weight: 26 oz./sq. yd..
2) Fabric Minimum Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3) Fabric Minimum Service Temperature Range: Minus 40 to plus 200 deg F.

C. Plenum Fan Housings: Steel frame and panel; fabricated without fan scroll and volute housing. Provide inlet screens for Type SWSI fans.

D. Backward-Inclined, Centrifugal Fan Wheels: Construction with curved inlet flange, backplate, backward-inclined blades welded or riveted to flange and backplate; steel hub riveted to backplate and fastened to shaft with setscrews.

E. Forward-Curved, 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 hub swaged to backplate and fastened to shaft with setscrews.

F. Airfoil, Centrifugal Fan Wheels: Smooth-curved inlet flange, backplate, and hollow die-formed airfoil-shaped blades continuously welded at tip flange and backplate; steel hub riveted to backplate and fastened to shaft with setscrews.

G. Fan Shaft Bearings:

1. Prelubricated and Sealed, Ball Bearings: Self-aligning, pillow-block type with an L-50 rated life of 200,000 hours according to ABMA 9.
2. Grease-Lubricated, Tapered-Roller Bearings: Self-aligning, pillow-block type with double-locking collars and two-piece, cast-iron housing with grease lines extended to outside unit and an L-50 rated life of 200,000 hours according to ABMA 11.
3. Grease-Lubricated Bearings: Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing with grease lines extended to outside unit and an L-50 rated life of 200,000.

H. Belt Drives: Factory mounted, with adjustable alignment and belt tensioning, and with 1.5 service factor based on fan motor.

1. Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
2. Motor Pulleys: Adjustable pitch for use with [5]-hp motors and smaller and constant volume units; fixed pitch for use with motors larger than 5 hp. Select pulley size so pitch adjustment is at the middle of adjustment range at fan design conditions.
3. Belts: Oil resistant, nonsparking, and nonstatic; in matched sets for multiple-belt drives.
4. Belt Guards: Comply with requirements specified by OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards"; 0.146 inch- thick, 3/4-inch diamond-mesh wire screen, welded to steel angle frame; prime coated.

I. Discharge Dampers: Heavy-duty steel assembly with channel frame and sealed ball bearings, and opposed or parallel blades constructed of two plates formed around and welded to shaft, with blades linked out of airstream to single control lever.

J. Internal Vibration Isolation: Fans shall be factory mounted with manufacturer's standard vibration isolation mounting devices having a minimum static deflection of 1 inch for units mounted on grade level and 2 inches mounted above grade on any floor or on the roof.

K. Motor: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

1. Enclosure Type: Totally enclosed, fan cooled.
2. NEMA Premium 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 1.15.
4. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
5. All fan motors shall be premium efficiency.
6. Motors shall be suitable for use in variable frequency application, per NEMA MG-1 Part 30 and inverter duty rated complying with NEMA STD MG1 PART 31.4.4.2 for fans with variable speed drive
7. Mount unit-mounted disconnect switches on exterior of unit.

L. All fan motors 5 hp or greater or all fan motors used in variable air volume units shall utilze variable frequency controllers

M. Variable-Frequency Motor Controller: Comply with Section 262923 "Variable-Frequency Motor Controllers."

2.6 MOTOR STARTERS AND DISCONNECTS

A. The air-handling unit shall be power wired for a single point connection. All power loads to be wired to one point of power source entrance.

B. Provide unit mounted disconnect switches for all motors including supply fan, exhaust fan, return fan, and energy recovery wheels. Disconnects shall be unit mounted and shall have NEMA enclosure ratings in accordance with the environment for which that are installed. All air handlers located outdoors shall disconnects in NEMA 3R enclosures. All Starters not mounted within a weather proof compartment of the unit shall have a NEMA 3x rating. All Starters shall be mounted on the primary access side of the fan section

C. Variable-air-volume units shall be equipped with factory mounted and wired variable frequency drives serving supply and return/exhaust for fan unloading control. Wiring to motor shall be provided in flexible conduit

D. Each unit mounted drive shall be mounted in a dedicated, NEMA 1 compartment located on the side of its associated fan section. Outdoor units shall encase controls in a weatherproof control enclosure.

E. Variable-Frequency Motor Controller: Comply with Section 232913 "Variable-Frequency Motor Controllers."

F. Constant volume units shall be equipped with factory mounted and wired motor starter panel(s) serving supply and return/exhaust] fan motor(s). Wiring to motor shall be provided in flexible conduit.
1. Motor starter panels will include:

2. Main power block
3. Motor contactor(s)
4. Individual short circuit and overload protection
5. 120 volt control power transformer with primary and secondary protection
6. 5 point terminal strip for field connections
7. Main power disconnect
8. Hand-Off-Auto switch

G. Starters and disconnects shall comply with Section 23 05 13 “Common motor requirements for HVAC”

2.7 COIL SECTION

A. General Requirements for Coil Section:

1. Comply with AHRI 410.
2. Fabricate coil section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s). coil shall be mounted on tracks. Coils shall be supported by galvanized coil support members, constructed of channeled members
3. For multizone units, provide air deflectors and air baffles to balance airflow across coils.
4. Coils shall not act as structural component of unit.
5. Coil grommets shall be provided on all coils to completely seal the area between the coil connection and the unit casing.
6. Coil casing shall be constructed of min 16-gauge galvanized steel [stainless steel]. Tube sheets on each end shall have drawn collars to support tubes. A single intermediate coil support shall be provided on coils with a finned length of more than 62 inches, two (2) intermediate supports above 100 inches in length, and three (3) intermediate supports on coils with a finned length of more than 141 inches.
7. Coils with finned height greater than 48 inches shall have an intermediate drain pan extending the entire finned length of the coil.

B. All steam coils shall be non-freeze type.

C. General Operating Parameters;
1. Steam coils and heating hydronic coils shall sized for a maximum air velocity of 650 ft/min.
2. All DX and chilled water-cooling coils shallbe sized for a maximum air velocity of 550 ft/min.
3. All hydronic coils shall have a maximum fluid pressure drop of 10’ WC.
4. All coils shall have an air side pressure drop not greater than 1.0” of wc or as scheduled
5.

2.8 HYDRONIC COILS

A. Performance Ratings: Tested and rated according to AHRI 410 and ASHRAE 33.

B. Minimum Working-Pressure/Temperature Ratings: 250 psig, 325 deg F.

C. Source Quality Control: Factory tested to 300 psig.

D. Tubes: ASTM B 743 copper, minimum thickness;
1. ½" OD tubes - .025" thick
2. 5/8" OD tubes - .035" thick
3. 7/8" OD tubes - .049" thick

E. Fins: Aluminum, minimum thickness;
1. Plate fins – 0.0065" thick
2. Spiral fins – 0.010" thick

F. Frames: Galvanized-steel channel frame, minimum thickness; for flanged mounting.
1. ½" OD and smaller, up to 4 rows and not longer than 48" fined length – 18 gage galvanized steel.
2. 5/8" OD and larger, longer than 48" and less than 72" fined length – 16 gage galvanized steel.
3. 5/8" OD and larger, longer than 72" fined length – 14 gage galvanized steel

G. Mounting; Slip in frame for retrofits, Flange frame for new construction.

H. Connections;
1. Coordinate left hand, right hand connections or supply return on opposite sides in the field.

2.9 REFRIGERANT AIR COILS

A. Performance Ratings: Tested and rated according to AHRI 410 and ASHRAE 33.

B. Direct expansion coils shall be designed to conform to the ANSI B9.1 when operating with a refrigerant pres- sure not exceeding 250 psig and shall be tested with 325 psig compressed air under water

C. Minimum Working-Pressure Rating: 300 psig.

D. Source Quality Control: Factory tested to 450 psig.

E. Tubes: ASTM B 743 copper, minimum thickness;
1. 3/8" OD tubes - .020" thick
2. ½" OD tubes - .025" thick
3. 5/8" OD tubes - .035" thick
4. 7/8" OD tubes - .049" thick

F. Fins: Aluminum, minimum thickness;
1. Plate fins – 0.0065" thick
2. Spiral fins – 0.010" thick

G. Suction and Distributor Piping: ASTM B 88, Type L copper tube with brazed joints.

H. Frames: Galvanized-steel channel frame, 16 gage minimum thickness; for flanged mounting.
1. ½” OD and smaller, up to 4 rows and not longer than 48” fined length – 18 gage galvanized steel.
2. 5/8” OD and larger, longer than 48” and less than 72” fined length – 16 gage galvanized steel.
3. 5/8” OD and larger, longer than 72” fined length – 14 gage galvanized steel

I. Mounting; Slip in frame for retrofits, Flange frame for new construction

2.10 AIR FILTRATION SECTION

A. Particulate air filtration is specified in Section 234100 "Particulate Air Filtration."

B. High-efficiency particulate air (HEPA) filtration is specified in Section 234133 "High-Efficiency Particulate Air Filtration."

C. Panel Filters:

1. Description: 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.
4. Filter-Media Frame: Beverage board with perforated metal retainer, or metal grid, on outlet side.
5. Prefilter media shall be throwaway or permanent cleanable or 30% MERV 8 efficient. Spare sets of media shall be provided as scheduled

D. Bag Filters:

1. Description: Factory-fabricated, dry, extended-surface, self-supporting filters with holding frames in steel, basket-type retainers.
2. Filter Unit Class: UL 900.
3. Media: Fibrous material, coated with antimicrobial agent, constructed so individual pockets are maintained in tapered form by flexible internal supports under rated-airflow conditions.
4. Filter-Media Frame: Galvanized steel.
5. Media shall be 22" bag 80-85% efficiency-MERV 14 or as scheduled

E. Cartridge Filters:

1. Description: Factory-fabricated, adhesive-coated disposable, packaged air filters with media perpendicular to airflow, and with holding frames.
2. Filter Unit Class: UL 900.
3. Media: Fibrous material, coated with antimicrobial agent, constructed so individual pleats are maintained in pleated form under rater-airflow conditions by corrugated aluminum separators.
4. Filter Media Frame: Galvanized steel.
5. Media shall be 4" mini-pleated (80-85% efficiency-MERV 13, or as scheduled.

6. Media shall be 12" rigid 80-85% efficiency-MERV 13or as scheduled.
7. HEPA filter segments (HF) shall be provided with MERV 17 (99.97% efficient

F. Front, Back or Side Access Filter Mounting Frames:

1. Particulate Air Filter Frames: Galvanized-steel or Aluminum framing members with access for filter servicing, cut to size and prepunched for assembly into modules. Vertically support filters to prevent deflection of horizontal members without interfering with either filter installation or operation.

   a. Prefilters: Incorporate a separate 2-inch- thick track with spring clips, with same access as primary filter.
   b. Sealing: Full periphery foam gaskets.

2. HEPA Filter Frames: Aluminum or Stainless-steel framing members, cut to size and prepunched for assembly into modules. Vertically support filters to prevent deflection of horizontal members without interfering with either filter installation operation. Bolted filter-sealing mechanism shall mount and continuously seal each individual filter.

   a. Prefilters: Incorporate a separate 2-inch- or 4-inch- as per schedule, thick track with spring clips with same access as primary filter.
   b. Sealing: Gasketed, hand-crank locking mechanism to provide positive-sealing for each filter to ensure seal between filter elements to prevent bypass of unfiltered air.

2.11 DAMPERS

A. General Requirements for Dampers: Leakage rate, according to AMCA 500, "Laboratory Methods for Testing Dampers for Rating," 4 cfm/sq. ft. at 1-inch wg and 8 cfm/sq. ft. at 4-inch wg. complying fully with the requirements of ASHRAE 90.1.

B. Damper Operators: Comply with requirements in Section 230923.12 "Control Dampers."

C. Electronic Damper Operators:

1. Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
2. Electronic damper position indicator shall have visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
3. Operator Motors:

   a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
   b. Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
   c. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring

mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.

4. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
5. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf.
6. Size dampers for running torque calculated as follows:

    a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. of damper.
    b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.
    c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft of damper.
    d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. of damper.
    e. Dampers with 2- to 3-Inch wg of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.
    f. Dampers with 3- to 4-Inch wg of Pressure Drop or Face Velocities of 2500 to 3000 fpm: Increase running torque by 2.0.

7. Coupling: V-bolt and V-shaped, toothed cradle.
8. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
9. Fail-Safe Operation: Mechanical, spring-return mechanism with external, manual gear release on nonspring-return actuators.
10. Power Requirements (Two-Position Spring Return): 24 V dc.
11. Power Requirements (Modulating): Maximum 10 VA at 24 V ac or 8 W at 24 V dc.
12. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
13. Temperature Rating: Minus 22 to plus 122 deg F.
14. Run Time: 12 seconds open, 5 seconds closed.

D. Outdoor- and Return-Air Dampers: Low-leakage, double-skin, airfoil-blade, galvanized-steel, aluminum, extruded-aluminum dampers with compressible jamb seals and extruded-vinyl blade edge seals in opposed-blade arrangement with zinc-plated steel operating rods rotating in stainless-steel sleeve or sintered bronze or nylon bearings mounted in a single galvanized-steel, aluminum, extruded-aluminum 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.

E. Mixing Section: Multiple-blade, air-mixer assembly located immediately downstream of mixing section.

F. Combination Filter and Mixing Section:

1. Cabinet support members shall hold 2-inch- thick, pleated, flat, permanent or throwaway filters.
2. Multiple-blade, air-mixer assembly shall mix air to prevent stratification, located immediately downstream of mixing box.

2.12 SOUND ATTENUATORS

A. General Requirements:

1. Factory fabricated.
2. Fire Performance Characteristics: Adhesives, sealants, packing materials, and accessory materials with flame-spread index not exceeding 25 and smoke-developed index not exceeding 50, ASTM E 84.
3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with ASHRAE 62.1.

B. Shape: Rectangular, or straight Rectangular, elbow.

C. Rectangular Silencer Outer Casing: Galvanized steel.

D. Round Silencer Outer Casing: Galvanized steel.

E. Inner Casing and Baffles: Galvanized steel.

F. Principal Sound-Absorbing Mechanism:

1. Packless Type: Controlled impedance membranes and broadly tuned resonators without adsorptive media.
2. Dissipative Type: Polymer film-lined absorptive fill material.

a. Fill Material: Inert and vermin-proof fibrous material.

3. Joints: Lock formed and sealed, continuously welded or flanged.
a. Variable-frequency controller, factory mounted and wired, with exhaust-air sensor to vary rotor speed and maintain exhaust temperature above freezing.

2.13 AIR BLENDER

A. Description: Static air mixer device to provide mixing of two airstreams to within plus/minus 6 deg F.

B. Material: Galvanized or steel Aluminum.

C. Coating: Corrosion-resistant coating.

2.14 DIFFUSER

A. Description: Velocity profile equalizer device for providing equalized airflow profile downstream of Type DWDI fans.

B. Material: Galvanized or steel Aluminum.

2.15 FILTER/MIXING BOX

A. Section shall be designed to accommodate 2" angled filter media. The filter media shall be side-loading.

B. A magnahelic differential pressure gauge shall be factory installed and flush mounted to mea- sure the pressure drop across the filter bank.

C. The return air inlet shall have standard control damper, constructed of aluminum, galvanized steel with opposed blades. Damper configuration shall be full faced..

D. The outside air inlet have Airflow Monitoring Station have standard control damper, constructed of aluminum, or galvanized steel with opposed blades. Damper configuration shall be full faced.

E. The airflow monitoring station must be tested for pressure drop in accordance with AMCA Stan- dard 611-95 in an AMCA registered laboratory. The airflow monitoring station must bear the AMCA Certified Ratings Seal for Airflow Measure- ment Performance.

2.16 AIR FLOW MONITORING (25-OAF, 75/100 OAF)

A. Optional airflow monitoring stations will be provided on air inlets, as shown in performance specifications.

B. Airflow monitoring stations will bear the AMCA Certified Ratings Seal for Airflow Measurement Performance.

C. Airflow monitoring station dampers will comply with leakage rates per ASHRAE 90.1.

D. Airflow monitoring stations will be accurate within 5% of actual airflow between 350 FPM and 4000 FPM free area velocity.

E. Outdoor air intake openings with air flow monitoring stations will have rain louver.

F. Louver will be a wind-driven rain penetration class A louver.

G. Louver effectiveness ratio will be 100% at the following conditions:

H. Wind velocity, 29 mph into louver.

I. Rain fall rate, 3 in./hr.

J. Free area air velocity, 1500 FPM.

K. All VAV units shall be equipped with an outside air volume measurement system similar to Tek-Air. The system shall continuously measure outside air and adjust the outside air damper to maintain the minimum air volume as indicated in the unit schedule.

2.17 OPTIONAL EQUIPMENT

A. Provide the following optional equipment and or controls
1. OAT sensor
2. differential pressure switch
3. Duct-mount Humidity/Temperature Sensor
4. Differential Pressure Switch
5. Static Pressure Transducer
6. Freeze stat/Low Limit Temperature Cutout Control
7. High Temperature Manual Reset Control (HTC)
8. IAQ Sensor - for demand control ventilation
9. Duct Humidity Limit (Auto Reset)
10. Current Operated Switch for fan status
11. Zone Temperature & Zone Humidity Sensor

2.18 MATERIALS

A. Steel:

1. ASTM A 36/A 36M for carbon structural steel.
2. ASTM A 568/A 568M for steel sheet.

B. Stainless Steel:

1. Manufacturer's standard grade for casing.
2. Manufacturer's standard type, ASTM A 240/A 240M for bare steel exposed to airstream or moisture.

C. Galvanized Steel: ASTM A 653/A 653M.

D. Aluminum: ASTM B 209.

E. Corrosion-Resistant Coating: Coat with a corrosion-resistant coating capable of withstanding a 3000-hour salt-spray test according to ASTM B 117.

1. Standards:

a. ASTM B 117 for salt spray.
b. ASTM D 2794 for minimum impact resistance of 100 in-lb.
c. ASTM B 3359 for cross hatch adhesion of 5B.

2. Application: Immersion.
3. Thickness: 1 mil.
4. Gloss: Minimum gloss of 60 on a 60-degree meter.

2.19 SOURCE QUALITY CONTROL

A. AHRI 430 Certification: Air-handling units and their components shall be factory tested according to AHRI 430 and shall be listed and labeled by AHRI.

B. AHRI 1060 Certification: Air-handling units that include air-to-air energy recovery devices shall be factory tested according to AHRI 1060 and shall be listed and labeled by AHRI.

C. AMCA 301 or AHRI 260: Air-handling unit fan sound ratings shall comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data," or AHRI 260, "Sound Rating of Ducted Air Moving and Conditioning Equipment."

D. Fan Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Fans shall bear AMCA-certified sound ratings seal.

E. Fan Performance Rating: Factory test fan performance for airflow, pressure, power, air density, rotation speed, and efficiency. Rate performance according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating."

F. Water Coils: Factory tested to 300 psig according to AHRI 410 and ASHRAE 33.

G. Steam Coils: Factory tested to 300 and 200 psig underwater according to AHRI 410 and ASHRAE 33.

H. Refrigerant Coils: Factory tested to minimum 450-psig internal pressure and to minimum 300-psig internal pressure while underwater, according to AHRI 410 and ASHRAE 33.

I. Witnessed Casing Leakage Tests:

1. Pay for all expenses, for one representative designated by Owner, to travel to the factory to witness cabinet air-leakage testing on the specific assembled unit(s) prior to release for delivery to Project site.
2. If the unit(s) does not meet specified leakage requirements, perform factory modifications and retest. Do not release unit for shipment until tested leakage is measured to be within specified leakage and leakage testing report has been accepted by Owner's designated representative.

2.20 VIBRATION ISOLATION EXTERNAL TO THE UNIT.

A. Floor mounted air handling units shall be mounted on free standing Spring isolators and laterally stable without any housing and complete with a molded neoprene cup or 1/4" neoprene acoustical friction pad between the baseplate and the support. All mountings shall have leveling bolts that must be rigidly bolted to the equipment and housekeeping pad. Installed and operating heights shall be equal. The ratio of the spring diameter divided by the compressed spring height shall be no less than 0.8. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Submittals shall include spring diameters, deflection, compressed spring height and solid spring height. Mountings shall be type SLR, as manufactured by Mason Industries, Inc

B. All suspended air handling units shall use hanger consisting of rigid steel frames containing minimum 1-1/4" thick neoprene elements at the top and a steel spring seated in a steel washer reinforced neoprene cup on the bottom. The neoprene element and the cup shall have neoprene bushings projecting through the steel box. In order to maintain stability, the boxes shall not be articulated as clevis hangers nor the neoprene element stacked on top of the spring. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30° arc from side to side before contacting the cup bushing and short circuiting the spring. Submittals shall include a hanger drawing showing the 30° capability. Hangers shall be type PC30N as manufactured by Mason Industries, Inc.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine casing insulation materials and filter media before air-handling unit installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for steam, hydronic, and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Equipment Mounting:

1. Install base-mounted air handling units on cast-in-place concrete housekeeping pads Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete." and Section 033053 "Miscellaneous Cast-in-Place Concrete." Concrete housekeeping pads shall be 3 ½” high and extend 6” longer on all sides then the mountings, and shall have 45° chamfered edges.
   a. Air handling units shall be mounted on spring isolation in accordance with section 2.21
2. Suspended Units: Suspend and brace units from structural-steel support frame using threaded steel rods and spring hangers. Comply with requirements for vibration isolation devices specified in section 2.26

B. Arrange installation of units to provide access space around air-handling units for service and maintenance.

C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters.

D. Install filter-gauge, static-pressure taps upstream and downstream of filters. Mount filter gauges on outside of filter housing or filter plenum in accessible position. Provide filter gauges on filter banks, installed with separate static-pressure taps upstream and downstream of filters.

E. Connect duct to air-handling units with flexible connections. Comply with requirements in Section 233300 "Air Duct Accessories."

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 air-handling unit, allow for service and maintenance.

C. Connect piping to air-handling units mounted on vibration isolators with flexible connectors.

D. Connect condensate drain pans using NPS 1-1/4, ASTM B 88, Type M copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.

E. Hot water Piping: Comply with applicable requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Install shutoff valve and union or flange at each coil supply connection. Install balancing valve and union or flange at each coil return connection.

F. Refrigerant Piping: Comply with applicable requirements in Section 232300 "Refrigerant Piping." Install shutoff valve and union or flange at each supply and return connection.

3.4 ELECTRICAL CONNECTIONS

A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

D. 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 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring according to Section 260523 "Control-Voltage Electrical Power Cables."

3.6 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 the following tests and inspections with the assistance of a factory-authorized service representative:

1. Leak Test: After installation, fill water and steam coils with water, and test coils and connections for leaks.
2. Charge refrigerant coils with refrigerant and test for leaks.
3. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. HEPA Filters: Pressurize housing to a minimum of 3-inch wg or to designed operating pressure, whichever is higher; test housing joints, door seals, and sealing edges of filter with soapy water to check for air leaks.

E. Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections.

F. Prepare test and inspection reports.

3.7 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that shipping, blocking, and bracing are removed.
3. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.

5. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.
6. Verify that zone dampers fully open and close for each zone.
7. Verify that face-and-bypass dampers provide full face flow.
8. Verify that outdoor- and return-air mixing dampers open and close, and maintain minimum outdoor-air setting.
9. Comb coil fins for parallel orientation.
10. Verify that proper thermal-overload protection is installed for electric coils.
11. Install new, clean filters.
12. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.

B. Starting procedures for air-handling units include the following:

1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm. Replace fan and motor pulleys as required to achieve design conditions.
2. Measure and record motor electrical values for voltage and amperage.
3. Manually operate dampers from fully closed to fully open position and record fan performance.

3.8 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.

3.9 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.

3.10 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain air-handling units.

END OF SECTION 237313.16

SECTION 237433 - DEDICATED OUTDOOR-AIR UNITS (DOAS)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Related Requirements:

1. Section 284621.11 "Addressable Fire-Alarm Systems."

1.2 SUMMARY

A. Section includes factory-assembled, dedicated outdoor air-handling units, including multiple components, capable of heating and cooling 100 percent outdoor air.

1.3 DEFINITIONS:

A. ECM: Electronically commutated motor.

B. ISCOP: Integrated Seasonal Coefficient of Performance.

C. ISMRE: Integrated Seasonal Moisture Removal Efficiency.

D. MRC: Moisture Removal Capacity.

1.4 ACTION SUBMITTALS

A. Product Data: For each dedicated outdoor-air unit.

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.
3. Include unit dimensions and weight.
4. Include cabinet material, metal thickness, finishes, insulation, and accessories.
5. Fans:

a. Certified fan-performance curves with system operating conditions indicated.
b. Certified fan-sound power ratings.
c. Fan construction and accessories.
d. 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 heat exchangers with performance characteristics.
9. Include dampers, including housings, linkages, and operators.

B. Shop Drawings: For each dedicated outdoor-air 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.

C. Delegated Design Submittal: For dedicated outdoor-air-unit supports indicated to comply with performance and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Include design calculations for selecting vibration isolators seismic restraints and wind restraints, and for designing vibration isolation bases.
2. Wind Restraint Details: Detail fabrication and attachment of wind and seismic restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.
3. Detail mounting, securing, and flashing of roof curb to roof structure. Indicate coordinating requirements with roof membrane system.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor/roof 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. Seismic Qualification Data: Certificates, for dedicated outdoor-air units, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
4. Restraint of internal components.

D. Product Certificates: Submit certification that specified equipment will withstand wind forces identified in "Performance Requirements" Articles

E. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
   1. Dimensioned Outline Drawings of Equipment Unit: Identify center of wind force and locate and describe mounting and anchorage provisions.
   2. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

F. Source quality-control reports.

G. Startup service reports.

H. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For dedicated outdoor-air units to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

   1. Fan Belts: One set for each belt-driven fan.
   2. Filters: One set for each unit.
   3. Gaskets: One set for each access door.

1.8 WARRANTY

A. Warranty: Manufacturer agrees to replace components of dedicated outdoor-air units that fail in materials or workmanship within specified warranty period.

   1. Warranty Period for Dedicated Outdoor-Air-Handling Units: Three Insert number years from date of Substantial Completion.
   2. Warranty Period for Compressors: Five years from date of Substantial Completion.
   3. Warranty Period for Heat Exchangers: Five years from date of Substantial Completion.
   4. Warranty Period for Rotary Heat Exchangers: Five 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" (nationally recognized testing laboratory) and marked for intended location and application.

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of units 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 and ASHRAE 34 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. ASHRAE 84 Compliance: Comply with capacity ratings for heat-wheel energy-recovery equipment.

G. UL Compliance:

1. Electric Coils: Comply with requirements in UL 1995.

H. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design vibration isolation and wind restraints.

2.2 CAPACITIES AND CHARACTERISTICS

A. Refer to plans and schedules.

2.3 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the basis of design manufacture LG. The following manufacturers may use subject compliance with the contract documents and review and approval by the engineer.

1. AAON.
2. LG
3. Desert Aire.
4. Munters Corporation.
5. Addison

B. Source Limitations: Obtain dedicated outdoor-air units from single manufacturer.

2.4 UNIT CASING

A. General Fabrication Requirements for Casings: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.

B. Configuration: Horizontal unit with horizontal, bottom discharge for roof-mounting installation.

C. Double-Wall Configuration:

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:
   a. Inside Casing, All Other Sections: Galvanized steel, solid or perforated.
   b. Antimicrobial Coating: Applied during the manufacturing process. Coating is to be EPA approved, NSF approved, and FDA listed.
3. Floor Plate: Reinforced metal surface; reinforced to limit deflection when walked on by service personnel. Insulation is provided below metal walking surface.
4. Roof: Standing seam or membrane; sloped to drain water.
5. Casing Insulation:
   a. Materials: Polyurethane foam insulation.
   b. Casing Panel R-Value: Minimum R-13.
   c. Insulation Thickness: 2 inches.
   d. Thermal Break: Provide continuity of insulation with no through-casing metal in casing walls, floors, or roofs of air-handling unit.

D. Airstream Surfaces: Surfaces in contact with airstream shall comply with requirements in ASHRAE 62.1.

E. Static-Pressure Classifications:

1. For Unit Sections Upstream of Fans: Minus 2 inches wg.
2. For Unit Sections Downstream and Including Fans: 3 inches wg.

F. Panels and Doors:

1. Panels:
   a. Fabrication: Formed and reinforced double-wall and insulated panels of same materials and thicknesses as casing.
   b. Fasteners: Two or more camlock-type fasteners for panel lift-out operation. Arrangement shall allow panels to be opened against airflow.
   c. Gasket: Neoprene, applied around entire perimeters of panel frames.

d. Size: Large enough to allow unobstructed access for inspection and maintenance of unit's internal components

2. Doors:

a. Fabrication: Formed and reinforced double-wall and insulated panels of same materials and thicknesses as casing.
b. Hinges: A minimum of two ball-bearing hinges or stainless-steel piano hinge and two wedge-lever latches, operable from inside and outside. Arrange doors to be opened against airflow. Provide safety latch retainers on doors so that doors do not open uncontrollably.
c. Gasket: Neoprene, applied around entire perimeters of panel frames.
d. Size: Large enough to allow for unobstructed access for inspection and maintenance of air-handling unit's internal components.

3. Locations and Applications:

a. Fan Section:
b. Access Section: Doors.
c. Damper Section:
d. Filter Section: large enough to allow periodic removal and installation of filters.
e. Relief Section: Doors.

G. Condensate Drain Pans:

1. Location: Each refrigerant coil and rotary heat exchanger.
2. Construction:

a. Single-wall, noncorrosive polymer or stainless steel sheet.

3. Size: Large enough to collect condensate from cooling coils, including coil piping connections, coil headers, and return bends.
4. Drain Connection:

a. Located on one end or both ends of pan, at lowest point of pan.
b. Terminated with threaded nipple.
c. Minimum Connection Size: NPS 1.

5. Slope: Minimum 0.125-inch/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.
6. Length: Extend drain pan downstream from leaving face for distance to comply with ASHRAE 62.1.
7. Width: Entire width of water-producing device.
8. Depth: A minimum of 2 inches deep.
9. Pan-Top Surface Coating for Galvanized-Steel Drain Pans: Asphaltic waterproofing compound.
10. Provide units having stacked coils with intermediate drain pan to collect condensate from top coil.

2.5 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 and Relief-Air Fans: Centrifugal; 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 in accordance with ABMA 9.

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. Housings, Plenum Fans: Steel frame and panel; fabricated without fan scroll and volute housing. Provide inlet screens for Type SWSI fans.
5. Backward-Inclined, Centrifugal Fan Wheels: Construction with curved inlet flange, backplate, backward-inclined blades welded or riveted to flange and backplate; steel or aluminum hub riveted to backplate and fastened to shaft with setscrews.
6. Forward-Curved, 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.
7. Airfoil, Centrifugal Fan Wheels (Plenum Fan Wheels): Smooth-curved inlet flange, backplate, and hollow die-formed airfoil-shaped blades continuously welded at tip flange and backplate; steel hub riveted to backplate and fastened to shaft with setscrews.
8. Mounting: For internal vibration isolation. Factory mount fans with manufacturer's standard restrained vibration isolation mounting devices having a minimum static deflection of 1 inch.
9. Shaft Lubrication Lines: Extended to a location outside the casing.
10. 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. Drive, Belt: Factory-mounted V-belt drive, with adjustable alignment and belt tensioning, and with 1.25 service factor based on fan motor.

1. Pulleys: Cast iron or cast steel with split, tapered bushing, dynamically balanced at the factory.
2. Belts: Oil resistant, nonsparking and nonstatic; in matched sets for multiple-belt drives.
3. Belt Guards: Comply with requirements specified by OSHA and fabricate in accordance with SMACNA's "HVAC Duct Construction Standards"; 0.146 inch thick, 3/4-inch diamond-mesh wire screen, welded to steel angle frame; prime coated.

D. Condenser-Coil Fan: Variable-speed propeller, mounted on shaft of permanently lubricated motors.

E. Motors:

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."
2. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
3. Enclosure Type: Open, drip proof.
4. Enclosure Materials: Cast iron.
5. Unusual Service Conditions:

    a. Ambient Temperature: 5 deg C.
    b. Altitude: 1000’ above sea level.

6. Efficiency: Premium efficient as defined in NEMA MG 1.
7. NEMA Design:
8. Motor Pulleys: Adjustable pitch for use with 5 hp motors and smaller; fixed pitch for use with motors larger than 5 hp. Select pulley size so pitch adjustment is at the middle of adjustment range at fan design conditions.
9. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
10. Mount unit-mounted disconnect switches on exterior or interior of unit.

F. Variable-Frequency Motor Controller: Serving each fan individually in fan array.

1. Manufactured Units: Pulse-width modulated; constant torque and variable torque for Design A and Design B inverter-duty motors.
2. Output Rating: Three phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.
3. Unit Operating Requirements:

    a. Internal Adjustability:

        1) Minimum Speed: 5 to 25 percent of maximum rpm.
        2) Maximum Speed: 80 to 100 percent of maximum rpm.

3) Acceleration: 0.1 to 999.9 seconds.
4) Deceleration: 0.1 to 999.9 seconds.
5) Current Limit: 30 to minimum of 150 percent of maximum rating.

b. Self-Protection and Reliability Features:

1) Surge suppression.
2) Loss of input signal protection.
3) Under- and overvoltage trips.
4) Variable-frequency motor controller and motor-overload/overtemperature protection.
5) Critical frequency rejection.
6) Loss-of-phase protection.
7) Reverse-phase protection.
8) Motor-overtemperature fault.

c. Bidirectional autospeed search.
d. Torque boost.
e. Motor temperature compensation at slow speeds.

1) Panel-mounted operator station.
2) Historical logging information and displays.
3) Digital indicating devices.

f. Control Signal Interface: Electric.
g. Proportional Integral Directive (PID) control interface.

4. Line Conditioning:

a. Input line conditioning.
b. Output filtering.
c. EMI/RFI filtering.

5. Bypass Systems:

a. Bypass Mode: Manual operation only.
b. Bypass Controller, Two-Contactor Style: With bypass and output isolating contactors and isolating switch.

2.6 COILS

A. General Requirements for Coils:

1. Comply with AHRI 410.
2. Fabricate coils section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).
3. Coils are not to act as structural component of unit.

B. Supply-Air Refrigerant Coils:

1. Tubes: Copper.
2. Fins:

    a. Material: Aluminum.
    b. Fin Spacing: Maximum 12, 10, or 8 fins per inch.

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 in accordance with ASHRAE 33 and AHRI 410.

    a. Working Pressure: Minimum 300 psig.

C. Hot-Gas Reheat Refrigerant Coils:

1. Tubes: Copper.
2. Fins:

    a. Material: Aluminum.
    b. Fin Spacing: Maximum 12, 10, or 8 Insert spacing fins per inch.

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 in accordance with ASHRAE 33 and AHRI 410.

    a. Working Pressure: Minimum 300 psig.
8. Suction-discharge bypass valve.

D. Condenser Refrigerant coils:

1. Tube Material: Copper.
2. Fin Material: Aluminum.
3. Fin and Tube Joint: Mechanical bond.
4. Coating: None.

2.7 REFRIGERATION CIRCUIT COMPONENTS

A. Compressors: Hermetic, variable-speed scroll compressors, mounted on integral vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief, and crankcase heater.

B. Refrigerant: [R-410A].

C. Refrigeration Specialties:

1. Expansion valve with replaceable thermostatic element.
2. Refrigerant filter/dryer.
3. Manual-reset high-pressure safety switch.
4. Automatic-reset low-pressure safety switch.
5. Minimum off-time relay.
6. Automatic-reset compressor motor thermal overload.
7. Thermostat for coil freeze-up protection during low-ambient-temperature operation or loss of air.
8. Brass service valves installed in discharge and liquid lines.
9. Low-ambient kit high-pressure sensor.
10. Single compressor with evaporator and condenser coil within the refrigerant section to provide initial pre-cooling and to reheat for humidity control.
11. Modulating hot-gas reheat solenoid valve with a replaceable magnetic coil.
12. Heat-pipe heat exchanger, wrapped around the evaporator coil to pre-cool the air entering the evaporator coil and reheat the air leaving the evaporator coil to control humidity.
13. Hot-gas bypass refrigerant control for capacity control with continuous dehumidification for single-speed compressor.

2.8 AIR FILTRATION

A. Particulate air filtration is specified in Section 234100 "Particulate Air Filtration."

B. Panel Filters:

1. Description: Flat, non-pleated pre-filters and 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: High wet-strength beverage board with perforated metal retainer, or metal grid, on outlet side.

C. Mounting Frames:

1. Panel filters arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or from access plenum.
2. Cartridge filters arranged for flat orientation, removable from access plenum.
3. Galvanized or stainless steel with gaskets and fasteners, suitable for bolting together into built-up filter banks with space for prefilter.

2.9 ROTARY HEAT EXCHANGER

A. Casing:

1. Galvanized steel, stainless steel, or aluminum with manufacturer's standard factory-painted finish.

2. Integral purge section limiting carryover of exhaust air to between 0.05 percent at 1.6-inch wg and 0.20 percent at 4-inch wg differential pressure.
3. Casing seals on periphery of rotor and on duct divider and purge section.
4. Support vertical rotor on grease-lubricated ball bearings having extended grease fittings or permanently lubricated bearings. Support horizontal rotors on tapered roller bearings.

B. Rotor - Aluminum, Metallic, or Polymer: Aluminum, metallic, or polymer segmented wheel, strengthened with radial spokes impregnated with nonmigrating, water-selective, molecular-sieve desiccant coating.

C. Drive: Fractional horsepower motor and gear reducer, with speed changed by variable-frequency controller. Provide permanently lubricated wheel bearings.

D. Controls:

1. Starting relay, factory mounted and wired, and manual motor starter for field wiring.
2. Variable-frequency controller, factory mounted and wired, permitting input of 4-20 mA or 1-10 V control signal.
3. Control energy recovery to permit air economizer operation.

    a. Bypass dampers to assist energy recovery control.

4. Pilot-Light Indicator: Display rotor rotation and speed.
5. Speed Settings: Adjustable settings for maximum and minimum rotor speed limits.
6. Integral purge section limiting carryover of exhaust air to between 0.05 percent at 1.6-inch wg and 0.20 percent at 4-inch wg differential pressure.
7. Defrost cycle.

2.10 INDIRECT-FIRED GAS FURNACE HEATING (not used)

A. Description: Factory assembled, piped, and wired; and complying with ANSI Z21.47 and with NFPA 54.

B. CSA Approval: Designed and certified by and bearing label of CSA.

C. Burners:

1. Heat-Exchanger Material: Stainless steel.
2. Fuel: Natural gas.
3. Ignition: Electronically controlled electric spark with flame sensor.
4. Gas Control Valve: Electronic modulating.
5. Gas Train: Single-body, regulated, redundant, 24 V ac gas valve assembly containing pilot solenoid valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff.

D. Venting, Gravity: Gravity vented.

E. Venting, Power: Power vented, with integral, motorized centrifugal fan interlocked with gas valve.

F. Heat-Exchanger Drain Pan: Stainless steel.

G. Safety Controls:

1. Gas Manifold: Safety switches and controls complying with ANSI standards and FM Global.
2. Vent Flow Verification: Differential pressure switch to verify open vent, Flame rollout switch. (NYC)
3. High Limit: Thermal switch or fuse to stop burner.
4. Purge-period timer shall automatically delay burner ignition and bypass low-limit control.
5. Airflow Proving Switch: Differential pressure switch senses correct airflow before energizing pilot.
6. Automatic-Reset, High-Limit Control Device: Stops burner and closes main gas valve if high-limit temperature is exceeded.
7. Safety Lockout Switch: Locks out ignition sequence if burner fails to light after three tries. Controls are reset manually by turning the unit off and on.

2.11 DAMPERS

A. Outdoor- and Relief-Air Dampers: Low-leakage, double-skin, airfoil-blade, galvanized-steel dampers with compressible jamb seals and extruded-vinyl blade edge seals in opposed-blade arrangement 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 inches wg.

B. Electronic Damper Operators:

1. Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
2. Electronic damper position indicator shall have visual scale indicating percentage of travel and 2 to 10 V dc feedback signal.
3. Operator Motors:

a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
b. Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
c. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.

4. Non-spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
5. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf.
6. Size dampers for running torque calculated as follows:

    a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. of damper.
    b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.
    c. Dampers with 2 to 3 Inches wg of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.
    d. Dampers with 3 to 4 Inches wg of Pressure Drop or Face Velocities of 2500 to 3000 fpm: Increase running torque by 2.0.

7. Coupling: V-bolt and V-shaped, toothed cradle.
8. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
9. Fail-Safe Operation: Mechanical, spring-return mechanism with external, manual gear release on non-spring-return actuators.
10. Power Requirements (Two-Position Spring Return): 24 V dc.
11. Power Requirements (Modulating): Maximum 10 VA at 24 V ac or 8 W at 24 V dc.
12. Proportional Signal: 2 to 10 V dc or 4 to 20 mA, and 2 to 10 V dc position feedback signal.
13. Temperature Rating: Minus 22 to plus 122 deg F.

2.12 ELECTRICAL POWER CONNECTIONS

A. Single-Point Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other necessary electrical devices shall provide a single-point field power connection to unit.

B. Enclosure: NEMA 250, Type 3R, mounted in unit with hinged access door in unit cabinet having a lock and key or padlock and key.

C. Wiring: Numbered and color-coded to match wiring diagram.

D. Wiring Location: Install factory wiring outside an enclosure in a raceway.

E. Power Interface: Field power interface to be NEMA KS 1, heavy-duty, nonfused disconnect switch.

F. Factory Wiring: Branch power circuit to each motor and to controls with one of the following disconnecting means:

1. NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection in accordance with IEC 60947-4-1.
2. NEMA KS 1, heavy-duty, non-fusible switch.
3. UL 489, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.

G. Factory-Mounted, Overcurrent-Protection Service: For each motor.

H. Transformer: Factory mounted with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.

I. Controls: Factory wire unit-mounted controls where indicated.

1. Service Lights: 60watt LED vaporproof luminaire with individual switched junction box located inside, adjacent to each access door and panel.

a. Locations: Each section accessed with door or panel.

2. Convenience Outlets: One 20 A duplex GFCI receptacle per location with junction box located on outside casing wall.

a. Locations: Fan section.

J. Control Relays: Auxiliary and adjustable time-delay relays.

2.13 CONTROLS

A. Comply with requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC" for control equipment and sequence of operation.

B. Control Wiring: Factory wire connection for controls' power supply.

C. Control Devices: Sensors, transmitters, relays, switches, detectors, operators, actuators, and valves shall be manufacturer's standard items to accomplish indicated control functions.

D. Remote or Unit-Mounted Status Panel:

1. Cooling/Off/Heating Controls: Control operational mode.
2. Damper Position: Indicate position of outdoor-air dampers in terms of percentage of outdoor air.
3. Status Lights:

a. Filter dirty.
b. Fan operating.
c. Cooling operating.
d. Heating operating.
e. Smoke alarm.
f. General alarm.

4. Digital Numeric Display:

a. Outdoor airflow.
b. Supply airflow.

c. Outdoor dry-bulb temperature.
d. Outdoor dew point temperature.
e. Space temperature.
f. Supply temperature.
g. Space relative humidity.
h. Space carbon dioxide level.

E. Refrigeration System Controls:

1. Unit-mounted enthalpy controller shall lock out refrigerant system when outdoor-air enthalpy is less than 28 Btu/lb of dry air or outdoor-air temperature is less than 60 deg F.
2. Outdoor-air sensor de-energizes dehumidifier operation when outdoor-air temperature is less than 60 deg F.
3. Relative-humidity sensor energizes dehumidifier operation when relative humidity is more than 50 percent.

F. Heat-Exchanger Control:

1. Sequence with refrigeration system controls and heating controls.

G. Damper Controls: Space-pressure sensor modulates outdoor- and relief-air dampers to maintain a positive pressure in space at a minimum of 0.05-inch wg with respect to outdoor reference.

H. DDC Temperature Control: Standalone control module for link between unit controls and DDC temperature-control system. Control module shall be compatible with control system specified in Section 230923 "Direct Digital Control (DDC) System for HVAC." Links shall include the following:
1. Start/stop interface relay, and relay to notify DDC temperature-control system alarm condition.
2. Hardware interface or additional sensors for the following:
a. Room temperature.
b. Discharge-air temperature.
c. Refrigeration system operating.
d. Constant and variable motor loads.
e. Variable-frequency-controller operation.
f. Cooling load.
g. Economizer status.
h. Air-distribution static pressure and ventilation-air volumes.

I. Interface with DDC System for HVAC: Factory-installed hardware and software to enable the DDC system for HVAC to monitor, control, and display unit status and alarms.

1. Hardwired Points:

a. Monitoring: On-off status, common trouble alarm.
b. Control: On-off operation, supply temperature set-point adjustment space humidity set-point adjustment.

2. ASHRAE 135 (BACnet) Modbus communication interface with the DDC system for HVAC shall enable the DDC system for HVAC operator to remotely control and monitor the unit from an operator workstation. Control features and monitoring points displayed locally at unit control panel shall be available through the DDC system for HVAC.

2.14 ROOF CURBS

A. SPRING VIBRATION ISOLATION ROOF CURBS

B. Wind Restraints: Metal brackets compatible with the curb and casing, painted to match RTU, used to anchor unit to the curb, and designed for loads at Project site. Comply with code requirements for wind-load requirements.

C. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.

D. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.

E. Materials: ASTM C 1071, Type I or II.

F. Minimum Thickness: 1-1/2 inches.

G. 3 pound per cubic foot density fiberglass insulation.

H. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.

I. Liner Adhesive: Comply with ASTM C 916, Type I.

J. 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.

K. Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.

L. Liner Adhesive: Comply with ASTM C 916, Type I.

M. Curb Dimensions: Height of 24 inches full length and width of unit.

N. The lower member shall consist of galvanized steel Z section or channel containing adjustable and removable steel springs that support the upper floating section. The upper frame shall provide continuous support for the equipment and shall be captive so as to resiliently resist wind forces. All directional neoprene snubber bushings shall be a minimum of 1/4" thick. Steel springs shall be laterally stable and rest on 1/4" thick neoprene acoustical pads. Hardware must be nickel plated and the springs provided with a rust resistant finish. The curbs waterproofing shall consist of a continuous

galvanized flexible counter flashing fastened over the lower curb's waterproofing and joined at the corners by EPDM bellows. All spring locations shall have access ports with removable waterproof covers. Lower curbs shall have provision for 2" of insulation. Curb shall be type RSC as manufactured by Mason Industries, Inc

1. Optional equipment.
2. Sheet metal access doors in front of spring isolators
3. Acoustic package (2) sealed layers of gypsum attached to the floating upper base supported by steel members around the perimeter and across the width of the curb.

O. Curb Dimensions: Height of 24 inches. Provide adaptable horizontal dimensions as required for existing roof openings.

P. Wind and Seismic Restraints: Metal brackets compatible with the curb and casing, painted to match unit, used to anchor unit to the curb, and designed for loads at Project site. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" for wind-load requirements.

2.15 INTAKE AND RELIEF OPENINGS

A. Type: Manufacturer's standard hood or louver, including moisture eliminator, at all unit intake and relief openings.

B. Materials: Match material and finish of casing exterior.

C. Bird Screen: Comply with requirements in ASHRAE 62.1.

D. Configuration: Designed to inhibit wind-driven rain and snow from entering unit.

2.16 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. Comply with Section 230546 "Coatings for HVAC" for corrosion-resistant coating.

2.17 SOURCE QUALITY CONTROL

A. AHRI 920: Manufacturer to certify that performance ratings are in accordance with AHRI 920 if AHRI 920 certification program is not in place. Provide AHRI 920 certification if AHRI 920 certification program is in place.

B. AHRI 260 or AMCA 311 Sound Performance Rating Certification: Test, rate, and label unit fan sound ratings in accordance with AHRI 260 or AMCA 311.

C. Fan Aerodynamic Performance Rating: Test and rate fan performance for airflow, pressure, power, air density, rotation speed, and efficiency.

1. Fan Aerodynamic Performance Rating: Test and rate fan performance in accordance with AMCA 210 or 211

D. Fan Energy Index (FEI): Test in accordance with AMCA 210 and rate in accordance with AMCA 99, AMCA 207, and AMCA 208.

E. Fan Operating Limits: Classify fans in accordance with AMCA 99, Section 14.

F. Damper Leakage and Air

G. Performance:

1. Damper Rating: Test and rate dampers for leakage and air performance in accordance with AMCA 510 or AMCA 511

H. Water Coils: Factory tested to 300 psig in accordance with AHRI 410 and ASHRAE 33.

I. Refrigerant Coils: Factory tested to minimum 300 psig internal pressure and to minimum 300 psig internal pressure while under water, in accordance with AHRI 410 and ASHRAE 33.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping, ducts, and electrical systems to verify actual locations of connections before equipment installation.

C. Examine roof curbs and equipment supports for suitable conditions where units will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Roof Curb: Install on roof structure or concrete base, level and secure, in accordance with NRCA's "The NRCA Roofing Manual: Membrane Roof Systems" <Insert reference document>. Install units on curbs and coordinate roof penetrations and flashing with roof construction specified in Section 077200 "Roof Accessories." Secure units to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts. Coordinate sizes and locations of roof curbs with actual equipment provided.

B. Unit Support: Install unit level on structural curbs. Coordinate roof penetrations and flashing with roof construction. Secure units to structural support with anchor bolts. Coordinate sizes and locations of curbs with actual equipment provided.

C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing with new, clean filters.

D. Install filter-gauge, static-pressure taps upstream and downstream of filters. Mount filter gauges on outside of filter housing or filter plenum in accessible position. Provide filter gauges on filter banks, installed with separate static-pressure taps upstream and downstream of filters.

E. Connect duct to air-handling units with flexible connections. Comply with requirements in Section 233300 "Air Duct Accessories."

F. Install wall- and duct-mounted sensors furnished by manufacturer for field installation. Install control wiring and make final connections to control devices and unit control panel.

G. Comply with requirements for gas-fired furnace installation in NFPA 54.

H. Install separate devices furnished by manufacturer and not factory installed.

I. Install new filters at completion of equipment installation and before testing, adjusting, and balancing.

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 units, allow space for service and maintenance.

C. Connect piping to units mounted on vibration isolators with flexible connectors.

D. Refrigerant Piping: Comply with applicable requirements in Section 232300 "Refrigerant Piping." Install shutoff valve and union or flange at each supply and return connection.

E. Duct Connections:

1. Comply with requirements in Section 233113 "Metal Ducts."
2. Drawings indicate the general arrangement of ducts.
3. Connect ducts to units with flexible duct connectors. Comply with requirements for flexible duct connectors in Section 233300 "Air Duct Accessories."

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. 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, as specified in Section 260553 "Identification for Electrical Systems."
2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.5 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

3.6 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. Inspect units for visible damage to furnace combustion chamber.
3. Perform the following operations for both minimum and maximum firing, and adjust burner for peak efficiency:

a. Measure gas pressure at manifold.
b. Measure combustion-air temperature at inlet to combustion chamber.
c. Measure flue-gas temperature at furnace discharge.
d. Perform flue-gas analysis. Measure and record flue-gas carbon dioxide and oxygen concentration.
e. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.

4. Verify operation of remote panel, including pilot-light operation and failure modes. Inspect the following:

    a. High-limit heat exchanger.
    b. Alarms.

5. Inspect units for visible damage to refrigerant compressor, condenser and evaporator coils, and fans.
6. Start refrigeration system when outdoor-air temperature is within normal operating limits. and measure and record the following:

    a. Cooling coil leaving-air, dry- and wet-bulb temperatures.
    b. Cooling coil entering-air, dry- and wet-bulb temperatures.
    c. Condenser coil entering-air dry-bulb temperature.
    d. Condenser coil leaving-air dry-bulb temperature.

7. Simulate maximum cooling demand and inspect the following:

    a. Compressor refrigerant suction and hot-gas pressures.
    b. Short-circuiting of air through outside coil or from outside coil to outdoor-air intake.

8. Inspect casing insulation for integrity, moisture content, and adhesion.
9. Verify that clearances have been provided for servicing.
10. Verify that controls are connected and operable.
11. Verify that filters are installed.
12. Clean coils and inspect for construction debris.
13. Clean furnace flue and inspect for construction debris.
14. Inspect operation of power vents.
15. Purge gas line.
16. Inspect and adjust vibration isolators and seismic restraints.
17. Verify bearing lubrication.
18. Clean fans and inspect fan-wheel rotation for movement in correct direction without vibration and binding.
19. Adjust fan belts to proper alignment and tension.
20. Start unit.
21. Inspect and record performance of interlocks and protective devices, including response to smoke detectors by fan controls and fire alarm.
22. Operate unit for run-in period.
23. Calibrate controls.
24. Adjust and inspect high-temperature limits.

25. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
26. Verify operational sequence of controls.
27. Measure and record the following airflows. Plot fan volumes on fan curve.

    a. Supply-air volume.
    b. Relief-air flow.
    c. Outdoor-air flow.

B. After startup, change filters, verify bearing lubrication, and adjust belt tension.

C. Remove and replace components that do not properly operate and repeat startup procedures as specified above.

D. Prepare written report of the results of startup services.

3.7 ADJUSTING

A. Adjust initial temperature and humidity set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to the Project during other-than-normal occupancy hours for this purpose.

3.8 CLEANING

A. After completing system installation; testing, adjusting, and balancing dedicated outdoor-air unit and air-distribution systems; and completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, casings, dampers, coils, and filter housings, and install new, clean filters.

3.9 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

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

1. Leak Test: After installation, fill water and steam coils with water, and test coils and connections for leaks.

2. Charge refrigerant coils with refrigerant and test for leaks.
3. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

3.10 SEQUENCE OF OPERATION

A. General

1. The building automation System (BAS) or Building management System (BMS) shall index the equipment into either summer or winter control based upon outdoor air temperature. Below 65 F, (adjustable), outside air temperature, the cooling shall be disabled. Above 55F, (adjustable), outside air temperature the heating shall disabled. The system operator shall have capacity of overriding the system for manual change over. A minimum time delay, (24 hrs adjustable), between summer/winter changes over shall prevent cycling between the 2 modes. During heating mode, the DX systems shall be locked out.

B. Dedicated Outside Air Units (Constant Volume)

The dedicated outdoor air ERV units (ERV) shall be arranged to operate during scheduled occupied hours. When the units are off. The outside air intake and exhaust dampers shall be closed. The fan shall be off. Enthalpy wheel and fans shall run continuously when the unit is energized to run. The heating cooling coil shall be arranged to maintain a supply air temperature of neutral at 70 deg F. Provide outside air temperature and humidity sensors. Provide SA temperature sensors. When OA temp drops below set point the DX coil shall be arranged to heat the SA. When OA temp rises above set point the DX coil shall be arranged to cool the SA. The system shall also be arranged to maintain % RH of the SA at a maximum of 50% RH adjustable. When SA RH rises above set point the unit shall active DX cooling and sub cool the SA in order to reduce RH. The air shall be reheated by use of modulating hot gas reheat coil. Provide enthalpy controls arranged to allow economizer cycle. Provide defrost controls arranged to operate the defrost cycle as per the manufacturers recommendations.

3.11 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 237433

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:

1. Ductless fan coil units and accessories.
2. Ducted fan coil units and accessories.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, and furnished specialties and accessories.

B. Shop Drawings:

1. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Include diagrams for power, signal, and control wiring.

C. Samples for Initial Selection: For units with factory-applied color finishes.

D. Samples for Verification: For each type of fan coil unit indicated.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Suspended ceiling components.
2. Structural members to which fan coil units 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 the finished ceiling, including the following:

    a. Lighting fixtures.
    b. Air outlets and inlets.
    c. Speakers.
    d. Sprinklers.
    e. Access panels.

6. Perimeter moldings.

7. Floor and wall openings

B. Field quality-control reports.

C. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fan coil units to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

    a. Maintenance schedules and repair part lists for motors, coils, integral controls, and filters.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fan Coil Unit Filters: Furnish 1 spare filter for each filter installed.
2. Fan Belts: Furnish 1 spare fan belt for each of the unit installed.

1.7 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.8 COORDINATION

A. Coordinate layout and installation of fan coil units and suspension system components with other construction that penetrates or is supported by ceilings, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

B. Coordinate size and location of wall sleeves for outdoor-air intake.

C. Coordinate the size and location of the floor opening for piping

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of condensing units that fail in materials or workmanship within the specified warranty period.

1. Warranty Period: Five years from the date of Substantial Completion.

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. Factory-packaged and -tested units rated according to AHRI 440, ASHRAE 33, and UL 1995.

2.2 DUCTED/DUCTLESS FAN COIL UNITS

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

1. Carrier Corporation; a unit of United Technologies Corp.
2. Daikin Applied.
3. ENVIRO-TEC; by Johnson Controls, Inc.
4. First Company Products.
5. Greenheck Fan Corporation.
6. Trane Inc.

B. Coil Configurations:

1. Number of Heating Coils: 1 row
2. Number of Cooling Coils: 4 row

C. Coil Section Insulation: 1-inch- thick, coated glass fiber complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.

1. Surface-Burning Characteristics: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84 by a qualified testing agency.
2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Coil Section Insulation: Insulate coil section according to Section 230616 "HVAC Equipment Insulation."

1. Surface-Burning Characteristics: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84 by a qualified testing agency.
2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

E. Main and Auxiliary Drain Pans: Stainless steel or Insulated galvanized steel with plastic liner. Fabricate pans and drain connections to comply with ASHRAE 62.1.

F. Chassis: Galvanized steel where exposed to moisture, with baked-enamel finish and removable access panel, or with powder-coat finish and removable access panel. Floor-mounting units shall have leveling screws.

G. Ducted Unit Cabinets: Steel with baked-enamel finish in manufacturer's standard paint color.

1. Supply-Air Plenum: Sheet metal plenum finished and insulated to match the chassis with mill-finish, aluminum, double-deflection grille.
2. Return-Air Plenum: Sheet metal plenum finished to match the chassis.
3. Dampers: Galvanized steel with extruded-vinyl blade seals, flexible-metal jamb seals, and interlocking linkage.

H. Ductless Unit Cabinet: Steel with baked enamel finish in manufacturer's custom paint color as selected by the architect.

1. Vertical Unit Front Panels: Removable, steel, with [integral stamped] [Stainless] [steel] discharge grille and channel-formed edges, cam fasteners, and insulation on back of panel.
2. Horizontal Unit Bottom Panels: Fastened to the unit with cam fasteners and a hinge and attached with a safety chain; with [integral stamped] [cast-aluminum] discharge grilles.
3. Steel recessing flanges for recessing fan coil units into ceiling or wall.

I. Filters: Minimum arrestance and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2 and all addenda.
1. MERV Rating: 6 when tested according to ASHRAE 52.2.

2. Pleated Cotton-Polyester Media: 90 percent arrestance and MERV 3.

J. Hydronic heating and cooling Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, 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.

K. Direct-Driven Fans: Double width, forward curved, centrifugal; with permanently lubricated, multispeed motor, resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and painted-steel or galvanized-steel fan scrolls.

1. Motors: Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."

L. Factory, Hydronic Piping Package: ASTM B 88, Type L or ASTM B 88, Type M copper tube with wrought-copper fittings and brazed joints. Label piping to indicate service, inlet, and outlet.

1. 2-way, two-position modulating control valve for chilled-water coil.
2. 2-way, two-position modulating control valve for heating coil.
3. Hose Kits: Minimum 400-psig working pressure and operating temperatures from 33 to 211 deg F. Tag hose kits to equipment designations.

    a. Length: 12 inches minimum.
    b. Minimum Diameter: Equal to fan coil unit connection size.

4. Two-Piece Ball Valves: Bronze body with full-port, chrome-plated bronze ball; PTFE or TFE seats; and 600-psig minimum CWP rating and blowout-proof stem. Supply side
5. Calibrated-Orifice Balancing Valves: Bronze body, ball type; 125-psig working pressure, 250 deg F maximum operating temperature; with calibrated orifice or venturi, connections for portable differential pressure meter with integral seals, threaded ends, and a memory stop to retain set position. Return side
6. Y-Pattern Hydronic Strainers: Cast-iron body (ASTM A 126, Class B); 125-psig working pressure; with threaded connections, bolted cover, perforated stainless-steel basket, and bottom drain connection. Include a minimum NPS 1/2 hose-end, full-port, ball-type blowdown valve in the drain connection.
7. Wrought-Copper Unions: ASME B16.22.
8. Risers: ASTM B 88, Type L or ASTM B 88, Type M copper pipe with hose and ball valve for system flushing.

M. Operational sequences are specified in Section 230993 "Sequence of Operations for HVAC Equipment."

N. DDC Terminal Controller:

1. Scheduled Operation: Occupied and unoccupied periods on a seven-day clock with a minimum of four programmable periods per day.

2. Unoccupied-Period-Override Operation: 2 hours.
3. Unit Supply-Air Fan Operation:

    a. Occupied Periods: Fan runs continuously.
    b. Unoccupied Periods: Fan cycles to maintain room setback temperature.

4. Hydronic-Cooling-Coil Operation:

    a. Occupied Periods: Modulate the control valve to maintain room temperature.
    b. Unoccupied Periods: Close the control valve.

5. Controller shall have volatile-memory backup.

O. Interface with DDC System for HVAC Requirements:

1. Interface relay for scheduled operation.
2. Interface relay to provide an indication of fault at the central workstation.
3. Provide BACnet interface for the central DDC system for HVAC workstation for the following functions:

    a. Adjust set points.
    b. Fan coil unit start, stop, and operating status.
    c. Data inquiry, including supply- and room-air temperature and humidity.
    d. Occupied and unoccupied schedules.

P. Electrical Connection: Factory-wired motors and controls for a single electrical connection.

Q. Capacities and Characteristics: Refer to drawing notes and Schedules

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, to receive fan coil units 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 fan coil unit installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install fan coil units level and plumb.

B. Install fan coil units to comply with NFPA 90A.

C. Suspend fan coil units from the structure with elastomeric hangers. Vibration isolators are specified in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."

D. Verify locations of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices in accordance with ADA requirements.

E. Install new filters in each fan coil unit within two weeks after Substantial Completion.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate the general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:

1. Install piping adjacent to the machine to allow service and maintenance.
2. Connect piping to the fan coil unit factory hydronic piping package. Install the piping package if shipped loose.
3. Connect the condensate drain to the indirect waste.

    a. Install condensate trap of adequate depth to seal against fan pressure. Install cleanouts in piping at changes of direction.

B. Connect supply-air and return-air ducts to fan coil units with flexible duct connectors specified in Section 233300 "Air Duct Accessories." Comply with safety requirements in UL 1995 for duct connections.

C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

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

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

3.5 ADJUSTING

A. Adjust initial temperature and humidity set points.

B. Occupancy Adjustments: When requested within 12 months of the date of Substantial Completion, provide on-site assistance in adjusting the 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. Train Owner's maintenance personnel to adjust, operate, and maintain fan coil units.

END OF SECTION 238219

SECTION 238236 - FINNED-TUBE AND FLAT PANEL RADIATION, AND CONVECTORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes hydronic, baseboard, and finned-tube radiation heaters.

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 and dimensions of custom-fabricated enclosures.
4. Indicate the location and size of each field connection.
5. Indicate location and arrangement of piping valves and specialties.
6. Indicate location and arrangement of integral controls.
7. Include enclosure joints, corner pieces, access doors, and other accessories.
8. Include diagrams for power, signal, and control wiring.

C. Samples: For each exposed product and for each color and texture specified.

D. Color Samples for Initial Selection: For finned-tube radiation heaters with factory-applied color finishes.

E. Color Samples for Verification: For each type of exposed finish.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Structural members, including wall construction, to which finned-tube radiation heaters will be attached.
2. Method of attaching finned-tube radiation heaters to building structure.
3. Penetrations of fire-rated wall and floor assemblies.

B. Field quality-control reports.

PART 2 - PRODUCTS

2.1 HOT-WATER FINNED-TUBE RADIATION

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

1. Slant/Fin Corp.
2. Sterling HVAC Products; a Mestek company.
3. Rittling
4. Vulcan

B. Performance Ratings: Rate finned-tube radiation heaters according to Hydronics Institute's "I=B=R Testing and Rating Standard for Finned-Tube (Commercial) Radiation."

C. Heating Elements: Copper tubing mechanically expanded into flanged collars of evenly spaced aluminum fins resting on element supports. One end of tube shall be belled for attachment to standard copper pipe.

D. Element Supports: Ball-bearing cradle type to permit longitudinal movement on enclosure brackets.

E. Front Panel: Minimum 0.0528-inch- thick steel.

F. Rust-Resistant Front Panel: Minimum 0.052-inch- thick, ASTM A 653/A 653M, G60 galvanized steel.

G. Wall-Mounted Back Panel: Minimum 0.0329-inch-thick steel, full height, with full-length channel support for front panel without exposed fasteners.

H. Floor-Mounted Pedestals: Conceal insulated piping at maximum 36-inch spacing. Pedestal-mounted back panel shall be a solid panel matching the front panel. Provide stainless-steel escutcheon for floor openings at pedestals.

I. Support Brackets: Locate at a maximum 36-inch spacing to support the front panel and element.

J. Finish: Baked-enamel finish in manufacturer's custom color as selected by Engineer/Architect. Submit the color chart for review and approval.

K. Damper: Knob-operated internal damper at enclosure outlet.

L. Access Doors: Factory-made, permanently hinged with tamper-resistant fastener, minimum size 6 by 7 inches, integral with enclosure.

M. Enclosure Style: Sloped or Flat top as indicated on plan.

1. Front Inlet Grille: enclosure shall be mounted 4” – 6” above finished floor.
2. Top Outlet Grille: Extruded-aluminum linear bar grille; pencil-proof bar spacing.

    a. Mill-finish aluminum.

3. Enclosure Height: refer to plans.
4. Enclosure Depth: refer to plans.

N. Accessories: Filler sections, corners, relay sections, and splice plates all matching the enclosure and grille finishes.

2.2 HOT-WATER CABINET CONVECTORS

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

1. Slant/Fin Corp.
2. Sterling HVAC Products; a Mestek company.
3. Rittling
4. Vulcan

B. Heating Elements: Seamless copper tubing mechanically expanded into evenly spaced aluminum fins and rolled into cast-iron or brass headers with inlet/outlet and air vent; steel side plates and supports. Factory-pressure-test element at a minimum 100 psig. Refer to plans and equipment notes for dimensions and capacities.

C. Front and Top Panel: Minimum 0.0677-inch- thick steel with exposed corners rounded; removable front panels with tamper-resistant fasteners braced and reinforced for stiffness.

D. Wall-Mounted Back and End Panels: Minimum 0.0428-inch-thick steel.

E. Floor-Mounted Pedestals: Conceal control wiring at a maximum 36-inch spacing. Pedestal-mounted back panel shall be a solid panel matching the front panel.

F. Support Brackets: Locate at maximum 36-inch spacing to support the front panel and element.

G. Insulation: 1/2-inch-thick, fibrous glass on the inside of the back of the enclosure.

H. Finish: Baked-enamel finish in manufacturer's custom color as selected by Engineer/Architect. Submit the color chart for review and approval.

I. Damper: Knob-operated internal damper.

J. Access Doors: Factory-made, permanently hinged with tamper-resistant fastener, minimum size 6 by 7 inches, integral with enclosure.

K. Enclosure Style: Sloped or Flat top as per plans and schedule.
   1. Front Inlet Grille: Extruded-aluminum linear bar grille; pencil-proof bar spacing.
      a. Mill-finish aluminum.
   2. Top Outlet Grille: Extruded-aluminum linear bar grille; pencil-proof bar spacing.
      a. Mill-finish aluminum.
   3. Refer to plans and schedules for dimensions.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive finned-tube radiation heaters for compliance with requirements for installation tolerances and other conditions affecting the performance of the Work.

B. Examine roughing-in for hydronic-piping connections to verify actual locations before installation of finned-tube radiation heaters.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FINNED-TUBE RADIATION HEATER INSTALLATION

A. Install unit-level and plumb.

B. Install enclosure continuously around corners, using outside and inside corner fittings.

C. Join sections with splice plates and filler pieces to provide a continuous enclosure.

D. Install access doors for access to valves.

E. Install enclosure continuously from wall to wall.

F. Terminate enclosures with manufacturer's end caps except where enclosures are indicated to extend to adjoining walls.

G. Install valves within reach of the access door provided in the enclosure.

H. Install an air-seal gasket between the wall and recessed flanges or front cover of a fully recessed unit.

I. Install piping within pedestals for freestanding units.

3.3 CONNECTIONS

A. Piping installation requirements are specified in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Drawings indicate the general arrangement of piping, fittings, and specialties.

B. Connect hot-water finned-tube radiation heaters and components to piping according to Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties."

1. Install shutoff valves on the inlet and outlet, and a balancing valve on the outlet.

2. Install a shutoff valve on the inlet; install a strainer, and a shutoff valve on the outlet.

C. Install control valves as required by Section 230923.11 "Control Valves."

D. Install piping adjacent to finned-tube radiation heaters to allow service and maintenance.

E. Ground electric finned-tube radiation heaters according to Section 260526 "Grounding and Bonding for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections:

1. Leak Test: After installation, charge the 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.

B. Units will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION 238236

SECTION 238239.16 - PROPELLER UNIT HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes propeller unit heaters with [hot-water] [steam] [electric-resistance heating] coils.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

B. PTFE: Polytetrafluoroethylene plastic.

C. TFE: Tetrafluoroethylene plastic.

1.4 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 the location and size of each field connection.
4. Include details of anchorages and attachments to the 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.

1.5 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 propeller 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 the finished ceiling, including the following:

a. Lighting fixtures.
b. Air outlets and inlets.
c. Speakers.
d. Sprinklers.
e. Access panels.
f. Other equipment

B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For propeller unit heaters to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products shall be one of the following;
1. Rattling
2. Sterling
3. Modine
4. Vulcan

2.2 DESCRIPTION

A. Assembly including casing, coil, fan, and motor in vertical and/or horizontal discharge configuration as scheduled with adjustable discharge louvers.

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. Electric propeller unit heaters shall comply with UL 2021

D. Explosion-proof electric propeller unit heaters shall comply with UL 823.

2.3 PERFORMANCE REQUIREMENTS

A. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

2.4 HOUSINGS

A. Finish: Manufacturer's standard baked enamel applied to factory-assembled and -tested propeller unit heaters before shipping.

B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

C. Discharge Louver: Adjustable fin diffuser for horizontal units and conical diffuser for vertical units.

2.5 COILS

A. General Coil Requirements: Test and rate hot-water and steam propeller unit-heater coils according to ASHRAE 33.

B. Hot-Water Coil: Copper tube, minimum 0.025-inch wall thickness, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 325 deg F, with manual air vent. Test for leaks to 350 psig underwater.

C. Steam Coil: Copper tube, minimum 0.025-inch wall thickness, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 75 psig.

D. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and 60-Hz hum, embedded in magnesium oxide refractory and sealed in steel or corrosion-resistant metallic sheath with fins no closer than 0.16 inch. Element ends shall be enclosed in a terminal box. Fin surface temperature shall not exceed 550 deg F at any point during normal operation.

1. Circuit Protection: One-time fuses in the terminal box for overcurrent protection and limit controls for high-temperature protection of heaters.
2. Wiring Terminations: Stainless-steel or corrosion-resistant material.

2.6 FAN AND MOTOR

A. Fan: Propeller type with aluminum wheel directly mounted on motor shaft in the fan venturi.

B. Motor: Permanently lubricated, multispeed. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."

2.7 CONTROLS

A. Control Devices:

1. Wall-mounted, fan-speed switch, and thermostat compatible with building temperature control system.

2. Provide strap on “aquastat” on the HW supply line to prevent fan start-up if hot water is not available.

2.8 CAPACITIES AND CHARACTERISTICS

A. Heating Capacity are as scheduled or noted on plans.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive propeller unit heaters for compliance with requirements for installation tolerances and other conditions affecting the 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 propeller unit heaters to comply with NFPA 90A.

B. Install propeller unit heaters level and plumb.

C. Suspend propeller unit heaters from structure with all-thread hanger rods and elastomeric hangers or spring hangers Hanger rods and attachments to structure are specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment." Vibration hangers are specified in Section 230548.13 "Vibration Controls for HVAC."

D. Install wall-mounted thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify the location of thermostats and other exposed control sensors with Drawings and room details before installation.

3.3 CONNECTIONS

A. Drawings indicate the general arrangement of piping, fittings, and specialties. Piping installation requirements are specified in the following Sections:
   1. [Section 232113 "Hydronic Piping."]
   2. [Section 232116 "Hydronic Piping Specialties."]
   3. [Section 232213 "Steam and Condensate Heating Piping."]
   4. Section 232216 "Steam and Condensate Heating Piping Specialties."

B. Install piping adjacent to the machine to allow service and maintenance.

C. Connect piping to the propeller unit heater's factory, hot-water piping package. Install the piping package if shipped loose.

D. For units, hot water or steam coils comply with safety requirements in UL 1995.

E. For hot water unit, unless otherwise indicated, install union and gate or ball valve and strainer on the supply-water connection and union and calibrated balancing valve on return-water connection of propeller unit heater. Hydronic specialties are specified in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties."

F. For steam units, unless otherwise indicated, install a union, drip leg, and gate or ball valve on the steam-supply connection and union, strainer, steam trap, and gate or ball valve on the condensate-return connection of the propeller unit heater. Steam specialties are specified in Section 232216 "Steam and Condensate Piping Specialties."

G. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

H. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests:

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 the date of Substantial Completion, provide on-site assistance in adjusting the 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. Train Owner's maintenance personnel to adjust, operate, and maintain propeller unit heaters.

END OF SECTION 238239.16

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Building wires and cables rated 600 V and less.
2. Connectors, splices, and terminations rated 600 V and less.

1.3 DEFINITIONS

A. VFC: Variable frequency controller.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

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. Alpha Wire Company.
2. Belden Inc.
3. Cerro Wire LLC.
4. Encore Wire Corporation.

5. General Cable Technologies Corporation.
6. General Cable; General Cable Corporation.
7. Senator Wire & Cable Company.
8. Southwire Company.

B. Copper Conductors: Comply with NEMA WC 70/ICEA S-95-658.

C. Conductor Insulation: Comply with NEMA WC 70/ICEA S-95-658 for Type THHN/THWN-2, Type XHHW-2 and Type SO.

D. Multiconductor Cable: Comply with NEMA WC 70/ICEA S-95-658 for metal-clad cable, Type MC mineral-insulated, metal-sheathed cable, Type MI and Type SO with ground wire.

E. VFC Cable:

1. Comply with UL 1277, UL 1685, and NFPA 70 for Type TC-ER cable.
2. Type TC-ER with oversized crosslinked polyethylene insulation, spiral-wrapped foil plus 85 percent coverage braided shields and insulated full-size ground wire, and sunlight- and oil-resistant outer PVC jacket.

2.2 CONNECTORS AND SPLICES

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. 3M.
2. AFC Cable Systems, Inc.
3. Gardner Bender.
4. Hubbell Power Systems, Inc.
5. Ideal Industries, Inc.
6. ILSCO.
7. NSi Industries LLC.
8. O-Z/Gedney; an EGS Electrical Group brand; an Emerson Industrial Automation business.
9. Tyco Electronics Corp.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.3 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 NFPA 70.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger, except VFC cable, which shall be extra flexible stranded.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type XHHW-2, single conductors in raceway.

B. Exposed Feeders: Type THHN/THWN-2, single conductors in raceway or Mineral-insulated, metal-sheathed cable, Type MI.

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN/THWN-2, single conductors in raceway, Metal-clad cable, Type MC or Mineral-insulated, metal-sheathed cable, Type MI.

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW-2, single conductors in raceway.

E. Exposed Branch Circuits, Including in Crawlspaces: Type THHN/THWN-2, single conductors in raceway.

F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway or Metal-clad cable, Type MC.

G. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway or Type XHHW-2, single conductors in raceway.

H. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

I. VFC Output Circuits: Type TC-ER cable with braided shield.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.

B. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.

C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

F. Support cables according to Section 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. 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. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

3.5 IDENTIFICATION

A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."

B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.6 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 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

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 Section 078413 "Penetration Firestopping."

3.8 FIELD QUALITY CONTROL

A. Perform the following 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. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
3. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.

    a. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
    b. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

B. Test and Inspection Reports: Prepare a written report 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.

C. Cables will be considered defective if they do not pass tests and inspections.

END OF SECTION 260519

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes grounding and bonding systems and equipment, plus the following special applications:

1. Underground distribution grounding.
2. Foundation steel electrodes.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency and testing agency's field supervisor.

B. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

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 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Burndy; Part of Hubbell Electrical Systems.
2. ERICO International Corporation.
3. Galvan Industries, Inc.; Electrical Products Division, LLC.
4. Harger Lightning & Grounding.
5. ILSCO.
6. O-Z/Gedney; an EGS Electrical Group brand; an Emerson Industrial Automation business.
7. Siemens Power Transmission & Distribution, Inc.

2.2 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with UL 467 for grounding and bonding materials and equipment.

2.3 CONDUCTORS

A. Insulated Conductors: Copper 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.

C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches in cross section, with 9/32-inch holes spaced 1-1/8 inches apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V and shall be Lexan or PVC, impulse tested at 5000 V.

2.4 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

D. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

2.5 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel; 5/8 by 96 inches.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 2/0 AWG minimum.

1. Bury at least 24 inches below grade.

C. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Install bus horizontally, on insulated spacers 2 inches minimum from wall, 6 inches above finished floor unless otherwise indicated.
2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

D. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING AT THE SERVICE

A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

3.3 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements.

B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.

C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields according to written instructions by manufacturer of splicing and termination kits.

D. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches from the foundation.

3.4 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

C. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

D. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

E. Metallic Fences: Comply with requirements of IEEE C2.

1. Grounding Conductor: Bare, tinned copper, not less than No. 8 AWG.
2. Gates: Shall be bonded to the grounding conductor with a flexible bonding jumper.
3. Barbed Wire: Strands shall be bonded to the grounding conductor.

3.5 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
2. For grounding electrode system, install at least two rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

C. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

D. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

E. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.

F. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.

G. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; use a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG.

1. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.
2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

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.
3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at individual ground rods. Make tests at ground rods before any conductors are connected.

    a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
    b. Perform tests by fall-of-potential method according to IEEE 81.

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.
2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.

3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
4. Manhole Grounds: 10 ohms.

F. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect 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 RELATED DOCUMENTS

A. Drawings 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. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:

a. Hangers.
b. Steel slotted support systems.
c. Trapeze hangers.
d. Clamps.
e. Turnbuckles.
f. Sockets.
g. Eye nuts.
h. Saddles.
i. Brackets.

2. Include rated capacities and furnished specialties and accessories.

B. Delegated-Design Submittal: For hangers and supports for electrical systems.

1. Include design calculations and details of trapeze hangers.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M.
2. AWS D1.2/D1.2M.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design hanger and support system.

2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4 factory-fabricated components for field assembly.

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. Allied Tube & Conduit.
b. Cooper B-Line, Inc.; a division of Cooper Industries.
c. ERICO International Corporation.
d. GS Metals Corp.
e. Thomas & Betts Corporation, A Member of the ABB Group.
f. Unistrut; an Atkore International company.

2. Material: Galvanized steel.
3. Channel Width: 1-5/8 inches.
4. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
5. Channel Dimensions: Selected for applicable load criteria.

B. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

C. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.

D. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M steel plates, shapes, and bars; black and galvanized.

E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

    a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

        1) Hilti, Inc.
        2) ITW Ramset/Red Head; Illinois Tool Works, Inc.
        3) MKT Fastening, LLC.
        4) Simpson Strong-Tie Co., Inc.

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.

    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) Cooper B-Line, Inc.; a division of Cooper Industries.
        2) Empire Tool and Manufacturing Co., Inc.
        3) Hilti, Inc.
        4) ITW Ramset/Red Head; Illinois Tool Works, Inc.
        5) MKT Fastening, LLC.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded steel.

2.3 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

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. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."

C. 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.

D. 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.

1. Secure raceways and cables to these supports with two-bolt conduit clamps.

E. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMTs, IMCs, and RMCs may be supported by openings through structure members, according to NFPA 70.

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

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.

5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
6. To Steel: Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69.
7. To Light Steel: Sheet metal screws.
8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 033000 "Cast-in-Place Concrete."

C. Anchor equipment to concrete base as follows:

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

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

END OF SECTION 260529

SECTION 260533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Metal conduits, tubing, and fittings.
2. Nonmetal conduits, tubing, and fittings.
3. Metal wireways and auxiliary gutters.
4. Surface raceways
5. Boxes, enclosures, and cabinets.
6. Handholes and boxes for exterior underground cabling.

1.3 DEFINITIONS

A. GRC: Galvanized rigid steel conduit.

B. IMC: Intermediate metal conduit.

1.4 ACTION SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

1.5 INFORMATIONAL SUBMITTALS

A. Source quality-control reports.

PART 2 - PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. AFC Cable Systems, Inc.
2. Allied Tube & Conduit.
3. O-Z/Gedney; an EGS Electrical Group brand; an Emerson Industrial Automation business.
4. Republic Conduit.
5. Southwire Company.
6. Thomas & Betts Corporation, A Member of the ABB Group.
7. Western Tube and Conduit Corporation.
8. Wheatland Tube Company.

B. 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.

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. FMC: Comply with UL 1; zinc-coated steel.

G. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

H. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
2. Fittings for EMT:

a. Material: Steel or die cast.
b. Type: Compression.

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.

I. 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 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. AFC Cable Systems, Inc.
2. Arnco Corporation.
3. CANTEX INC.
4. CertainTeed Corporation.
5. Kraloy.
6. RACO; Hubbell.
7. Thomas & Betts Corporation, A Member of the ABB Group.

B. Listing and Labeling: Nonmetallic 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.

C. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.

D. Fittings for RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

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. Cooper B-Line, Inc.; a division of Cooper Industries.
2. Hoffman; a brand of Pentair Equipment Protection.
3. MonoSystems, Inc.
4. Square D.

B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.

1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Hinged type unless otherwise indicated.

E. Finish: Manufacturer's standard enamel finish.

2.4 SURFACE RACEWAYS

A. Listing and Labeling: Surface raceways shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color selected by Architect.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. Hubbell Incorporated; Wiring Device-Kellems.
b. MonoSystems, Inc.
c. Legrand/Wiremold
d. Panduit

2.5 BOXES, ENCLOSURES, AND CABINETS

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. Cooper Technologies Company.
2. EGS/Appleton Electric.
3. Erickson Electrical Equipment Company.
4. Hoffman; a brand of Pentair Equipment Protection.
5. Hubbell Incorporated.
6. MonoSystems, Inc.
7. O-Z/Gedney; an EGS Electrical Group brand; an Emerson Industrial Automation business.
8. RACO; Hubbell.
9. Thomas & Betts Corporation, A Member of the ABB Group.
10. Wiremold / Legrand.

B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.

E. Metal Floor Boxes:

1. Material: Cast metal or sheet metal.
2. Type: Fully adjustable.
3. Shape: Rectangular.
4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. 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.

G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

H. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, galvanized, cast iron with gasketed cover.

I. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

J. Device Box Dimensions: 4 inches square by 2-1/8 inches deep.

K. Gangable boxes are allowed.

L. 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.

M. 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.

2.6 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. General Requirements for Handholes and Boxes:

1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. Armorcast Products Company.
b. Carson Industries LLC.
c. NewBasis.
d. Oldcastle Precast, Inc.
e. Quazite: Hubbell Power Systems, Inc.
f. Synertech Moulded Products.

2. Standard: Comply with SCTE 77.
3. Configuration: Designed for flush burial with open bottom unless otherwise indicated.
4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
5. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
6. Cover Legend: Molded lettering, "ELECTRIC.".
7. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
8. Handholes 12 Inches Wide by 24 Inches Long and Larger: Have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.7 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Tests of materials shall be performed by an independent testing agency.
2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012 and traceable to NIST standards.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed Conduit: GRC or IMC.

2. Concealed Conduit, Aboveground: GRC or IMC.
3. Underground Conduit: RNC, Type EPC-40-PVC or Type EPC-80-PVC.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Indoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT.
2. Exposed, Not Subject to Severe Physical Damage: EMT.
3. Exposed and Subject to Severe Physical Damage: GRC or IMC. Raceway locations include the following:

   a. Loading dock.
   b. Mechanical rooms.

4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
6. Damp or Wet Locations: GRC or IMC.
7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in damp or wet locations.

C. Minimum Raceway Size: 3/4-inch trade size.

D. Raceway Fittings: Compatible with raceways 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 compression, steel or cast-metal fittings. Comply with NEMA FB 2.10.
3. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

E. Do not install aluminum conduits, boxes, or fittings.

F. Install surface raceways only where indicated on Drawings.

G. 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. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.

E. Arrange stub-ups so curved portions of bends are not visible above finished slab.

F. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.

G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

H. Support conduit within 12 inchesof enclosures to which attached.

I. Raceways Embedded in Slabs:

1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-footintervals.
2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
3. Arrange raceways to keep a minimum of 2 inches of concrete cover in all directions.
4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
5. Change from RNC, Type EPC-40-PVC to GRC or IMC before rising above floor.

J. Stub-ups to Above Recessed Ceilings:

1. Use EMT, IMC, or RMC for raceways.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

K. 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.

L. 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.

M. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

N. 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.

O. 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.

P. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

Q. 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.

R. 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.

S. 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.

T. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

U. 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.
    d. Attics: 135 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.

V. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFMC in damp or wet locations not subject to severe physical damage.

W. 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 bottom of box unless otherwise indicated.

X. 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.

Y. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

Z. Locate boxes so that cover or plate will not span different building finishes.

AA. 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.

BB. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

CC. Set metal floor boxes level and flush with finished floor surface.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 312000 "Earth Moving" for pipe less than 6 inches in nominal diameter.
2. Install backfill as specified in Section 312000 "Earth Moving."

3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 312000 "Earth Moving."
4. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.

    a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete for a minimum of 12 inches on each side of the coupling.
    b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.

5. Warning Planks: Bury warning planks approximately 12 inches above direct-buried conduits but a minimum of 6 inches below grade. Align planks along centerline of conduit.
6. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.

D. Install handholes with bottom below frost line, below grade.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables but short enough to preserve adequate working clearances in enclosure.

F. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.6 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.7 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533

SECTION 260544 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Silicone sealants.

B. Related Requirements:

1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

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 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 SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

    a. Advance Products & Systems, Inc.
    b. CALPICO, Inc.
    c. Metraflex Company (The).
    d. Pipeline Seal and Insulator, Inc.
    e. Proco Products, Inc.

2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Plastic.
4. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

    a. HOLDRITE.

2.4 GROUT

A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

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

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

D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

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 or cast-iron 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-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 260544

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Identification for raceways.
2. Identification of power and control cables.
3. Identification for conductors.
4. Underground-line warning tape.
5. Warning labels and signs.
6. Instruction signs.
7. Equipment identification labels.
8. Miscellaneous identification products.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for electrical identification products.

B. Identification Schedule: For each piece of electrical equipment and electrical system components to be an index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.

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. Raceways and Cables Carrying Circuits at More Than 600 V:

1. Black letters on an orange field.
2. Legend: "DANGER - CONCEALED HIGH VOLTAGE WIRING."

C. Warning labels and signs shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

2.3 LABELS

A. Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. Brady Corporation.
b. Champion America.
c. emedco.
d. Grafoplast Wire Markers.
e. LEM Products Inc.
f. Marking Services, Inc.
g. Panduit Corp.
h. Seton Identification Products.

B. Snap-Around Labels for Raceways and Cables Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters of raceways they identify, and that stay in place by gripping action.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

    a. Brady Corporation.
    b. Marking Services, Inc.
    c. Panduit Corp.
    d. Seton Identification Products.

C. Self-Adhesive Labels:

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. A'n D Cable Products.
    b. Brady Corporation.
    c. Brother International Corporation.
    d. emedco.
    e. Grafoplast Wire Markers.
    f. Ideal Industries, Inc.
    g. LEM Products Inc.
    h. Marking Services, Inc.
    i. Panduit Corp.
    j. Seton Identification Products.

2. Preprinted, 3-mil-thick, polyester or vinyl flexible label with acrylic pressure-sensitive adhesive.

    a. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over the legend. Labels sized to fit the cable or raceway diameter, such that the clear shield overlaps the entire printed legend.

3. Polyester or Vinyl, thermal, transfer-printed, 3-mil-thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

    a. Nominal Size: 3.5-by-5-inch.

4. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.
5. Marker for Tags: Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.

2.4 BANDS AND TUBES:

A. Snap-Around, Color-Coding Bands for Raceways and Cables: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches long, with diameters sized to suit diameters of raceways or cables they identify, and that stay in place by gripping action.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. Brady Corporation.
b. Marking Services, Inc.
c. Panduit Corp.

B. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tubes with machine-printed identification labels, sized to suit diameters of and shrunk to fit firmly around cables they identify. Full shrink recovery occurs at a maximum of 200 deg F. Comply with UL 224.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. Brady Corporation.
b. Panduit Corp.

2.5 TAPES AND STENCILS:

A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

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. Carlton Industries, LP.
b. Champion America.
c. Ideal Industries, Inc.
d. Marking Services, Inc.
e. Panduit Corp.

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.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. Brady Corporation.
b. Carlton Industries, LP.
c. emedco.
d. Marking Services, Inc.

C. Tape and Stencil for Raceways Carrying Circuits 600 V or Less: 4-inch-wide black stripes on 10-inch centers placed diagonally over orange background that extends full length of raceway or duct and is 12 inches wide. Stop stripes at legends.

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. LEM Products Inc.
b. Marking Services, Inc.
c. Seton Identification Products.

D. Floor Marking Tape: 2-inch-wide, 5-mil pressure-sensitive vinyl tape, with yellow and black stripes and clear vinyl overlay.

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. Carlton Industries, LP.
b. Seton Identification Products.

E. Underground-Line Warning Tape

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. Brady Corporation.
b. Ideal Industries, Inc.
c. LEM Products Inc.
d. Marking Services, Inc.
e. Reef Industries, Inc.
f. Seton Identification Products.

2. Tape:

a. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
b. Printing on tape shall be permanent and shall not be damaged by burial operations.
c. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.

3. Color and Printing:

    a. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, ANSI Z535.4, and ANSI Z535.5.
    b. Inscriptions for Red-Colored Tapes: "ELECTRIC LINE, HIGH VOLTAGE".
    c. Inscriptions for Orange-Colored Tapes: "TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE".

4. Tag:

    a. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core; bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
    b. Width: 3 inches.
    c. Overall Thickness: 5 mils.
    d. Foil Core Thickness: 0.35 mil.
    e. Weight: 28 lb/1000 sq. ft..
    f. Tensile according to ASTM D 882: 70 lbf and 4600 psi.

F. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

2.6 Tags

A. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking cable tie fastener.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

    a. Brady Corporation.
    b. Carlton Industries, LP.
    c. emedco.
    d. Marking Services, Inc.
    e. Seton Identification Products.

B. Nonmetallic Preprinted Tags: Polyethylene tags, 0.015 inch thick, color-coded for phase and voltage level, with factory printed permanent designations; punched for use with self-locking cable tie fastener.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

    a. Brady Corporation.
    b. Carlton Industries, LP.

c. emedco.
d. Grafoplast Wire Markers.
e. LEM Products Inc.
f. Marking Services, Inc.
g. Panduit Corp.
h. Seton Identification Products.

C. Write-On Tags:

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. Carlton Industries, LP.
b. LEM Products Inc.
c. Seton Identification Products.

2. Polyester Tags: 0.010 inch thick, with corrosion-resistant grommet and cable tie for attachment to raceway, conductor, or cable.
3. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.7 Signs

A. Baked-Enamel Signs:

1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
2. 1/4-inch grommets in corners for mounting.
3. Nominal Size: 7 by 10 inches.

4. 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. Carlton Industries, LP.
b. Champion America.
c. emedco.
d. Marking Services, Inc.

B. Metal-Backed Butyrate Signs:

1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs, with 0.0396-inch galvanized-steel backing and with colors, legend, and size required for application.
2. 1/4-inch grommets in corners for mounting.
3. Nominal Size: 10 by 14 inches.

4. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. Brady Corporation.
b. Champion America.
c. emedco.
d. Marking Services, Inc.

C. Laminated Acrylic or Melamine Plastic Signs:

1. Engraved legend.
2. Thickness:

a. For signs up to 20 sq. inches, minimum 1/16-inch-
b. For signs larger than 20 sq. inches, 1/8 inch thick.
c. Engraved legend with black letters on white face.
d. Punched or drilled for mechanical fasteners.
e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

3. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

a. Brady Corporation.
b. Carlton Industries, LP.
c. emedco.
d. Marking Services, Inc.

2.8 CABLE TIES

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. Ideal Industries, Inc.
2. Marking Services, Inc.
3. Panduit Corp.

B. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, 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.

C. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, 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.

D. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, self-locking.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F according to ASTM D 638: 7000 psi.
3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: Minus 50 to plus 284 deg F.
5. Color: Black.

2.9 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 PREPARATION

A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 INSTALLATION

A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.

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

C. Verify identity of each item before installing identification products.

D. 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.

E. Apply identification devices to surfaces that require finish after completing finish work.

F. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

G. Attach plastic raceway and cable labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.

H. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

I. Painted Identification: Comply with requirements in painting Sections for surface preparation and paint application.

J. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.

K. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

L. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.

3.3 IDENTIFICATION SCHEDULE

A. Accessible Raceways, Armored and Metal-Clad Cables, More Than 600 V: Snap-around labels. Install labels at 10-foot maximum intervals.

B. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits, More Than 30 A and 120 V to Ground: Identify with self-adhesive vinyl label. Install labels at 30-foot maximum intervals.

C. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels containing the wiring system legend and system voltage. System legends shall be as follows:

1. "STANDBY POWER."
2. "POWER."
3. "UPS."

D. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.

1. Color-Coding for Phase- and Voltage-Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder and branch-circuit conductors.

a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG if authorities having jurisdiction permit.
b. Colors for 208/120-V Circuits:

1) Phase A: Black.
2) Phase B: Red.
3) Phase C: Blue.

c. Colors for 480/277-V Circuits:

1) Phase A: Brown.
2) Phase B: Orange.
3) Phase C: Yellow.

d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

E. Power-Circuit Conductor Identification, More Than 600 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use nonmetallic preprinted tags colored and marked to indicate phase, and a separate tag with the circuit designation.

F. Install instructional sign, including the color code for grounded and ungrounded conductors using adhesive-film-type labels.

G. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use self-adhesive, self-laminating polyester labels with the conductor or cable designation, origin, and destination.

H. Control-Circuit Conductor Termination Identification: For identification at terminations, provide self-adhesive, self-laminating polyester labels with the conductor designation.

I. Conductors To Be Extended in the Future: Attach marker tape to conductors and list source.

J. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
2. Use system of marker-tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.

K. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.

1. Limit use of underground-line warning tape to direct-buried cables.
2. Install underground-line warning tape for direct-buried cables and cables in raceways.

L. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

M. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Metal-backed, butyrate warning signs.

1. Comply with 29 CFR 1910.145.
2. Identify system voltage with black letters on an orange background.
3. Apply to exterior of door, cover, or other access.
4. For equipment with multiple power or control sources, apply to door or cover of equipment, including, but not limited to, the following:

    a. Power-transfer switches.
    b. Controls with external control power connections.

N. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

O. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch-high letters for emergency instructions at equipment used for power transfer.

P. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm unless equipment is provided with its own identification.

1. Labeling Instructions:

    a. Indoor Equipment: Engraved, laminated acrylic or melamine plastic label, punched or drilled for mechanical fasteners. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high label; where two lines of text are required, use labels 2 inches high.
    b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
    c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
    d. Unless labels are provided with self-adhesive means of attachment, fasten them with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

2. Equipment To Be Labeled:

    a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be in the form of a engraved, laminated acrylic or melamine label.
    b. Enclosures and electrical cabinets.
    c. Access doors and panels for concealed electrical items.
    d. Switchboards.
    e. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.
    f. Emergency system boxes and enclosures.
    g. Enclosed switches.
    h. Enclosed circuit breakers.
    i. Enclosed controllers.
    j. Variable-speed controllers.
    k. Push-button stations.
    l. Power-transfer equipment.
    m. Contactors.
    n. Remote-controlled switches, dimmer modules, and control devices.
    o. Battery-inverter units.
    p. Power-generating units.
    q. Monitoring and control equipment.
    r. UPS equipment.

END OF SECTION 260553

SECTION 260923 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Time switches.
2. Photoelectric switches.
3. Standalone daylight-harvesting switching and dimming controls.
4. Indoor occupancy and vacancy sensors.
5. Switchbox-mounted occupancy sensors.
6. Digital timer light switches.
7. High-bay occupancy sensors.
8. Extreme temperature occupancy sensors.
9. Outdoor motion sensors.
10. Lighting contactors.
11. Emergency shunt relays.

B. Related Requirements:

1. Section 262726 "Wiring Devices" for wall-box dimmers, non-networkable wall-switch occupancy sensors, and manual light switches.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Show installation details for the following:

a. Occupancy sensors.
b. Vacancy sensors.

2. Interconnection diagrams showing field-installed wiring.
3. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Sample Warranty: For manufacturer's warranties.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of lighting control device to include in operation and maintenance manuals.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On USB media. Provide names, versions, and website addresses for locations of installed software.
3. Device address list.
4. Printout of software application and graphic screens.

1.6 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace lighting control devices that fail(s) in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Faulty operation of lighting control software.
b. Faulty operation of lighting control devices.

2. Warranty Period: Two year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 INDOOR OCCUPANCYAND VACANCY SENSORS

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. Acuity Brands.
2. Cooper Industries, Inc.
3. Leviton Manufacturing Co., Inc.

B. General Requirements for Sensors:

1. Wall or Ceiling-mounted, solid-state indoor occupancy and vacancy sensors.

2. Dual technology.
3. Integrated power pack.
4. Hardwired connection to switch; 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. Vacancy Sensor: Unless otherwise indicated, lights are manually turned on and sensor turns lights off when the room is unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.

7. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A Sensor is powered from the power pack Wireless.
8. Power: Line voltage.
9. Power Pack: Dry contacts rated for 20-A LED load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
10. Mounting:

    a. Sensor: Suitable for mounting in any position on a standard outlet box.
    b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
    c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

11. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
12. Bypass Switch: Override the "on" function in case of sensor failure.
13. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; turn lights off when selected lighting level is present.

C. 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 (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch- high ceiling.
4. Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of 2000 square feet when mounted48 inches above finished floor.

2.2 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

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. Acuity Brands.
2. Cooper Industries, Inc.
3. Leviton Manufacturing Co., Inc.

B. General Requirements for Sensors: Automatic-wall-switch occupancy sensor with manual on-off switch, suitable for mounting in a single gang switchbox, with provisions for connection to BAS using hardwired connection.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Occupancy Sensor Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn lights off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
3. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.
4. Switch Rating: Not less than 800-VA LED load at 120 V, 1200-VA LED load at 277 V, and 800-W incandescent.

C. Wall-Switch Sensor Tag WS1:

1. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of 2100 sq. ft.
2. Sensing Technology: Dual technology - PIR and ultrasonic.
3. Switch Type: SP, manual "on," automatic "off" or SP, field-selectable automatic "on," or manual "on," automatic "off."
4. Capable of controlling load in three-way application.
5. Voltage: Match the circuit voltage.
6. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc. The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
7. Concealed, field, "off" time-delay selector at up to 30 minutes.
8. Concealed, "off" time-delay selector at 30 seconds and 5, 10, and 20 minutes.
9. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.
10. Color: as specified by architect.
11. Faceplate: Color matched to switch.

2.3 LIGHTING CONTACTORS

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. ASCO Power Technologies, LP; a business of Emerson Network Power.
2. Eaton.
3. General Electric Company.
4. Square D.

B. Description: Electrically operated and electrically held, combination-type lighting contactors with nonfused disconnect, complying with NEMA ICS 2 and UL 508.

1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less THD of normal load current).
2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
3. Enclosure: Comply with NEMA 250.
4. Provide with control and pilot devices as indicated on Drawings, matching the NEMA type specified for the enclosure.

2.4 EMERGENCY SHUNT RELAY

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. Lighting Control and Design.
2. WattStopper; a Legrand® Group brand.

B. Description: NC, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts; complying with UL 924.

1. Coil Rating: as specified on drawings.

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 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.

3.3 CONTACTOR INSTALLATION

A. Comply with NECA 1.

B. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.4 WIRING INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 3/4 inch.

C. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

D. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.

E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.5 IDENTIFICATION

A. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."

1. Identify controlled circuits in lighting contactors.
2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.

B. Label time switches and contactors with a unique designation.

3.6 FIELD QUALITY CONTROL

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

1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Lighting control devices will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.7 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting lighting control devices to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.
3. Align high-bay occupancy sensors using manufacturer's laser aiming tool.

3.8 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3.9 DEMONSTRATION

A. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control systems specified in Section 260943.16 "Addressable-Luminaire Lighting Controls" and Section 260943.23 "Relay-Based Lighting Controls."

B. Train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices.

END OF SECTION 260923

SECTION 262413 - SWITCHBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Service and distribution switchboards rated 600 V and less.
2. Surge protection devices.
3. Disconnecting and overcurrent protective devices.
4. Instrumentation.
5. Control power.
6. Accessory components and features.
7. Identification.

1.3 ACTION SUBMITTALS

A. Product Data: For each switchboard, overcurrent protective device, surge protection device, ground-fault protector, accessory, and component.

1. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

B. Shop Drawings: For each switchboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Detail short-circuit current rating of switchboards and overcurrent protective devices.
5. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.
6. Detail utility company's metering provisions with indication of approval by utility company.
7. Include evidence of NRTL listing for series rating of installed devices.
8. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

9. Include diagram and details of proposed mimic bus.
10. Include schematic and wiring diagrams for power, signal, and control wiring.

C. Samples: Representative portion of mimic bus with specified material and finish, for color selection.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Field Quality-Control Reports:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Routine maintenance requirements for switchboards and all installed components.
b. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
c. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

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. Potential Transformer Fuses: Equal to 10 percent of quantity installed for each size and type but no fewer than two of each size and type.
2. Control-Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
3. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.
4. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type but no fewer than three of each size and type.

5. Indicating Lights: Equal to 10 percent of quantity installed for each size and type but no less than one of each size and type.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver switchboards in sections or lengths that can be moved past obstructions in delivery path.

B. Remove loose packing and flammable materials from inside switchboards and install temporary electric heating (250 W per section) to prevent condensation.

C. Handle and prepare switchboards for installation according to NEMA PB 2.1.

1.9 FIELD CONDITIONS

A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.

B. Environmental Limitations:

1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards is complete, and 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 104 deg F (40 deg C).
    b. Altitude: Not exceeding 6600 feet (2000 m).

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

1. Notify Owner no fewer than seven days in advance of proposed interruption of electric service.
2. Indicate method of providing temporary electric service.
3. Do not proceed with interruption of electric service without Owner's written permission.
4. Comply with NFPA 70E.

1.10 COORDINATION

A. Coordinate layout and installation of switchboards 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. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.11 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace switchboard enclosures, buswork, overcurrent protective devices, accessories, and factory installed interconnection wiring that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Three years from date of Substantial Completion.

B. Manufacturer's Warranty: Manufacturer's agrees to repair or replace surge protection devices that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SWITCHBOARDS

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. Eaton.
2. General Electric Company.
3. Siemens Power Transmission & Distribution, Inc.
4. Square D; by Schneider Electric.

B. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards 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 a qualified testing agency, and marked for intended location and application.

E. Comply with NEMA PB 2.

F. Comply with NFPA 70.

G. Comply with UL 891.

H. Front-Connected, Front-Accessible Switchboards:

1. Main Devices: Fixed, individually mounted.
2. Branch Devices: Panel mounted.
3. Sections front and rear aligned.

I. Nominal System Voltage: 208Y/120 V.

J. Main-Bus Continuous: See drawings for ampere rating.

K. Indoor Enclosures: Steel, NEMA 250, Type 1.

L. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

M. Barriers: Between adjacent switchboard sections.

N. Insulation and isolation for main bus of main section and main and vertical buses of feeder sections.

O. Service Entrance Rating: Switchboards intended for use as service entrance equipment shall contain from one to six service disconnecting means with overcurrent protection, a neutral bus with disconnecting link, a grounding electrode conductor terminal, and a main bonding jumper.

P. Utility Metering Compartment: Barrier compartment and section complying with utility company's requirements; hinged sealable door; buses provisioned for mounting utility company's current transformers and potential transformers or potential taps as required by utility company. If separate vertical section is required for utility metering, match and align with basic switchboard. Provide service entrance label and necessary applicable service entrance features.

Q. Customer Metering Compartment: A separate customer metering compartment and section with front hinged door, for indicated metering, and current transformers for each meter. Current transformer secondary wiring shall be terminated on shorting-type terminal blocks.

R. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

S. Hinged Front Panels: Allow access to switch, metering, accessory, and blank compartments.

T. Buses and Connections: Three phase, four wire unless otherwise indicated.

1. Provide phase bus arrangement A, B, C from front to back, top to bottom, and left to right when viewed from the front of the switchboard.
2. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity, silver-plated.
3. Copper feeder switch line connections.
4. Ground Bus: 1/4-by-2-inch- (6-by-50-mm-) hard-drawn copper of 98 percent conductivity, equipped with mechanical connectors for feeder and branch-circuit ground conductors.
5. Main-Phase Buses and Equipment-Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
6. Disconnect Links:

    a. Isolate neutral bus from incoming neutral conductors.
    b. Bond neutral bus to equipment-ground bus for switchboards utilized as service equipment or separately derived systems.
7. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with mechanical connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
8. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.

U. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of switch compartment.

2.2 SURGE PROTECTION DEVICES

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. Advanced Protection Technologies Inc. (APT).
2. Eaton.
3. General Electric Company.
4. Siemens Power Transmission & Distribution, Inc.
5. Square D; by Schneider Electric.

B. SPDs: Comply with UL 1449, Type 2.

C. Features and Accessories:
1. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
2. Indicator light display for protection status.
3. 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. Surge counter.

D. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 300 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

E. Protection modes and UL 1449 VPR for grounded wye circuits with 208Y/120 V, three-phase, four-wire circuits shall not exceed the following:

1. Line to Neutral: 700 V for 208Y/120 V.
2. Line to Ground: 1200 V for 208Y/120 V.
3. Line to Line: 1000 V for 208Y/120 V.

F. SCCR: Equal or exceed 100 kA.

G. Nominal Rating: 20 kA.

2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Main Service Switch - Bolted-Pressure Contact Switch: Operating mechanism uses rotary-mechanical-bolting action to produce and maintain high clamping pressure on the switch blade after it engages the stationary contacts.

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. Boltswitch, Inc.
b. Eaton.
c. Siemens Industry, Inc.
d. Square D.

2. Main-Contact Interrupting Capability: Minimum of 12 times the switch current rating.

3. Operating Mechanism: Manual handle operation to close switch; stores energy in mechanism for opening and closing.
   a. Mechanical Trip: Operation of mechanical lever, push button, or other device causes switch to open.

4. Auxiliary Switches: Factory installed, SPDT, with leads connected to terminal block, and including one set more than quantity required for functional performance indicated.
5. Service-Rated Switches: Labeled for use as service equipment.

6. Open-Fuse Trip Device: Arranged to trip switch open if a phase fuse opens.

B. Branch Devices - Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current 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.
2. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
3. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
4. MCCB Features and Accessories:

    a. Standard frame sizes, trip ratings, and number of poles.
    b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.
    c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
    d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
    e. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
    f. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
    g. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
    h. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
    i. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position

C. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

D. Fuses are specified in Section 262813 "Fuses."

2.4 INSTRUMENTATION

A. Instrument Transformers: NEMA EI 21.1, and the following:

1. Potential Transformers: NEMA EI 21.1; 120 V, 60 Hz, single secondary; disconnecting type with integral fuse mountings. Burden and accuracy shall be consistent with connected metering and relay devices.
2. Current Transformers: NEMA EI 21.1; 5 A, 60 Hz, secondary; wound type; single secondary winding and secondary shorting device. Burden and accuracy shall be consistent with connected metering and relay devices.

3. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kVA.

B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:

1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:

a. Phase Currents, Each Phase: Plus or minus 0.5 percent.
b. Phase-to-Phase Voltages, Three Phase: Plus or minus 0.5 percent.
c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 0.5 percent.
d. Megawatts: Plus or minus 1 percent.
e. Megavars: Plus or minus 1 percent.
f. Power Factor: Plus or minus 1 percent.
g. Frequency: Plus or minus 0.1 percent.
h. Accumulated Energy, Megawatt Hours: Plus or minus 1 percent; accumulated values unaffected by power outages up to 72 hours.
i. Megawatt Demand: Plus or minus 1 percent; demand interval programmable from five to 60 minutes.

2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.

2.5 CONTROL POWER

A. Control Circuits: 120-V ac, supplied through secondary disconnecting devices from control-power transformer.

2.6 IDENTIFICATION

A. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store switchboards according to NEMA PB 2.1.

1. Lift or move panelboards with spreader bars and manufacturer-supplied lifting straps following manufacturer's instructions.
2. Use rollers, slings, or other manufacturer-approved methods if lifting straps are not furnished.
3. Protect from moisture, dust, dirt, and debris during storage and installation.
4. Install temporary heating during storage per manufacturer's instructions.

B. Examine switchboards before installation. Reject switchboards that are moisture damaged or physically damaged.

C. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance of the Work or that affect the performance of the equipment.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install switchboards and accessories according to NEMA PB 2.1.

B. Equipment Mounting: Install switchboards on concrete base, 4-inch (100-mm) nominal thickness. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."

1. Install conduits entering underneath the switchboard, entering under the vertical section where the conductors will terminate. Install with couplings flush with the concrete base. Extend 2 inches (50-mm) above concrete base after switchboard is anchored in place.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to switchboards.
6. Anchor switchboard to building structure at the top of the switchboard if required or recommended by the manufacturer.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, straps and brackets, and temporary blocking of moving parts from switchboard units and components.

D. Install filler plates in unused spaces of panel-mounted sections.

E. Install overcurrent protective devices, surge protection devices, and instrumentation.

F. Comply with NECA 1.

3.3 CONNECTIONS

A. Bond conduits entering underneath the switchboard to the equipment ground bus with a bonding conductor sized per NFPA 70.

B. Support and secure conductors within the switchboard according to NFPA 70.

C. Extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.

3.4 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

1. Acceptance Testing:

    a. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit. Open control and metering circuits within the switchboard, and remove neutral connection to surge protection and other electronic devices prior to insulation test. Reconnect after test.
    b. Test continuity of each circuit.

2. Test ground-fault protection of equipment for service equipment per NFPA 70.
3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
4. Correct malfunctioning units on-site where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
5. Perform the following infrared scan tests and inspections, and prepare reports:

    a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchboard. Remove front panels so joints and connections are accessible to portable scanner.
    b. Instruments and Equipment:

1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

6. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

B. Switchboard will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

3.7 PROTECTION

A. Temporary Heating: Apply temporary heat, to maintain temperature according to manufacturer's written instructions, until switchboard is ready to be energized and placed into service.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories.

END OF SECTION 262413

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.

1.3 DEFINITIONS

A. ATS: Acceptance testing specification.

B. GFCI: Ground-fault circuit interrupter.

C. GFEP: Ground-fault equipment protection.

D. HID: High-intensity discharge.

E. MCCB: Molded-case circuit breaker.

F. VPR: Voltage protection rating.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of panelboard.

1. Include materials, switching and overcurrent protective devices, accessories, and components indicated.
2. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details.
2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.

3. Detail enclosure types, including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
4. Detail bus configuration, current, and voltage ratings.
5. Short-circuit current rating of panelboards and overcurrent protective devices.
6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
7. Include wiring diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.7 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.

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications: ISO 9001 or 9002 certified.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation according to NEMA PB 1.

1.10 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 Owner no fewer than seven 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.

1.11 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace panelboards that fail in materials or workmanship within specified warranty period.

1. Panelboard Warranty Period: 18 months from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PANELBOARDS 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. Enclosures: Flush and Surface-mounted, dead-front cabinets.

1. Rated for environmental conditions at installed location.

a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
b. Outdoor Locations: NEMA 250, Type 4.
c. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.

2. Height: 84 inches maximum.
3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims shall cover all live parts and shall have no exposed hardware.
4. Finishes:

a. Panels and Trim: 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.

F. 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.

G. Phase, Neutral, and Ground Buses:

1. Material: Hard-drawn copper, 98 percent conductivity.

a. Plating shall run entire length of bus.
b. Bus shall be fully rated the entire length.

2. Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors.
3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
4. 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.

H. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Terminations shall allow use of 75 deg C rated conductors without derating.
3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.

4. Main and Neutral Lugs: Mechanical type, with a lug on the neutral bar for each pole in the panelboard.
5. Ground Lugs and Bus-Configured Terminators: Mechanical type, with a lug on the bar for each pole in the panelboard.
6. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
7. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.

I. Future Devices: Panelboards shall have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

1. Percentage of Future Space Capacity: 20 percent.

J. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed by an NRTL for 100 percent interrupting capacity.

1. Panelboards and overcurrent protective devices rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.
2. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V shall have short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.

2.2 POWER PANELBOARDS

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

1. Eaton Electrical Sector; Eaton Corporation.
2. General Electric Company; GE Energy Management - Electrical Distribution.
3. Siemens Energy.
4. Square D; by Schneider Electric.

B. Panelboards: NEMA PB 1, distribution type.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

1. For doors more than 36 inches high, provide two latches, keyed alike.

D. Mains: Circuit breaker or Lugs only.

E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.

F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

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

1. Eaton Electrical Sector; Eaton Corporation.
2. General Electric Company; GE Energy Management - Electrical Distribution.
3. Siemens Energy.
4. Square D; by Schneider 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. 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.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

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

1. Eaton Electrical Sector; Eaton Corporation.
2. General Electric Company; GE Energy Management - Electrical Distribution.
3. Siemens Energy.
4. Square D; by Schneider Electric.

B. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers:

    a. Inverse time-current element for low-level overloads.
    b. Instantaneous magnetic trip element for short circuits.
    c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. 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. Subfeed Circuit Breakers: Vertically mounted.
5. 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. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
h. Rating Plugs: Three-pole breakers with ampere ratings greater than 150 amperes shall have interchangeable rating plugs or electronic adjustable trip units.
i. Multipole units enclosed in a single housing with a single handle.
j. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.

2.5 IDENTIFICATION

A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.

B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.

C. Circuit Directory: Directory card inside panelboard door, mounted in metal frame with transparent protective cover.

1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

2.6 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

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. Comply with NECA 1.

C. Install panelboards and accessories according to NEMA PB 1.1.

D. Equipment Mounting:
   1. Attach panelboard to the vertical finished or structural surface behind the panelboard.

E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

F. Mount top of trim 90 inches above finished floor unless otherwise indicated.

G. Mount panelboard cabinet plumb and rigid without distortion of box.

H. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

I. Mounting panelboards with space behind is recommended for damp, wet, or dirty locations. The steel slotted supports in the following paragraph provide an even mounting surface and the recommended space behind to prevent moisture or dirt collection.

J. Mount surface-mounted panelboards to steel slotted supports 1 1/4 inch in depth. Orient steel slotted supports vertically.

K. 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.

L. 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.

M. Install filler plates in unused spaces.

N. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.

O. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

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 stated in NETA ATS, Paragraph 7.6 Circuit Breakers. Perform optional tests. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:

    a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
    b. Instruments and Equipment:

        1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

D. Panelboards will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results, with comparisons of the two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges.

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

SECTION 262713 - ELECTRICITY METERING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings 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 work to accommodate utility company revenue meters.

1.3 ACTION SUBMITTALS

A. Product Data:

1. For each type of meter.
2. For metering infrastructure components.
3. For metering software.

B. Shop Drawings: For electricity-metering equipment.

1. Include elevation views of front panels of control and indicating devices and control stations.
2. Include diagrams for power, signal, and control wiring.
3. Wire Termination Diagrams and Schedules: Include diagrams for power, signal, and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features. Differentiate between manufacturer-installed and field-installed wiring.
4. Include series-combination rating data for modular meter centers with main disconnect device.

1.4 FIELD CONDITIONS

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

1. Owner shall be notified and issued written permission no fewer than seven days in advance of proposed interruption of electrical service.

1.5 COORDINATION

A. Electrical Service Connections:

1. Coordinate with utility companies and utility-furnished components.

a. Comply with requirements of utility providing electrical power services.
b. Coordinate installation and connection of utilities and services, including provision for electricity-metering components.

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 916.

2.2 UTILITY METERING INFRASTRUCTURE

A. Install metering accessories furnished by the utility company, complying with its requirements.

B. Current-Transformer Cabinets: Comply with requirements of electrical-power utility company.

C. Meter Sockets:

1. Comply with requirements of electrical-power utility company.
2. Meter Sockets: Steady-state and short-circuit current ratings shall meet indicated circuit ratings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with equipment installation requirements in NECA 1.

B. Install meters furnished by utility company. Install raceways and equipment according to utility company's written instructions. Provide empty conduits for metering leads and extend grounding connections as required by utility company.

C. Wiring Method:

1. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
2. Minimum conduit size shall be 1/2 inch (13 mm).

3.2 IDENTIFICATION

A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1. Series Combination Warning Label: Self-adhesive labels, with text as required by NFPA 70.

END OF SECTION 262713

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Twist-locking receptacles.
3. Weather-resistant receptacles.
4. Snap switches.
5. Pendant cord-connector devices.

1.3 DEFINITIONS

A. GFCI: Ground-fault circuit interrupter.

B. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

C. UTP: Unshielded twisted pair.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Receptacles for Owner-Furnished Equipment: Match plug configurations.
2. Cord and Plug Sets: Match equipment requirements.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

1.6 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Floor Service-Outlet Assemblies: One for every 10, but no fewer than one.
2. Poke-Through, Fire-Rated Closure Plugs: One for every five floor service outlets installed, but no fewer than two.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.
2. Hubbell Incorporated; Wiring Device-Kellems.
3. Leviton Manufacturing Co., Inc.
4. Pass & Seymour/Legrand (Pass & Seymour).

B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 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.

2.3 TWIST-LOCKING RECEPTACLES

A. Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration as indicated on drawings, and UL 498.

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. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.
b. Hubbell Incorporated; Wiring Device-Kellems.
c. Leviton Manufacturing Co., Inc.
d. Pass & Seymour/Legrand (Pass & Seymour).

2.4 DECORATOR-STYLE DEVICES

A. Convenience Receptacles: Square face, 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, and UL 498.

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. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.
b. Hubbell Incorporated; Wiring Device-Kellems.
c. Leviton Manufacturing Co., Inc.
d. Pass & Seymour/Legrand (Pass & Seymour).

B. GFCI, Feed-Through Type, Convenience Receptacles: Square face, 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and UL 943 Class A.

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. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.
b. Hubbell Incorporated; Wiring Device-Kellems.
c. Leviton Manufacturing Co., Inc.
d. Pass & Seymour/Legrand (Pass & Seymour).

C. GFCI, Weather-Resistant Convenience Receptacles: Square face, 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and UL 943 Class A.

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. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.
b. Hubbell Incorporated; Wiring Device-Kellems.
c. Pass & Seymour/Legrand (Pass & Seymour).

D. Toggle Switches, Square Face, 120/277 V, 20 A: Comply with NEMA WD 1, UL 20, and FS W-S-896.

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. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.
b. Hubbell Incorporated; Wiring Device-Kellems.
c. Leviton Manufacturing Co., Inc.
d. Pass & Seymour/Legrand (Pass & Seymour).

E. Lighted Toggle Switches, Square Face, 120 V, 20 A: Comply with NEMA WD 1 and UL 20.

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. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc.
b. Hubbell Incorporated; Wiring Device-Kellems.
c. Leviton Manufacturing Co., Inc.
d. Pass & Seymour/Legrand (Pass & Seymour).

2. Description: With neon-lighted handle, illuminated when switch is "off."

F. All branch circuits rated at 15 amperes shall only have receptacles rated at 15 amperes connected to it.

2.5 WALL PLATES

A. Single and combination types shall match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: Steel with white baked enamel, suitable for field painting.
3. Material for Unfinished Spaces: Galvanized steel.
4. Material for Damp Locations: Thermoplastic with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.

2.6 FLOOR SERVICE FITTINGS

A. Type: Modular, flush-type, dual-service units suitable for wiring method used.

B. Compartments: Barrier separates power from voice and data communication cabling.

C. Service Plate: Rectangular, solid brass with satin finish.

D. Power Receptacle: NEMA WD 6 Configuration 5-20R, gray finish, unless otherwise indicated.

2.7 FINISHES

A. Device Color:

1. Wiring Devices Connected to Normal Power System: As selected by Architect unless otherwise indicated or required by NFPA 70 or device listing.

B. Wall Plate Color: For plastic covers, match device color.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

B. Coordination with Other Trades:

1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.

3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:

    a. Cut back and pigtail, or replace all damaged conductors.
    b. Straighten conductors that remain and remove corrosion and foreign matter.
    c. 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. Dimmers:

1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan speed control are listed for that application.
3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 GFCI RECEPTACLES

A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

3.3 IDENTIFICATION

A. Comply with Section 260553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Test Instruments: Use instruments that comply with UL 1436.
2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

B. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

C. Wiring device will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 262726

SECTION 262813 - FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Cartridge fuses rated 600 V ac and less for use in the following:

    a. Control circuits.
    b. Switchboards.
    c. Enclosed controllers.
    d. Enclosed switches.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles. Include the following for each fuse type indicated:

1. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
2. Coordination charts and tables and related data.
3. Fuse sizes for elevator feeders and elevator disconnect switches.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017700 "Closeout Procedures," include the following:

1. Ambient temperature adjustment information.
2. Current-limitation curves for fuses with current-limiting characteristics.
3. Coordination charts and tables and related data.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.6 FIELD CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Cooper Bussmann; a division of Cooper Industries.
2. Edison; a brand of Cooper Bussmann; a division of Cooper Industries.
3. Littelfuse, Inc.
4. Mersen USA.

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.
2. Type CC: 600-V, zero- to 30-A rating, 200 kAIC, fast acting.
3. Type J: 600-V, zero- to 600-A rating, 200 kAIC.
4. Type L: 600-V, 601- to 6000-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. Service Entrance: Class L, time delay.
2. Feeders: Class RK1, time delay.
3. Motor Branch Circuits: Class RK1, time delay.
4. Power Electronics Circuits: Class J, high speed.
5. Other Branch Circuits: Class J, fast acting.
6. Control Transformer Circuits: Class CC, time delay, control transformer duty.
7. 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.

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

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Nonfusible switches.
3. Enclosures.

1.3 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

C. SPDT: Single pole, double throw.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include 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.

B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: For power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
2. Fuse Pullers: Two for each size and type.

1.8 QUALITY ASSURANCE

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

B. 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.

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.

D. Comply with NFPA 70.

1.9 PROJECT 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.

1.10 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

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

1. Eaton Electrical Sector; Eaton Corporation.
2. General Electric Company.
3. Siemens Industry, Inc.
4. Square D; by Schneider Electric.

B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
4. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
5. Lugs: Mechanical type, suitable for number, size, and conductor material.
6. Service-Rated Switches: Labeled for use as service equipment.
7. Accessory Control Power Voltage: Remote mounted and powered; 120-V ac.

2.2 NONFUSIBLE SWITCHES

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

1. Eaton Electrical Sector; Eaton Corporation.
2. General Electric Company.
3. Siemens Industry, Inc.
4. Square D; by Schneider Electric.

B. Type HD, Heavy Duty, 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. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
4. Lugs: Mechanical type, suitable for number, size, and conductor material.
5. Accessory Control Power Voltage: Remote mounted and powered; 120-V ac.

2.3 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
2. Outdoor Locations: NEMA 250, Type 4.
3. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.

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.

3.2 INSTALLATION

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

C. Install fuses in fusible devices.

D. Comply with NECA 1.

3.3 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.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each enclosed switch and circuit breaker, 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 stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:

a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.

b. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. 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.

END OF SECTION 262816

SECTION 263100 - PHOTOVOLTAIC SYSTEM

Part 1 - GENERAL

1.1 Applicable provisions of the Conditions of the Contract and Division #1, General Requirements, govern work in this Section.

1.2 DESCRIPTION OF WORK

A. Section contains all components necessary for complete functioning, grid-tied photovoltaic system including but not limited to:
   1. Photovoltaic Modules.
   2. Inverters.
   3. Solar Panel Mounting System including ballast requirements.
   4. PV Array Wiring.
   5. PV System Informational Display Kiosk.
   6. Combiner boxes.
   7. DC Disconnect Switches.
   8. Engineering criteria.

B. The proposed photovoltaic systems shall have a minimum size as identified with components installed in locations as shown on plans. Provider shall be responsible for designing, supplying and installing a photovoltaic electric system capable of meeting the design performance criteria.

C. Final design proposed by the Provider shall be submitted to the design professional as per this specification.

1.3 REFERENCES

A. American National Standards Institute
   ANSI C2 National Electrical Safety Code
   ANSI/ASCE 7 Building Code Requirements for Minimum Design Loads in Buildings and Other Structures

B. Federal Communications Commission (FCC): Electromagnetic Interference (EMI) Part 15, Subparts A and B

C. Institute of Electrical and Electronics Engineers (IEEE)
   IEEE 519 Recommended Practice and Requirements for Harmonic Control in Electrical Power Systems
   IEEE 928 Recommended Criteria for Terrestrial PV Power Systems
   IEEE 929 Recommended Practice for Utility Interface of Residential and Intermediate PV Systems
   IEEE 1296 IEEE Recommended Practice for Qualification of Photovoltaic (PV) Modules
   IEEE 1373 Recommended Practice for Field Test Methods and Procedures for Grid Connected PV Systems
   IEEE 1374 Guide for Terrestrial PV Power System Safety
   IEEE 1479 Recommended Practice for the Evaluation of Photovoltaic Module Energy Production
   IEEE 1547 Standard for Interconnecting Distributed Resources with Electric Power Systems

D. International Electro technical Commission (IEC)

IEC 904-1	Measurement of PV I-V Characteristics
IEC 1173	Overvoltage Protection for PV Power Generating Systems
IEC 1277	Guide General Description of PV Power Generating System
IEC 61215	Crystalline silicon terrestrial photovoltaic (PV) modules - Design qualification and type approval
IEC 61730/1 & 2	Photovoltaic (Pv) Module Safety Qualification
IEC 61646	Thin film Terrestrial Photovoltaic Modules
IEC 1721	Susceptibility of a Module to Accidental Impact Damage (Resistance to Impact Test)
IEC 1727	PV Characteristics of the Utility Interface

E. National Fire Protection Association (NFPA)

NFPA 70 Article 690	Solar Photovoltaic Systems
NFPA 70 Article 705	Interconnected Electric Power Production Sources

G. Underwriters Laboratories (UL)

UL 1741	Static Inverters and Charge Controllers for use in PV Power Systems
UL 1703	Flat Plate PV Modules and Panels
UL 1998	Software in Programmable Components

H. General Codes and Standards

1. National Electrical Safety Code
2. Occupational Safety and Health Administration (OSHA)
3. Uniform Building Code (UBC)
4. International Building Code (IBC)
5. Insulated Cable Engineers Association (ICEA) Standards
6. New York State and Local Building Codes

I. Abbreviations used in this section have the following meanings:

A	Ampere (also I)
AC	Alternating current
AM 1.5	Air Mass 1.5
BOS	Balance of system
DC	Direct current
deg. or N	Degree
IMax	Maximum current
ISC	Short circuit current
J	Joule
kg	kilograms
kW	Kilowatt
kWh	Kilowatt hour
lbf	foot-pounds
min	minimum
mm	millimeter
MPPT	maximum power point tracking
N	Newton
%	percent
PV	Photovoltaic
psi	Pounds per square inch
SI	Solar irradiance
V	Volt
Vmax	Maximum voltage

Voc	Open circuit voltage
W	Watt

1.4 SUBMITTALS – Coordinate with Section 01 33 00

A. Product Data: Include dimensions, size, voltage ratings, and current ratings for each type of product indicated.

B. Operation and Maintenance Data: For all components of installed photovoltaic system. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

C. Manufacturer's user training manuals.
   1. Maintenance information.
   2. Equipment warranty information.
   3. Manufacturer's required maintenance related to system warranty requirements.

D. Shop Drawings: For photovoltaic system. Include plans, wiring diagrams, details, and attachments to steel structure, attachment of structure to roof and the following:
   1. Roof plan with panel layout.
   2. Include locations and types of all penetrations, drains, vents and mechanical equipment.
   3. Show all roof structures and screens, dimensioned for size and location.
   4. Electrical three-line diagram of proposed system including changes from the bid documents.
   5. Expected AC output, projected monthly energy production, projected annual energy production.
   6. Include floor plans to indicate final equipment locations. Show size and route of cable and conduits.

E. Field quality-control reports.

F. Manufacturer’s Instructions: Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements.

G. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fuses: Two of each type installed in the system.

H. Engineering submittals prepared by a licensed Professional Engineer in the State of New York evidencing the following:
   1. Wind Design Criteria: Wind loading is in accordance with the current IBC and ASCE requirements.
   2. Basic Wind Speed – 120 mph
   3. Importance Factor – 1.15
   4. Exposure Category - C
   5. SEISMIC Design Criteria: Seismic loads are in accordance with the current IBC/ New York State Building Code and ASCE requirements. Refer to structural drawings and specifications for additional information and requirements.

I. Certificates: Submit certified evidence of installer's qualifications and experience record in installation of solar roof panel systems or submit certification from manufacturer of solar roof panels that proposed installer has been trained by manufacturer's representatives and is considered by manufacturer to be fully qualified to install the system.

1.5 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer: Company specializing in solar roof panel system manufacturing with a minimum of 4 continuous years of documented experience.
   2. Installer: Company with a minimum of 3 years documented experience in the installation of solar power and further with NYSERDA accreditation and NABCEP certification.
   3. Submit a list of at least five 5 installations that have been in use for a minimum of two years using solar power systems as described in this document. Include contact name and phone numbers – a minimum of installations nominated shall be in the NYSERDA region.
   4. Installer shall be certified by the manufacturer.

B. Contractor shall provide written document including total system and itemized cost, size of system, system description and expected energy production as per this specification.

C. All systems and system components shall comply with applicable codes, licensing and permitting requirements including but not limited to the New York State Building Code, National Electric Code and local ordinances.

D. All equipment shall be UL listed.

E. Compliance with Regulatory Requirements: The installation of solar panels and electrical components shall be performed in compliance with IEEE 928, IEEE 929, IEEE 1374, IEC 1277, NFPA 70 Article 690 and 705, the National Electrical Safety Code, Occupational Safety and Health Administration (OSHA) regulations, International Building Code (IBC), state and local codes.

F. Pre-Installation Meeting: After approval of submittals but prior to beginning installation of work of this Section, conduct a meeting at the site attended by Architect, Contractor, installers of solar panel system and related electrical work to be installed with the system, to describe in detail the installation process and to establish agreement, coordination, safety and responsibilities. Prepare a detailed report of this meeting and furnish copies to the Architect and all attendees. Also present at this meeting shall be a representative from the original roof manufacturer who holds the warranty which has not expired. The roof membrane manufacturer and warrantor will be given to the Contractor in advance so as to allow for arrangements to be made.

1.6 SYSTEM STARTUP

A. Furnish the services of a trained representative of the solar panel manufacturer to instruct the Owner's personnel in operation and routine maintenance of the solar panel system for a period of not less than one day at a time directed by Owner.

1.7 OWNER'S INSTRUCTIONS

A. Furnish a complete operation and maintenance manual to the Owner at time of system startup.

1.8 WARRANTY – Coordinate with Article 3.7 herein.

A. Provide certified copies of the following manufacturer's product warranty:

1. Solar panel manufacturer's 25-year warranty covering power output of panels, and 5 year warranty of rebated material and workmanship.

1.9 MAINTENANCE SERVICE – See Article 3.6 herein.

Part 2 - PRODUCTS

2.1 PHOTOVOLTAIC MODULES

A. Comply with IEC 61215, IEC 61730 & UL 1703
B. Basis-of-Design Product: Subject to compliance with requirements, provide 530 Watt Silfab Bifacial, SIL-530 XM solar module, or approved equal.
C. Operating Temperature: -40ºC to 85ºC.
D. Power Tolerance: ± 3%
E. PV modules shall contain integrated IP65 junction box with integrated bypass diodes.
F. Product Warranty: Manufacturer replacement for defect in material or workmanship for 5 years.
G. Power Warranty, 5 Years: PV modules shall be warranted for 95% power output, according to the datasheet, for 5 years.
H. Power Warranty, 25 Years: PV modules shall be warranted for 80% power output, according to the datasheet, for 25 years.

2.2 INVERTERS

A. Comply with IEEE-929, IEEE-1547, UL 1741-2005, UL 1998, FCC Part 15 A & B.
B. The proposed inverters shall have a minimum size as identified with components installed in locations as shown on plans. Provider shall be responsible for designing, supplying and installing an inverter or series of inverters capable of meeting the design performance criteria.
C. Final design proposed by the Provider shall be submitted to the design professional as per this specification.
D. Peak Efficiency: Greater than 96%.
E. PV Start Voltage: 300V.
F. Inverters shall include integral UL listed DC disconnect switch.
G. Inverters shall include integral LCD display, showing performance parameters.
H. Product Warranty: Manufacturer’s warranty for 10 years.
I. AC and DC grounding shall be provided as per National Electric Code, manufacturer’s recommendations and local authority’s requirements.

2.3 SOLAR PANEL MOUNTING SYSTEM

A. Basis-of-Design Product:
   1. Ballasted Roof System
      a. Provide a ballasted roof system compatible with new roofing materials.
      b. Ballast shall not exceed 7 lbs/SF and shall be submitted to Architect for review and approval.
      c. Provide complete racking, mounting system with ballast as required for completed installation in compliance with state/local codes.
B. PV modules shall be installed in a professional, workman-like manner. Even and uniform spacing shall be used.
C. Refer to drawings for PV module locations.

2.4 PV ARRAY WIRING

A. Provide three-line wiring diagrams of system prior to construction.
B. Wiring shall be in accordance to the National Electric Code.
C. Provide DC electrode grounding conductor to building AC grounding electrode as per National Electric Code.

2.5 PV SYSTEM INFORMATIONAL DISPLAY KIOSK

A. Installer shall provide display kiosk in entrance lobby of each school.
B. Kiosk shall display real-time and historical power output data for the PV system.

Part 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Install devices and equipment in accordance with manufacturer's instructions and National Electric Code.
B. Contractor shall procure all materials, components and equipment necessary for a turn-key PV system as identified on the design drawings, specifications and approved final design.

3.2 PV SYSTEM DESIGN

A. Conceptual Design: The installer shall prepare and submit a conceptual design of the PV system. Design shall include:
   1. Structural analysis as per Part 1 above.
   2. PV system one-line diagram.
   3. DC rating, expected AC output and projected monthly and annual energy production.
   4. A shading or obstruction analysis.
   5. Location of all PV system components in and on the building.
   6. Quantity and type of inverters and PV modules.
   7. Itemized cost breakdown.
   8. Estimate of annual operation and maintenance expenses
B. Upon completion of installation, installer shall prepare record drawings including final system design, layout and one-line diagram.

3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.4 GROUNDING

A. Ground photovoltaic system and associated circuits.
B. AC and DC grounding shall be provided as per National Electric Code, manufacturer's recommendations and local authority's requirements.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspection. System shall run at or above rated capacity under test conditions of:
   1. 1000 watts/square meter solar irradiance.

2. 25ºC ambient temperature with wind speed no greater than 1 meter/second.

B. Should test conditions not be available, generally accepted practices for converting the values found at actual conditions to reference conditions shall be acceptable.

C. System shall run at 95% availability with a maximum of 2 incidents requiring attention (remotely or on-site) before the system is accepted.

3.6 MAINTENANCE

A. The installer shall provide maintenance for the PV system for a minimum of 2 years after system acceptance, including:
   1. Installer shall perform general inspection of the PV system every 6 months during the contract.
   2. Inspection shall include verification of inverter power output
   3. Visual inspection of all equipment including PV arrays.

3.7 PV SYSTEM WARRANTY

A. The PV system shall be covered by a 5-year full warranty and a 10-year warranty on the labor.

B. The warranty shall cover all components of the PV system against degradation of power output of more than 10% from the output at system acceptance.

3.8 DEMONSTRATION

A. Installer shall train Owner's maintenance personnel to perform basic inspection, proper method of clearing debris and perform visual inspection.

B. Installer shall provide two (2) four (4) hour training sessions for the Owner’s representative to understand system operation and equipment monitoring.

3.9 WASTE MANAGEMENT – Coordinate with Section 01570

A. Separate and recycle materials and material packaging in accordance with Waste Management Plan and to the maximum extent economically feasible and place in designated areas for recycling.

B. Set aside and protect materials suitable for reuse and/or remanufacturing.

C. Separate and fold up metal banding; flatten and place along with other metal scrap for recycling in designated area.

END OF SECTION 263100

SECTION 264313 - SURGE PROTECTION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings 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 field-mounted SPDs for low-voltage (120 to 600 V) power distribution and control equipment.

1.3 DEFINITIONS

A. Inominal: Nominal discharge current.

B. MCOV: Maximum continuous operating voltage.

C. Mode(s), also Modes of Protection: The pair of electrical connections where the VPR applies.

D. MOV: Metal-oxide varistor; an electronic component with a significant non-ohmic current-voltage characteristic.

E. OCPD: Overcurrent protective device.

F. SCCR: Short-circuit current rating.

G. SPD: Surge protective device.

H. VPR: Voltage protection rating.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
2. Copy of UL Category Code VZCA certification, as a minimum, listing the tested values for VPRs, Inominal ratings, MCOVs, type designations, OCPD requirements, model numbers, system voltages, and modes of protection.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Sample Warranty: For manufacturer's special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For SPDs to include in maintenance manuals.

1.7 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to replace or replace SPDs that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL SPD REQUIREMENTS

A. SPD with 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. Comply with UL 1449.

D. MCOV of the SPD shall be the nominal system voltage.

2.2 SERVICE ENTRANCE SUPPRESSOR

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. ABB USA.
2. Advanced Protection Technologies Inc. (APT).
3. Alltec Corporation.
4. Current Technology Inc.
5. Eaton Electrical Sector; Eaton Corporation.
6. General Electric Company.
7. LEA International.
8. Leviton Manufacturing Co., Inc.
9. Liebert; a brand of Emerson Electric Co.
10. Schneider Electric USA, Inc.
11. Siemens Industry, Inc.

12. Square D; by Schneider Electric.

B. SPDs: Comply with UL 1449, Type 2.

1. SPDs with the following features and accessories:
   a. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
   b. Indicator light display for protection status.
   c. 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.
   d. Surge counter.

C. Comply with UL 1283.

D. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 320 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

E. 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.
2. Line to Ground: 1200 V for 480Y/277 V.
3. Line to Line: 2000 V for 480Y/277 V.

4. Line to Neutral: 700 V for 208Y/120 V.
5. Line to Ground: 1200 V for 208Y/120 V.
6. Line to Line: 1000 V for 208Y/120 V.

F. SCCR: Equal or exceed 100 kA.

G. Inominal Rating: 20 kA.

2.3 PANEL SUPPRESSORS

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. ABB USA.
2. Advanced Protection Technologies Inc. (APT).
3. Alltec Corporation.
4. Atlantic Scientific.
5. Current Technology Inc.
6. Eaton Electrical Sector; Eaton Corporation.
7. General Electric Company.

8. LEA International.
9. Leviton Manufacturing Co., Inc.
10. Liebert; a brand of Emerson Electric Co.
11. Northern Technologies, Inc.

B. SPDs: Comply with UL 1449, Type 2.

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.

C. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 100 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.

D. Protection modes and UL 1449 VPR for grounded wye circuits with 208Y/120 V, three-phase, four-wire circuits shall not exceed the following:

1. Line to Neutral: 700 V for 208Y/120 V.
2. Line to Ground: 700 V for 208Y/120 V.
3. Neutral to Ground: 700 V for 208Y/120 V.
4. Line to Line: 1200 V for 208Y/120 V

E. SCCR: Equal or exceed 100 kA.

F. Inominal Rating: 20 kA.

2.4 ENCLOSURES

A. Indoor Enclosures: NEMA 250, Type 1.

B. Outdoor Enclosures: NEMA 250, Type 3R.

2.5 CONDUCTORS AND CABLES

A. Power Wiring: Same size as SPD leads, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

B. Class 2 Control Cables: Multiconductor cable with copper conductors not smaller than No. 18 AWG, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cables: Multiconductor cable with copper conductors not smaller than No. 14 AWG, complying with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1.

B. Install an OCPD or disconnect as required to comply with the UL listing of the SPD.

C. Install SPDs with conductors between suppressor and points of attachment as short and straight as possible, and adjust circuit-breaker positions to achieve shortest and straightest leads. Do not splice and extend SPD leads unless specifically permitted by manufacturer. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.

D. Use crimped connectors and splices only. Wire nuts are unacceptable.

E. Wiring:

1. Power Wiring: Comply with wiring methods in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
2. Controls: Comply with wiring methods in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.2 FIELD QUALITY CONTROL

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

1. Compare equipment nameplate data for compliance with Drawings and Specifications.
2. Inspect anchorage, alignment, grounding, and clearances.
3. Verify that electrical wiring installation complies with manufacturer's written installation requirements.

B. An SPD will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.3 STARTUP SERVICE

A. Complete startup checks according to manufacturer's written instructions.

B. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests, and reconnect them immediately after the testing is over.

C. Energize SPDs after power system has been energized, stabilized and tested.

3.4 DEMONSTRATION

A. Train Owner's maintenance personnel to operate and maintain SPDs.

END OF SECTION 264313

SECTION 265119 - LED INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Interior solid-state luminaires that use LED technology.
2. Lighting fixture supports.

B. Related Requirements:

1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color Rendering Index.

C. Fixture: See "Luminaire."

D. IP: International Protection or Ingress Protection Rating.

E. LED: Light-emitting diode.

F. Lumen: Measured output of lamp and luminaire, or both.

G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Arrange in order of luminaire designation.
2. Include data on features, accessories, and finishes.
3. Include physical description and dimensions of luminaires.

4. Include emergency lighting units, including batteries and chargers.
5. Include life, output (lumens, CCT, and CRI), and energy efficiency data.
6. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing and Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps and accessories identical to those indicated for the lighting fixture as applied in this Project.

    a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

A. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Product Certificates: For each type of luminaire.

C. Product Test Reports: For each luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency.

D. Sample warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.

1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps: Ten for every 100 of each type and rating installed. Furnish at least one of each type.
2. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
3. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.8 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.

B. Provide luminaires from a single manufacturer for each luminaire type.

C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.10 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

B. Warranty Period: Five year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 LUMINAIRE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.

C. Recessed Fixtures: Comply with NEMA LE 4.

D. Bulb shape complying with ANSI C79.1.

E. Lamp base complying with ANSI C81.61 or IEC 60061-1.

F. Rated lamp life of 35,000 hours.

G. Lamps dimmable from 100 percent to 0 percent of maximum light output.

H. Internal driver.

I. Nominal Operating Voltage: As indicated on Plans.

1. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

J. Housings:

1. Extruded-aluminum housing and heat sink.
2. powder-coat finish.

2.2 DOWNLIGHT

A. See Plans for manufacturers.

B. Minimum 1,000 lumens. Minimum allowable efficacy of 80 lumens per watt.

C. Universal mounting bracket.

D. Integral junction box with conduit fittings.

2.3 LINEAR INDUSTRIAL

A. See Plans for manufacturers.

B. Minimum 5,000 lumens. Minimum allowable efficacy of 80 lumens per watt.

C. Housing and heat sink rated to the following:
1. NEMA 4X.
2. IP 54.
3. IP 66.
4. Marine and wet locations.
5. CSA C22.2 No 137.

2.4 RECESSED LINEAR

A. See Plans for manufacturers.

B. Minimum 2,000 lumens. Minimum allowable efficacy of 85 lumens per watt.

C. Integral junction box with conduit fittings.

2.5 STRIP LIGHT

A. See Plans for manufacturers.

B. Minimum 750 lumens. Minimum allowable efficacy of 80 lumens per watt.

C. Integral junction box with conduit fittings.

2.6 SURFACE MOUNT, LINEAR

A. See Plans for manufacturers.

B. Minimum 750 lumens. Minimum allowable efficacy of 80 lumens per watt.

C. Integral junction box with conduit fittings.

2.7 SURFACE MOUNT, NONLINEAR

A. See Plans for manufacturers.

B. Minimum 750 lumens. Minimum allowable efficacy of 80 lumens per watt.

C. Integral junction box with conduit fittings.

2.8 SUSPENDED, LINEAR

A. See Plans for manufacturers.

B. Minimum 2,000 lumens. Minimum allowable efficacy of 85 lumens per watt.

2.9 SUSPENDED, NONLINEAR

A. See Plans for manufacturers.

B. Minimum 2,000 lumens. Minimum allowable efficacy of 85 lumens per watt.

C. Integral junction box with conduit fittings.

2.10 MATERIALS

A. Metal Parts:

1. Free of burrs and sharp corners and edges.
2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.

B. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

C. Diffusers and Globes:

1. prismatic acrylic

2. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
3. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

D. Housings:

1. Extruded-aluminum housing and heat sink.
2. powder-coat finish.

E. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp characteristics:

a. "USE ONLY" and include specific lamp type.
b. Lamp diameter, shape, size, wattage, and coating.
c. CCT and CRI for all luminaires.

2.11 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.

2.12 LUMINAIRE FIXTURE SUPPORT COMPONENTS

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.

C. Wires: ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, 12 gage.

D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before fixture installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting and install new lamps.

3.3 INSTALLATION

A. Comply with NECA 1.

B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

C. Install lamps in each luminaire.

D. Supports:

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position after cleaning and relamping.
3. Provide support for luminaire without causing deflection of ceiling or wall.
4. Luminaire mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and vertical force of 400 percent of luminaire weight.

E. Flush-Mounted Luminaire Support:

1. Secured to outlet box.
2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
3. Trim ring flush with finished surface.

F. Wall-Mounted Luminaire Support:

1. Attached to structural members in walls.

2. Do not attach luminaires directly to gypsum board.

G. Ceiling-Mounted Luminaire Support:

1. Ceiling mount with two 5/32-inch-diameter aircraft cable supports adjustable to 120 inches in length.
2. Ceiling mount with pendant mount with 5/32-inch-diameter aircraft cable supports adjustable to 120 inches in length.
3. Ceiling mount with hook mount.

H. Suspended Luminaire Support:

1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and wire support for suspension for each unit length of luminaire chassis, including one at each end.
4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

I. Ceiling-Grid-Mounted Luminaires:

1. Secure to any required outlet box.
2. Secure luminaire to the luminaire opening using approved fasteners 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.

J. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

3.6 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.

1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
3. Adjust the aim of luminaires in the presence of the Architect.

END OF SECTION 265119

SECTION 265219 - EMERGENCY AND EXIT LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Emergency lighting units.
2. Exit signs.
3. Luminaire supports.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color Rendering Index.

C. Emergency Lighting Unit: A lighting unit with internal or external emergency battery powered supply and the means for controlling and charging the battery and unit operation.

D. Fixture: See "Luminaire" Paragraph.

E. Lumen: Measured output of lamp and luminaire, or both.

F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of emergency lighting unit, exit sign, and emergency lighting support.

1. Include data on features, accessories, and finishes.
2. Include physical description of the unit and dimensions.
3. Battery and charger for light units.
4. Include life, output of luminaire (lumens, CCT, and CRI), and energy-efficiency data.
5. Include photometric data and adjustment factors based on laboratory tests, complying with IES LM-45, for each luminaire type.

a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Shop Drawings: For nonstandard or custom luminaires.

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

C. Product Schedule:

1. For emergency lighting units. Use same designations indicated on Drawings.
2. For exit signs. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of luminaire.

B. Product Test Reports: For each luminaire for tests performed by manufacturer and witnessed by a qualified testing agency.

C. Sample Warranty: For manufacturer's warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and lighting systems to include in emergency, operation, and maintenance manuals.

1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
2. Luminaire-mounted, emergency battery pack: One for every 20 emergency lighting units. Furnish at least one of each type.
3. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
4. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.8 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.10 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two year(s) from date of Substantial Completion.

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.

1. Warranty Period for Emergency Power Unit Batteries: 5 years from date of Substantial Completion. Full warranty shall apply for the entire warranty period.
2. Warranty Period for Emergency Fluorescent Ballast and Self-Powered Exit Sign Batteries: Seven years from date of Substantial Completion. Full warranty shall apply for the entire warranty period.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR EMERGENCY LIGHTING

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. NRTL Compliance: Fabricate and label 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. Comply with UL 1598 for fluorescent luminaires.

F. Lamp Base: Comply with ANSI C81.61 or IEC 60061-1.

G. Bulb Shape: Complying with ANSI C79.1.

H. Internal Type Emergency Power Unit: Self-contained, modular, battery-inverter unit, factory mounted within luminaire body and compatible with ballast.

1. Emergency Connection: Operate one lamp(s) continuously at an output of 1100 lumens each 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. Nightlight Connection: Operate lamp continuously at 40 percent of rated light output.
5. 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.

6. Battery: Sealed, maintenance-free, nickel-cadmium type.
7. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
8. Remote Test: Switch in handheld remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.

2.2 EMERGENCY LIGHTING

A. General Requirements for Emergency Lighting Units: Self-contained units.

B. Emergency Luminaires:

1. See Plans for manufacturers.

2. Emergency Luminaires: as indicated on Interior Lighting Fixture Schedule, with the following additional features:

   a. Operating at nominal voltage of 120 V ac or 277 V ac.
   b. Internal emergency power unit.
   c. Rated for installation in damp locations, and for sealed and gasketed luminaires in wet locations.

C. Emergency Lighting Unit:

1. See Plans for manufacturers.

2. Emergency Lighting Unit: as indicated on Interior Lighting Fixture Schedule.
3. Operating at nominal voltage of 120 V ac or 277 V ac.
4. Wall with universal junction box adaptor.
5. UV stable thermoplastic housing, rated for damp locations.
6. Two LED lamp heads.
7. Internal emergency power unit.

D. Remote Emergency Lighting Units:

1. See Plans for manufacturers.

2. Emergency Lighting Unit: as indicated on Interior Lighting Fixture Schedule.
3. Operating at nominal voltage of 120 V ac or 277 V ac.
4. Wall with universal junction box adaptor.
5. UV stable thermoplastic housing, rated for damp locations.
6. LED lamp heads.
7. External emergency power unit.

2.3 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. See Plans for manufacturers.
2. Operating at nominal voltage of 120 V ac or 277 V ac.
3. Lamps for AC Operation: Fluorescent, two for each luminaire; 20,000 hours of rated lamp life.
4. Lamps for AC Operation: LEDs; 50,000 hours minimum rated lamp life.
5. Self-Powered Exit Signs (Battery Type): Internal emergency power unit.
6. Master/Remote Sign Configurations:

a. Master Unit: Comply with requirements above for self-powered exit signs, and provide additional capacity in LED power supply and battery for power connection to remote unit.
b. Remote Unit: Comply with requirements above for self-powered exit signs, except omit power supply, battery, and test features. Arrange to receive full power requirements from master unit. Connect for testing concurrently with master unit as a unified system.

2.4 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. Diffusers and Globes:

1. Prismatic acrylic.
2. Acrylic: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
3. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

D. Housings:

1. Extruded aluminum housing and heat sink.
2. powder coat finish.

E. Conduit: Electrical metallic tubing or Flexible metallic conduit, minimum 3/4 inch in diameter.

2.5 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.

2.6 LUMINAIRE SUPPORT COMPONENTS

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

B. Support Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.

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. Install lamps in each luminaire.

D. 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.

E. Wall-Mounted Luminaire Support:

1. Attached to structural members in walls.
2. Do not attach luminaires directly to gypsum board.

F. Suspended Luminaire Support:

1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and wire support for suspension for each unit length of luminaire chassis, including one at each end.
4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

G. Ceiling Grid Mounted Luminaires:

1. Secure to any required outlet box.
2. Secure emergency power unit using approved fasteners in a minimum of four locations, spaced near corners of emergency power unit.
3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.4 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.

3.5 STARTUP SERVICE

A. Perform startup service:

1. Charge emergency power units and batteries minimum of one hour and depress switch to conduct short-duration test.

2. Charge emergency power units and batteries minimum of 24 hours and conduct one-hour discharge test.

3.6 ADJUSTING

A. Adjustments: Within 12 months of date of Substantial Completion, provide on-site visit to do the following:

1. Inspect all luminaires. Replace lamps, emergency power units, batteries, signs, or luminaires that are defective.

a. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

2. Conduct short-duration tests on all emergency lighting.

END OF SECTION 265219

SECTION 265619 - EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Exterior solid-state luminaires that are designed for and exclusively use LED lamp technology.
2. Luminaire supports.

B. Related Requirements:

1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color rendering index.

C. Fixture: See "Luminaire."

D. IP: International Protection or Ingress Protection Rating.

E. Lumen: Measured output of lamp and luminaire, or both.

F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of luminaire.

1. Arrange in order of luminaire designation.
2. Include data on features, accessories, and finishes.
3. Include physical description and dimensions of luminaire.
4. Lamps, include life, output (lumens, CCT, and CRI), and energy-efficiency data.

5. Photometric data and adjustment factors based on laboratory tests, complying with IES Lighting Measurements Testing and Calculation Guides, of each luminaire type. The adjustment factors shall be for lamps and accessories identical to those indicated for the luminaire as applied in this Project.

    a. Manufacturer's Certified Data: Photometric data certified by manufacturer’s laboratory with a current accreditation under the NVLAP for Energy Efficient Lighting Products.

6. Wiring diagrams for power, control, and signal wiring.
7. Means of attaching luminaires to supports and indication that the attachment is suitable for components involved.

B. LEED Submittals:
1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating cost for each product having recycled content.

C. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

D. Delegated-Design Submittal: For luminaire supports.

1. Include design calculations for luminaire supports.

1.5 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of the following:

1. Luminaire.

B. Product Test Reports: For each luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency.

C. Source quality-control reports.

D. Sample warranty.

1.6 CLOSEOUT SUBMITTALS

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

1. Provide a list of all lamp types used on Project. Use ANSI and manufacturers' codes.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps: Ten for every 100 of each type and rating installed. Furnish at least one of each type.
2. Glass, Acrylic, and Plastic Lenses, Covers, and Other Optical Parts: One for every 100 of each type and rating installed. Furnish at least one of each type.
3. Diffusers and Lenses: One for every 100of each type and rating installed. Furnish at least one of each type.
4. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.8 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturers' laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.

B. Provide luminaires from a single manufacturer for each luminaire type.

C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

D. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering prior to shipping.

1.10 FIELD CONDITIONS

A. Verify existing and proposed utility structures prior to the start of work associated with luminaire installation.

B. Mark locations of exterior luminaires for approval by Architect prior to the start of luminaire installation.

1.11 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

    a. Structural failures, including luminaire support components.
    b. Faulty operation of luminaires and accessories.
    c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

2. Warranty Period: 2 year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

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. NRTL Compliance: Luminaires shall be listed and labeled for indicated class and division of hazard by an NRTL.

C. UL Compliance: Comply with UL 1598 and listed for wet location.

D. Lamp base complying with ANSI C81.61 or IEC 60061-1.

E. Bulb shape complying with ANSI C79.1.

F. CRI of minimum 70. CCT of 4000 K.

G. L70 lamp life of 50,000 hours.

H. Lamps dimmable from 100 percent to 0 percent of maximum light output.

I. Internal driver.

J. Nominal Operating Voltage: 277 V ac.

K. Lamp Rating: Lamp marked for outdoor use and in enclosed locations.

L. Source Limitations: For luminaires, obtain each color, grade, finish, type, and variety of luminaire from single source with resources to provide products of consistent quality in appearance and physical properties.

2.3 LUMINAIRE TYPES

A. Area and Site:

1. See Plans for manufacturers.
2. Luminaire Shape: Square.
3. Mounting: Building.
4. Luminaire-Mounting Height: As indicated on architectural plans.
5. Distribution: Type IV.
6. Diffusers and Globes: Prismatic acrylic.
7. Housings:

    a. Extruded-aluminum housing and heat sink.
    b. powder-coat finish.

2.4 MATERIALS

A. Metal Parts: Free of burrs and sharp corners and edges.

B. Sheet Metal Components: Corrosion-resistant aluminum. Form and support to prevent warping and sagging.

C. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses.

D. Diffusers and Globes:

1. Acrylic Diffusers: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
2. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

E. Lens and Refractor Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

F. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:

1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.

G. Housings:

1. Rigidly formed, weather- and light-tight enclosure that will not warp, sag, or deform in use.
2. Provide filter/breather for enclosed luminaires.

H. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp characteristics:

    a. "USE ONLY" and include specific lamp type.
    b. Lamp diameter, shape, size, wattage and coating.
    c. CCT and CRI for all luminaires.

2.5 FINISHES

A. Variations in Finishes: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

B. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

C. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20 requirements; and seal aluminum surfaces with clear, hard-coat wax.
3. Class I, Clear-Anodic Finish: AA-M32C22A41 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
4. Class I, Color-Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker), complying with AAMA 611.

    a. Color: As indicated on plans.

2.6 LUMINAIRE SUPPORT COMPONENTS

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

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 electrical conduit to verify actual locations of conduit connections before luminaire installation.

C. Examine walls for suitable conditions where luminaires will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is substantially complete, clean luminaires used for temporary lighting and install new lamps.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Comply with NECA 1.

B. Install lamps in each luminaire.

C. Fasten luminaire to structural support.

D. Supports:

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position after cleaning and relamping.
3. Support luminaires without causing deflection of finished surface.
4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.

E. Wall-Mounted Luminaire Support:

1. Attached to structural members in walls.

F. Wiring Method: Install cables in raceways. Conceal raceways and cables.

G. Install luminaires level, plumb, and square with finished grade unless otherwise indicated. Install luminaires at height and aiming angle as indicated on Drawings.

H. Coordinate layout and installation of luminaires with other construction.

I. Adjust luminaires that require field adjustment or aiming.

J. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and 260533 "Raceways and Boxes for Electrical Systems" for wiring connections and wiring methods.

3.4 BOLLARD LUMINAIRE INSTALLATION:

A. Align units for optimum directional alignment of light distribution.

B. Install on concrete base with top 4 inches above finished grade or surface at luminaire location. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 033000 "Cast-in-Place Concrete."

3.5 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Section 260533 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch-thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.6 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.7 FIELD QUALITY CONTROL

A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.

B. Perform the following tests and inspections:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.

C. Illumination Tests:

1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IES testing guide(s):

a. IES LM-5.

b. IES LM-50.
c. IES LM-52.
d. IES LM-64.
e. IES LM-72.

2. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.

D. Luminaire will be considered defective if it does not pass tests and inspections.

E. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.8 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain luminaires.

3.9 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.

1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
3. Adjust the aim of luminaires in the presence of the Architect.

END OF SECTION 265619

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 SUSTAINABLE DESIGN OBJECTIVES

A. The City requires the contractor to implement practices and procedures to meet the project's environmental performance goals, which include;

1. Minimize the environmental impacts of the construction and operation of the project during the construction phase. The project shall implement the following procedures singly or in combination:

   a. Select products that minimize consumption of non-renewable resources, consume reduced amounts of energy, minimize environmental pollution, and to utilize recycled and/or recyclable materials.
   b. Reduce sources of potential Indoor Air Quality pollutants by controlled selection of materials and processes used in project construction. (015721)
   c. Minimize waste produced by construction through efficient construction practices and landfill diversion, as detailed in the Construction Waste Management Plan. (017419)

2. Products and processes that achieve the above objectives have been selected and included in the Construction Documents.

1.3 SUMMARY

A. Section Includes:

1. Metal conduits and fittings.
2. Metal wireways and auxiliary gutters.
3. Boxes, enclosures, and cabinets.

B. Related Requirements:

1. Section 260533 "Raceways and Boxes for Electrical Systems" for conduits, wireways, surface raceways, boxes, enclosures, cabinets, handholes, and faceplate adapters serving electrical systems.

1.4 DEFINITIONS

A. ARC: Aluminum rigid conduit.

B. GRC: Galvanized rigid steel conduit.

C. IMC: Intermediate metal conduit.

1.5 ACTION SUBMITTALS

A. Product Data: For surface pathways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.
2. Laboratory Test Reports for Credit IEQ 4: For solvent cements and adhesive primers, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For licensed professional engineer.

B. Source quality-control reports.

1.7 DELIVERY, STORAGE AND HANDLING

A. Comply with the requirements of the Construction Indoor Air Quality Management Plan and the Construction Waste Management Plan.

1.8 PROJECT CONDITIONS

A. Waste Management: Comply with the requirements of the Construction Waste Management Plan.

PART 2 - PRODUCTS

2.1 PRODUCT REQUIREMENTS FOR SUSTAINABLE DESIGN- GENERAL

A. All field applied paints, coatings, sealants, sealer, adhesives in this section shall meet the requirements of VOC limits in 016116- Indoor Finishes Performance Requirements.

B. All Products in this Section shall be free of Materials of Concern as noted in 015721- Indoor Air Quality Control (where achievable).

2.2 METAL CONDUITS AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following or approved equal:

1. AFC Cable Systems, Inc.
2. Allied Tube & Conduit.
3. Alpha Wire Company.
4. Anamet Electrical, Inc.
5. Electri-Flex Company.
6. O-Z/Gedney.
7. Picoma Industries.
8. Republic Conduit.
9. Robroy Industries.
10. Southwire Company.
11. Thomas & Betts Corporation.
12. Western Tube and Conduit Corporation.
13. Wheatland Tube Company.

B. General Requirements for Metal Conduits and Fittings:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with TIA-569-B.

C. GRC: Comply with ANSI C80.1 and UL 6.

D. ARC: Comply with ANSI C80.5 and UL 6A.

E. IMC: Comply with ANSI C80.6 and UL 1242.

F. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.

1. Comply with NEMA RN 1.
2. Coating Thickness: 0.040 inch, minimum.

G. EMT: Comply with ANSI C80.3 and UL 797.

H. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
2. Fittings for EMT:

   a. Material: Steel.
   b. Type: Setscrew.

3. Expansion Fittings: PVC or steel to match conduit type, complying with UL-467, rated for environmental conditions where installed, and including flexible external bonding jumper.
4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

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 or approved equal:

1. Cooper B-Line, Inc.
2. Hoffman.
3. Mono-Systems, Inc.
4. Square D.

B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.

1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with TIA-569-B.

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: Hinged type unless otherwise indicated.

E. Finish: Manufacturer's standard enamel finish.

2.4 BOXES, ENCLOSURES, AND CABINETS

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 or approved equal:

1. Adalet.
2. Cooper Technologies Company; Cooper Crouse-Hinds.
3. EGS/Appleton Electric.
4. Hoffman.
5. Mono-Systems, Inc.
6. O-Z/Gedney.
7. RACO; Hubbell.
8. Robroy Industries.
9. Spring City Electrical Manufacturing Company.
10. Thomas & Betts Corporation.
11. Wiremold / Legrand.

B. General Requirements for Boxes, Enclosures, and Cabinets:

1. Comply with TIA-569-B.
2. Boxes, enclosures and cabinets installed in wet locations shall be listed for use in wet locations.

C. Sheet-Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.

E. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

F. Metal Floor Boxes:

1. Material: Cast metal.
2. Type: Fully adjustable.
3. Shape: Rectangular.
4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

H. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, galvanized, cast iron with gasketed cover.

I. Device Box Dimensions: 4 inches square by 2-1/8 inches deep.

J. Gangable boxes are prohibited.

K. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

L. 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.

M. 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.

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: RGS.
2. Exposed, Not Subject to Severe Physical Damage: RGS.
3. Concealed in Ceilings and Interior Walls and Partitions: EMT.
4. Boxes and Enclosures: NEMA 250 Type 1.

B. Minimum Pathway Size: 3/4-inch trade size. Minimum size for optical-fiber cables is 1 inch.

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. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
3. EMT: Use setscrew, steel fittings. Comply with NEMA FB 2.10.

D. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

3.2 INSTALLATION

A. Comply with NECA 1, NECA 101, and TIA-569-B for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum pathways. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.

B. Keep pathways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.

C. Complete pathway installation before starting conductor installation.

D. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.

E. Arrange stub-ups so curved portions of bends are not visible above finished slab.

F. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches of changes in direction. Utilize long radius ells for all optical-fiber cables.

G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

H. Support conduit within 12 inches of enclosures to which attached.

I. 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.

J. 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.

K. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.

L. 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.

M. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

N. 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.

O. Cut conduit perpendicular to the length. For conduits of 2-inch trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.

P. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lbtensile strength. Leave at least 12 inchesof slack at each end of pull wire. Cap underground pathways designated as spare above grade alongside pathways in use.

Q. Pathways for Optical-Fiber and Communications Cable: Install pathways, metal and nonmetallic, rigid and flexible, as follows:

1. 3/4-Inch Trade Size and Smaller: Install pathways in maximum lengths of 50 feet.
2. 1-Inch Trade Size and Larger: Install pathways in maximum lengths of 75 feet.
3. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

R. Install pathway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, 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 pathway sealing fittings according to NFPA 70.

S. 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.

T. Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.

U. 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 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.

3. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
4. 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. 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 surface to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

W. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

X. 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.

Y. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

Z. Set metal floor boxes level and flush with finished floor surface.

AA. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

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 270544 "Sleeves and Sleeve Seals for Communications Pathways 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."

3.5 PROTECTION

A. Protect coatings, finishes, and cabinets from damage or deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 270528

SECTION 270553 - IDENTIFICATION 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. Color and legend requirements for labels and signs.
2. Labels.
3. Bands and tubes.
4. Tapes.
5. Signs.
6. Cable ties.
7. Fasteners for labels and signs.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for communications identification products.

B. Samples: For each type of label and sign to illustrate composition, size, colors, lettering style, mounting provisions, and graphic features of identification products.

C. Identification Schedule:

1. Outlets: Scaled drawings indicating location and proposed designation.
2. Backbone Cabling: Riser diagram showing each communications room, backbone cable, and proposed backbone cable designation.
3. Racks: Scaled drawings indicating location and proposed designation.
4. Patch Panels: Enlarged scaled drawings showing rack row, number, and proposed designations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with NFPA 70 and TIA 606-B.

B. Comply with ANSI Z535.4 for safety signs and labels.

C. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

D. 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. Equipment Identification Labels:

1. Black letters on a white field.
2. Patch Panels.

2.3 LABELS

A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.

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

a. Champion America.
b. HellermannTyton.
c. Marking Services, Inc.

B. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters of raceway or cable they identify, that stay in place by gripping action.

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

a. Brady Corporation.
b. HellermannTyton.
c. Marking Services, Inc.

C. Self-Adhesive Wraparound Labels: Preprinted, 3-mil-thick, polyester or vinyl flexible labels with acrylic pressure-sensitive adhesive.

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

   a. Brady Corporation.
   b. LEM Products Inc.
   c. Marking Services, Inc.

2. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating protective shields over the legend. Labels sized such that the clear shield overlaps the entire printed legend.
3. Marker for Labels: Permanent, waterproof black ink marker recommended by tag manufacturer.
4. Marker for Labels: Machine-printed, permanent, waterproof black ink recommended by printer manufacturer.

D. Self-Adhesive Labels: Polyester or Vinyl, thermal, transfer-printed, 3-mil-thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.

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

   a. Brady Corporation.
   b. HellermannTyton.
   c. Marking Services, Inc.

2. Minimum Nominal Size:

   a. 1-1/2 by 6 inches for raceway and conductors.
   b. 3-1/2 by 5 inches for equipment.
   c. As required by authorities having jurisdiction.

2.4 BANDS AND TUBES

A. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches long, with diameters sized to suit diameters of raceway or cable they identify, that stay in place by gripping action.

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

   a. Brady Corporation.
   b. HellermannTyton.
   c. Marking Services, Inc.

2.5 CABLE TIES

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

1. HellermannTyton.
2. Ideal Industries, Inc.
3. Marking Services, Inc.

B. 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.

C. 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.

D. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F according to ASTM D 638: 7000 psi.
3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: Minus 50 to plus 284 deg F.
5. Color: Black.

2.6 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 PREPARATION

A. Self-Adhesive Identification Products: Before applying communications 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 communications systems and connected items.

G. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.

H. Vinyl Wraparound Labels:

1. Secure tight to surface of raceway or cable at a location with high visibility and accessibility.
2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.
3. Provide label 6 inches from cable end.

I. Snap-Around Labels:

1. Secure tight to surface at a location with high visibility and accessibility.
2. Provide label 6 inches from cable end.

J. Self-Adhesive Wraparound Labels:

1. Secure tight to surface at a location with high visibility and accessibility.
2. Provide label 6 inches from cable end.

K. Self-Adhesive Labels:

1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high label; where two lines of text are required, use labels 2 inches high.

L. Snap-Around, Color-Coding Bands: Secure tight to surface at a location with high visibility and accessibility.

M. Underground-Line Warning Tape:

1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench [**or concrete envelope**]exceeds 16 inches overall.
2. Limit use of underground-line warning tape to direct-buried cables.
3. Install underground-line warning tape for direct-buried cables and cables in raceways.

N. Cable Ties: General purpose, 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 with high visibility. Identify by system and circuit designation.

C. Accessible Fittings for Raceways and Cables within Buildings: Identify covers of each junction and pull box with self-adhesive labels containing wiring system legend.

1. System legends shall be as follows:

a. Telecommunications.

D. Faceplates: Label individual faceplates with self-adhesive labels. Place label at top of faceplate. Each faceplate shall be labeled with its individual, sequential designation, numbered clockwise when entering room from primary egress, composed of the following, in the order listed:

1. Wiring closet designation.
2. Colon.

3. Faceplate number.

E. Equipment Room Labeling:

1. Racks, Frames, and Enclosures: Identify front and rear of each with self-adhesive labels containing equipment designation.
2. Patch Panels: Label individual rows and outlets, starting at to left and working down, with self-adhesive labels.
3. Data Outlets: Label each outlet with a self-adhesive label indicating the following, in the order listed:

    a. Room number being served.
    b. Colon.
    c. Faceplate number.

F. Backbone Cables: Label each cable with a self-adhesive wraparound label indicating the location of the far or other end of the backbone cable. Patch panel or punch down block where cable is terminated should be labeled identically.

G. Horizontal Cables: Label each cable with a self-adhesive wraparound label indicating the following, in the order listed:

1. Room number.
2. Colon.
3. Faceplate number.

H. Locations of Underground Lines: Underground-line warning tape for copper, coaxial, hybrid copper/fiber, and optical-fiber cable.

I. Instructional Signs: Self-adhesive labels.

J. Warning Labels for Indoor Cabinets, Boxes, and Enclosures: Baked-enamel warning signs.

1. Apply to exterior of door, cover, or other access.

K. Equipment Identification Labels:

1. Indoor Equipment: Self-adhesive label.
2. Equipment to Be Labeled:

    a. Communications cabinets.
    b. Uninterruptible power supplies.
    c. Computer room air conditioners.
    d. Fire-alarm and suppression equipment.
    e. Egress points.
    f. Power distribution components.

END OF SECTION 270553

SECTION 271513 - COMMUNICATIONS COPPER HORIZONTAL CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Category 6 twisted pair cable.
2. Twisted pair cable hardware, including plugs and jacks.
3. Cabling identification products.
4. Grounding provisions for twisted pair cable.
5. Source quality control requirements for twisted pair cable.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. FTP: Shielded twisted pair.

C. F/FTP: Overall foil screened cable with foil screened twisted pair.

D. F/UTP: Overall foil screened cable with unscreened twisted pair.

E. IDC: Insulation displacement connector.

F. LAN: Local area network.

G. Jack: Also commonly called an "outlet," it is the fixed, female connector.

H. Plug: Also commonly called a "connector," it is the removable, male telecommunications connector.

I. RCDD: Registered Communications Distribution Designer.

J. Screen: A metallic layer, either a foil or braid, placed around a pair or group of conductors.

K. Shield: A metallic layer, either a foil or braid, placed around a pair or group of conductors.

L. S/FTP: Overall braid screened cable with foil screened twisted pair.

M. S/UTP: Overall braid screened cable with unscreened twisted pairs.

N. UTP: Unscreened (unshielded) twisted pair.

1.4 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., and includes the components that extend from the equipment outlets to the station equipment.

C. The maximum allowable horizontal cable length is 295 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment or in the horizontal cross-connect.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Reviewed and stamped by RCDD.
1. Cabling administration Drawings and printouts.
2. 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.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For installer, installation supervisor, and field inspector.

B. Product Certificates: For each type of product.

C. Source quality-control reports.

D. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For splices and connectors to include in maintenance manuals.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Faceplates: One of each type per school.
2. Jacks: 5 of each type per school.

1.9 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings and cabling administration 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.
3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

1.10 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.

1.11 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.

1.12 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: Type CMP complying with UL 1685.
2. Communications, Non-plenum: 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 E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

C. RoHS compliant.

2.3 CATEGORY 6 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AMP NETCONNECT; a TE Connectivity Ltd. company.
2. Belden CDT Networking Division/NORDX.

3. Draka USA.

C. Standard: Comply with NEMA WC 66/ICEA S-116-732 and TIA-568-C.2 for Category 6 cables.

D. Conductors: 100-ohm, 23 AWG solid copper.

E. Shielding/Screening: Unshielded twisted pairs (UTP).

F. Cable Rating: Plenum.

G. Jacket: Blue thermoplastic.

2.4 TWISTED PAIR CABLE HARDWARE

A. Description: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.

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

1. AMP NETCONNECT; a TE Connectivity Ltd. company.
2. Belden CDT Networking Division/NORDX.
3. Draka USA.

C. 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.

D. Source Limitations: Obtain twisted pair cable hardware from single source from single manufacturer.

E. 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.

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 equipment racks.
3. Number of Jacks per Field: One for each four-pair cable indicated.

G. 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 faceplate.
3. Standard: Comply with TIA-568-C.2.

H. Faceplate:

1. Two and Four port, vertical single gang faceplates designed to mount to single gang wall boxes.
2. Plastic Faceplate: High-impact plastic. Coordinate color with architect.
3. 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.

I. Legend:

1. Machine printed, in the field, using adhesive-tape label.
2. Snap-in, clear-label covers and machine-printed paper inserts.

2.5 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.

2.6 GROUNDING

A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.

B. Comply with TIA-607-B.

2.7 SOURCE QUALITY CONTROL

A. Factory test twisted pair cables according to TIA-568-C.2.

B. Cable will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 WIRING METHODS

A. Wiring Method: 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.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. 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 PATHWAYS

A. Comply with Section 260533 "Raceways and Boxes for Electrical Systems."

B. Comply with Section 260529 "Hangers and Supports for Electrical Systems."

C. Drawings indicate general arrangement of pathways and fittings.

3.3 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 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. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
7. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.
8. 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.
9. 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.
10. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
11. In the communications equipment room, install a 10-foot-long service loop on each end of cable.
12. 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 above ceilings by cable supports not more than 36 inches 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.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

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.
b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

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.
c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.4 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 BISCI's "Telecommunications Distribution Methods Manual."

3.5 GROUNDING

A. Install grounding according to the "Grounding, Bonding, and Electrical Protection" chapter in BICSI's "Telecommunications Distribution Methods Manual."

B. Comply with TIA-607-B and NECA/BICSI-607.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall, allowing at least a 2-inch clearance behind the grounding bus bar. Connect grounding bus bar to suitable electrical building ground, using a minimum No. 4 AWG grounding electrode conductor.

D. Bond metallic equipment to the grounding bus bar, using not smaller than a No. 6 AWG equipment grounding conductor.

3.6 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."

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 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. 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.

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. 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.

    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.

C. 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.

D. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

E. End-to-end cabling will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION 271513

SECTION 280513 - CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Fire alarm wire and cable.
2. Identification products.

1.3 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. EMI: Electromagnetic interference.

C. IDC: Insulation displacement connector.

D. 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.

E. Open Cabling: Passing telecommunications cabling through open space (e.g., between the studs of a wall cavity).

F. RCDD: Registered Communications Distribution Designer.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.

B. Source quality-control reports.

C. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: An NRTL.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

B. Comply with the requirements of the Construction Indoor Air Quality Management Plan and the Construction Waste Management Plan.

1.8 PROJECT CONDITIONS

A. Do not install conductors and cables that are wet, moisture damaged, or mold damaged.

1. Indications that wire and cables are wet or moisture damaged include, but are not limited to, discoloration and sagging of factory packing materials.

B. Environmental Limitations: Do not deliver or install UTP, optical fiber, and coaxial 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.

C. Waste Management: Comply with the requirements of the Construction Waste Management Plan.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches. Comply with requirements for plywood backing panels in Section 061000 "Rough Carpentry."

2.3 FIRE ALARM WIRE AND CABLE

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 or approved equal:

1. Comtran Corporation.
2. Draka Cableteq USA.
3. Genesis Cable Products; Honeywell International, Inc.
4. Rockbestos-Suprenant Cable Corp.
5. West Penn Wire.

B. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.

C. Signaling Line Circuits: Twisted, shielded pair, not less than No. 16 AWG.

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 2-hour rating.

D. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.

1. Low-Voltage Circuits: No. 16 AWG, minimum.
2. Line-Voltage Circuits: No. 12 AWG, minimum.
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, NTRL listed for fire alarm and cable tray installation, plenum rated, and complying with requirements in UL 2196 for a 2-hour rating.

2.4 IDENTIFICATION PRODUCTS

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 or approved equal:

1. Brady Worldwide, Inc.
2. HellermannTyton North America.
3. Kroy LLC.
4. Panduit Corp.

B. Comply with UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

C. Comply with requirements in Section 260553 "Identification for Electrical Systems."

2.5 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test UTP and optical fiber cables on reels according to TIA/EIA-568-B.1.

C. Factory test UTP cables according to TIA/EIA-568-B.2.

D. Factory test multimode optical fiber cables according to TIA-526-14-A and TIA/EIA-568-B.3.

E. Factory sweep test coaxial cables at frequencies from 5 MHz to 1 GHz. Sweep test shall test the frequency response, or attenuation over frequency, of a cable by generating a voltage whose frequency is varied through the specified frequency range and graphing the results.

F. Cable will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 INSTALLATION OF HANGERS AND SUPPORTS

A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for installation of supports for cables.

3.2 WIRING METHOD

A. Install wiring in metal pathways and wireways.

1. Minimum conduit size shall be 3/4 inch. Control and data transmission wiring shall not share conduit with other building wiring systems.

B. Install cable, concealed in accessible ceilings, walls, and floors when possible.

C. Wiring within Enclosures:

1. Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
2. Install lacing bars and distribution spools.
3. Separate power-limited and non-power-limited conductors as recommended in writing by manufacturer.
4. Install conductors parallel with or at right angles to sides and back of enclosure.
5. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with intrusion system to terminal blocks.
6. Mark each terminal according to system's wiring diagrams.
7. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1.

B. Conductors: Size according to system manufacturer's written instructions unless otherwise indicated.

C. General Requirements for Cabling:

1. Comply with TIA/EIA-568-B.1.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
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. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
5. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
6. 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.
7. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
8. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

D. 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 above ceilings by cable supports not more than 60 inches apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

E. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA-569-B recommendations for separating unshielded copper voice and data 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.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

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.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

4. Separation between 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 Rating Less Than 2 kVA: No requirement.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.

5. Separation between Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.4 FIRE ALARM WIRING INSTALLATION

A. Comply with NECA 1 and NFPA 72.

B. Wiring Method: Install wiring in metal raceway according to Section 260533 "Raceways and Boxes for Electrical Systems."

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Fire alarm circuits and equipment control wiring associated with the fire alarm system shall be installed in a dedicated raceway system. This system shall not be used for any other wire or cable.

C. Wiring Method:

1. Cables and raceways used for fire alarm circuits, and equipment control wiring associated with the fire alarm system, may not contain any other wire or cable.

2. Fire-Rated Cables: Use of 2-hour, fire-rated fire alarm cables, NFPA 70, Types MI and CI, is not permitted.
3. Signaling Line Circuits: Power-limited fire alarm cables shall not be installed in the same cable or raceway as signaling line circuits.

D. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

E. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

F. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and another for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.

G. Risers: Install at least two vertical cable risers to serve the fire alarm system. Separate risers in close proximity to each other with a minimum one-hour-rated wall, so the loss of one riser does not prevent the receipt or transmission of signals from other floors or zones.

H. Wiring to Remote Alarm Transmitting Device: 1-inch conduit between the fire alarm control panel and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

3.5 POWER AND CONTROL-CIRCUIT CONDUCTORS

A. 120-V Power Wiring: Install according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables" unless otherwise indicated.

B. 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 CONNECTIONS

A. Comply with requirements in Section 283111 "Digital, Addressable Fire-Alarm System for connecting, terminating, and identifying wires and cables.

3.7 FIRESTOPPING

A. Comply with requirements in Section 078413 "Penetration Firestopping."

B. Comply with TIA-569-B, "Firestopping" Annex A.

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.8 GROUNDING

A. For communications wiring, comply with J-STD-607-A and with BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. For low-voltage wiring and cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

3.9 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.10 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. 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.

C. End-to-end cabling will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 280513

SECTION 280526 - GROUNDING AND BONDING FOR ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings 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. Grounding conductors.
2. Grounding connectors.
3. Grounding busbars.

1.3 DEFINITIONS

A. Signal Ground: The ground reference point designated by manufacturer of the system that is considered to have zero voltage.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 CONDUCTORS

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. Harger Lightning and Grounding.
2. Panduit Corp.
3. Tyco Electronics Corp.

B. Comply with UL 486A-486B.

C. Insulated Conductors: Stranded copper wire, green or green with yellow stripe insulation, insulated for 600 V, and complying with UL 83.

1. Ground wire for custom-length equipment ground jumpers shall be No. 6 AWG, 19-strand, UL-listed, Type THHN wire.

D. 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 kcmils (14.2 sq. mm), 14 strands of No. 17 AWG conductor, and 1/4 inch (6.3 mm) in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Tinned-copper tape, braided conductors terminated with two-hole copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

2.2 CONNECTORS

A. Irreversible connectors listed for the purpose. Listed by an NRTL as complying with NFPA 70 for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 486A-486B.

B. 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. Burndy; Part of Hubbell Electrical Systems.
2. Chatsworth Products, Inc.
3. Harger Lightning and Grounding.
4. Panduit Corp.
5. Tyco Electronics Corp.

C. Compression Wire Connectors: Crimp-and-compress connectors that bond to the conductor when the connector is compressed around the conductor. Comply with UL 467.

1. Electroplated tinned copper, C and H shaped.

D. Busbar Connectors: Cast silicon bronze, solderless compression-type mechanical connector; with a long barrel and two holes spaced on 5/8- or 1-inch (15.8- or 25.4-mm) centers for a two-bolt connection to the busbar.

E. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.3 GROUNDING BUSBARS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Chatsworth Products, Inc.
2. Harger Lightning and Grounding.
3. Panduit Corp.

B. Grounding Busbars: Predrilled rectangular bars of hard-drawn solid copper, 1/4 by 2 inches (6.3 by 50 mm) in cross section, length as indicated on Drawings. The busbar shall be for wall mounting, shall be NRTL listed as complying with UL 467, and shall comply with J-STD-607-A.

1. Predrilling shall be with holes for use with lugs specified in this Section.
2. Mounting Hardware: Stand-off brackets that provide at least a 2-inch (50-mm clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.)
3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600 V switchboards, impulse tested at 5000 V.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with IEEE 1100, "Recommended Practice for Power and Grounding Electronic Equipment."

1. Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
2. Bond shields and drain conductors to ground at only one point in each circuit.

B. Signal Ground:

1. For each system, establish the signal ground and label that location as such.
2. Bond the signal ground to the alternating-current (ac) power system service by connecting to one of the following listed locations, using insulated No. 6 AWG, stranded, Type THHN wire:

a. Grounding bar in an electrical power panelboard if located in the same room or space as the signal ground.
b. Telecommunications grounding busbar.

C. Comply with NECA 1.

3.2 APPLICATION

A. Conductors: Install solid conductor for No. 8 AWG and smaller and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

B. Grounding and Bonding Conductors:

1. Install in the straightest and shortest route between the origination and termination point, and no longer than required. The bend radius shall not be smaller than eight times the diameter of the conductor. No one bend may exceed 90 degrees.
2. Install without splices.
3. Support at not more than 36-inch (900-mm) intervals.

3.3 CONNECTIONS

A. Stacking of conductors under a single bolt is not permitted when connecting to busbars.

B. Assemble the wire connector to the conductor, complying with manufacturer's written instructions and as follows:

1. Use crimping tool and the die specific to the connector.
2. Pretwist the conductor.
3. Apply an antioxidant compound to all bolted and compression connections.

C. Shielded Cable: Bond the shield of shielded cable to the signal ground. Comply with TIA/EIA-568-B.1 and TIA/EIA-568-B.2 when grounding screened, balanced, twisted-pair cables.

D. Rack- and Cabinet-Mounted Equipment: Bond powered equipment chassis to the cabinet or rack grounding bar. Power connection shall comply with NFPA 70; the equipment grounding conductor in the power cord of cord- and plug-connected equipment shall be considered as a supplement to bonding requirements in this Section.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.

C. Grounding system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 280526

SECTION 284621.11 - ADDRESSABLE FIRE-ALARM 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. Fire-alarm control unit.
2. Manual fire-alarm boxes.
3. System smoke detectors.
4. Air-sampling smoke detectors.
5. Heat detectors.
6. Notification appliances.
7. Device guards.
8. Magnetic door holders.
9. Remote annunciator.
10. Addressable interface device.
11. Digital alarm communicator transmitter.
12. Radio alarm transmitter.
13. Network communications.

B. Related Requirements:

1. Section 271513 "Communications Copper Horizontal Cabling" for cables and conductors for fire-alarm systems.

1.3 DEFINITIONS

A. EMT: Electrical Metallic Tubing.

B. FACP: Fire Alarm Control Panel.

C. HLI: High Level Interface.

D. NICET: National Institute for Certification in Engineering Technologies.

E. PC: Personal computer.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product, including furnished options and accessories.

1. Include construction details, material descriptions, dimensions, profiles, and finishes.
2. Include rated capacities, operating characteristics, and electrical characteristics.

B. Shop Drawings: For fire-alarm system.

1. Comply with recommendations and requirements in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
2. Include plans, elevations, sections, details, and attachments to other work.
3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.
4. Detail assembly and support requirements.
5. Include voltage drop calculations for notification-appliance circuits.
6. Include battery-size calculations.
7. Include input/output matrix.
8. Include statement from manufacturer that all equipment and components have been tested as a system and meet all requirements in this Specification and in NFPA 72.
9. Include performance parameters and installation details for each detector.
10. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
11. Provide program report showing that air-sampling detector pipe layout balances pneumatically within the airflow range of the air-sampling detector.
12. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale; coordinate location of duct smoke detectors and access to them.

    a. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators.
    b. Show field wiring required for HVAC unit shutdown on alarm.
    c. Locate detectors according to manufacturer's written recommendations.

13. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.

C. General Submittal Requirements:

1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
2. Shop Drawings shall be prepared by persons with the following qualifications:

    a. Trained and certified by manufacturer in fire-alarm system design.
    b. NICET-certified, fire-alarm technician; Level III minimum.
    c. Licensed or certified by authorities having jurisdiction.

D. Delegated-Design Submittal: For notification appliances and smoke and heat detectors, in addition to submittals listed above, indicate compliance with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Drawings showing the location of each notification appliance and smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of the device.
2. Design Calculations: Calculate requirements for selecting the spacing and sensitivity of detection, complying with NFPA 72. Calculate spacing and intensities for strobe signals and sound-pressure levels for audible appliances.
3. Indicate audible appliances required to produce square wave signal per NFPA 72.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Field quality-control reports.

1.6 Sample Warranty: For special warranty.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following and deliver copies to authorities having jurisdiction:

a. Comply with the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
b. Provide "Fire Alarm and Emergency Communications System Record of Completion Documents" according to the "Completion Documents" Article in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
c. Complete wiring diagrams showing connections between all devices and equipment. Each conductor shall be numbered at every junction point with indication of origination and termination points.
d. Riser diagram.
e. Device addresses.
f. Record copy of site-specific software.
g. Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:

1) Equipment tested.
2) Frequency of testing of installed components.
3) Frequency of inspection of installed components.

4) Requirements and recommendations related to results of maintenance.
5) Manufacturer's user training manuals.

h. Manufacturer's required maintenance related to system warranty requirements.
i. Abbreviated operating instructions for mounting at fire-alarm control unit and each annunciator unit.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.
2. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.
3. Smoke Detectors, Heat Detectors, and Carbon Monoxide Detectors: Quantity equal to 10 percent of amount of each type installed, but no fewer than one unit of each type.
4. Detector Bases: Quantity equal to two percent of amount of each type installed, but no fewer than one unit of each type.
5. Keys and Tools: One extra set for access to locked or tamperproofed components.
6. Audible and Visual Notification Appliances: One of each type installed.
7. Fuses: Two of each type installed in the system. Provide in a box or cabinet with compartments marked with fuse types and sizes.
8. Provide all necessary hardware and programming to provide the client with 20% spare capacity on all initiating and indicating circuits.
9. Provide as part of the base contract all labor and materials to install twenty (20) additional fire alarm devices during construction. The twenty (20) fire alarm device can be but not limited to smoke detector, heat detector, door holder, duct detector, fan shutdown, tamper switches, flow switches, etc. Include all labor and materials including wire, boxes, conduit, terminations, hardware, software, programming and testing.

1.9 QUALITY ASSURANCE

A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level III technician.

C. NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed alarm company.

1.10 PROJECT CONDITIONS

A. Use of Devices during Construction: Protect devices during construction unless devices are placed in service to protect the facility during construction.

1.11 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail in materials or workmanship within specified warranty period.

1. Warranty Extent: All equipment and components not covered in the Maintenance Service Agreement.
2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Source Limitations for Fire-Alarm System and Components: Components shall be compatible with, and operate as an extension of, existing system. Provide system manufacturer's certification that all components provided have been tested as, and will operate as, a system.

B. Noncoded, UL-certified addressable system, with multiplexed signal transmission and voice/strobe evacuation.

C. Automatic sensitivity control of certain smoke detectors.

D. All components provided shall be listed for use with the selected system.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

A. Fire-alarm signal initiation shall be by one or more of the following devices:

1. Manual stations.
2. Heat detectors.

3. Smoke detectors.
4. Duct smoke detectors.
5. Carbon monoxide detectors.
6. Automatic sprinkler system water flow.

B. Fire-alarm signal shall initiate the following actions:

1. Continuously operate alarm notification appliances including voice evacuation notices.
2. Identify alarm and specific initiating device at fire-alarm control unit, connected network control panels, off-premises network control panels, and remote annunciators.
3. Transmit an alarm signal to the remote alarm receiving station.
4. Unlock electric door locks in designated egress paths.
5. Release fire and smoke doors held open by magnetic door holders.
6. Activate voice/alarm communication system.
7. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
8. Close smoke dampers in air ducts of designated air-conditioning duct systems.
9. Recall elevators to primary or alternate recall floors.
10. Activate elevator power shunt trip.
11. Record events in the system memory.
12. Override Cafeteria PA Sound System.
13. Override Gym PA Sound System.

C. Supervisory signal initiation shall be by one or more of the following devices and actions:

1. Valve supervisory switch.
2. Elevator shunt-trip supervision.
3. User disabling of zones or individual devices.
4. Loss of communication with any panel on the network.

D. System trouble signal initiation shall be by one or more of the following devices and actions:

1. Open circuits, shorts, and grounds in designated circuits.
2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
3. Loss of communication with any addressable sensor, input module, relay, control module, remote annunciator, printer interface, or Ethernet module.
4. Loss of primary power at fire-alarm control unit.
5. Ground or a single break in internal circuits of fire-alarm control unit.
6. Abnormal ac voltage at fire-alarm control unit.
7. Break in standby battery circuitry.
8. Failure of battery charging.
9. Abnormal position of any switch at fire-alarm control unit or annunciator.
10. Voice signal amplifier failure.

E. System Supervisory Signal Actions:

1. Initiate notification appliances.
2. Identify specific device initiating the event at fire-alarm control unit, connected network control panels, off-premises network control panels, and remote annunciators.
3. After a time delay of 200 seconds, transmit a trouble or supervisory signal to the remote alarm receiving station.
4. Transmit system status to building management system.

2.3 FIRE-ALARM CONTROL UNIT

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

1. GE UTC Fire & Security; A United Technologies Company.
2. Notifier.
3. Siemens Industry, Inc.; Fire Safety Division.
4. SimplexGrinnell LP.

B. General Requirements for Fire-Alarm Control Unit:

1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864.

    a. System software and programs shall be held in nonvolatile flash, electrically erasable, programmable, read-only memory, retaining the information through failure of primary and secondary power supplies.
    b. Include a real-time clock for time annotation of events on the event recorder and printer.
    c. Provide communication between the FACP and remote circuit interface panels, annunciators, and displays.
    d. The FACP shall be listed for connection to a central-station signaling system service.
    e. Provide nonvolatile memory for system database, logic, and operating system and event history. The system shall require no manual input to initialize in the event of a complete power down condition. The FACP shall provide a minimum 500-event history log.

2. Addressable Initiation Device Circuits: The FACP shall indicate which communication zones have been silenced and shall provide selective silencing of alarm notification appliance by building communication zone.
3. Addressable Control Circuits for Operation of Notification Appliances and Mechanical Equipment: The FACP shall be listed for releasing service.

C. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: Liquid-crystal type, 80 characters, minimum.

2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.

D. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: Liquid-crystal type, three line(s) of 80 characters, minimum.
2. Keypad: Arranged to permit entry and execution of programming, display, and control commands and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters.

E. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits:

1. Pathway Class Designations: NFPA 72, Class B.
2. Pathway Survivability: Level 1.
3. Install no more than 100 addressable devices on each signaling-line circuit.
4. Serial Interfaces:

a. One dedicated RS 485 port for central-station operation using point ID DACT.
b. One RS 485 port for remote annunciators, Ethernet module, or multi-interface module (printer port).
c. One USB port for PC configuration.
d. One RS 232 port for voice evacuation interface.

F. Notification-Appliance Circuit:

1. Fire Alarm Audible appliances shall sound in a three-pulse temporal pattern, as defined in NFPA 72. Carbon Monoxide Alarm Audible appliances shall sound in a four pulse temporal pattern or a constant tone. Carbon monoxide Alarm tone shall be different than the Fire Alarm tone.
2. Where notification appliances provide signals to sleeping areas, the alarm signal shall be a 520-Hz square wave with an intensity 15 dB above the average ambient sound level or 5 dB above the maximum sound level, or at least 75 dBA, whichever is greater, measured at the pillow.
3. Visual alarm appliances shall flash in synchronization where multiple appliances are in the same field of view, as defined in NFPA 72.

G. Elevator Recall:

1. Elevator recall shall be initiated only by one of the following alarm-initiating devices:

a. Elevator lobby detectors except the lobby detector on the designated floor.
b. Smoke detector in elevator machine room.
c. Smoke detectors in elevator hoistway.

2. Elevator controller shall be programmed to move the cars to the alternate recall floor if lobby detectors located on the designated recall floors are activated.
3. Heat Detectors in an elevator shaft and elevator machine room shall shut down elevators associated with the location without time delay.

H. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke-barrier walls shall be connected to fire-alarm system.

I. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory, and print out the final adjusted values.

J. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.

K. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory signals and supervisory and digital alarm communicator transmitters shall be powered by 24-V dc source.

1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.

L. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.

1. Batteries: Sealed lead calcium Sealed, recombinant lead acid] Vented, wet-cell pocket, plate nickel cadmium.

M. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.4 MANUAL FIRE-ALARM BOXES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. GE UTC Fire & Security; A United Technologies Company.
2. Notifier.
3. Siemens Industry, Inc.; Fire Safety Division.
4. SimplexGrinnell LP.

B. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color;

shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.

1. Double-action mechanism requiring two actions to initiate an alarm, pull-lever type; with integral attached addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
2. Station Reset: Key- or wrench-operated switch.

2.5 SYSTEM SMOKE DETECTORS

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

1. GE UTC Fire & Security; A United Technologies Company.
2. Notifier.
3. Siemens Industry, Inc.; Fire Safety Division.
4. SimplexGrinnell LP.

B. General Requirements for System Smoke Detectors:

1. Comply with UL 268; operating at 24-V dc, nominal.
2. Detectors shall be two-wire type.
3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
4. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
6. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
7. Remote Control: Unless otherwise indicated, detectors shall be digital-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.
   a. Multiple levels of detection sensitivity for each sensor.
   b. Sensitivity levels based on time of day.

C. Photoelectric Smoke Detectors:

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:

   a. Primary status.
   b. Device type.
   c. Present average value.
   d. Present sensitivity selected.
   e. Sensor range (normal, dirty, etc.).

D. Duct Smoke Detectors: Photoelectric type complying with UL 268A.

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:

    a. Primary status.
    b. Device type.
    c. Present average value.
    d. Present sensitivity selected.
    e. Sensor range (normal, dirty, etc.).
3. Each sensor shall have multiple levels of detection sensitivity.
4. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
5. Relay Fan Shutdown: Fully programmable relay rated to interrupt fan motor-control circuit.

2.6 PROJECTED BEAM SMOKE DETECTORS

A. Projected Beam Light Source and Receiver: Designed to accommodate small angular movements and continue to operate and not cause nuisance alarms.

B. Detector Address: Accessible from fire-alarm control unit and able to identify the detector's location within the system and its sensitivity setting.

C. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:

1. Primary status.
2. Device type.
3. Present average value.
4. Present sensitivity selected.
5. Sensor range (normal, dirty, etc.).

2.7 CARBON MONOXIDE DETECTORS

A. General: Carbon monoxide detector listed for connection to fire-alarm system.

1. Mounting: Adapter plate for outlet box mounting.
2. Testable by introducing test carbon monoxide into the sensing cell.
3. Detector shall provide alarm contacts and trouble contacts.
4. Detector shall send trouble alarm when nearing end-of-life, power supply problems, or internal faults.
5. Comply with UL 2075.
6. Locate, mount, and wire according to manufacturer's written instructions.
7. Provide means for addressable connection to fire-alarm system.
8. Test button simulates an alarm condition.
9. Provide with sounder bases for local audio annunciator.

2.8 MULTICRITERIA DETECTORS

A. Mounting: Twist-lock base interchangeable with smoke-detector bases.

B. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

C. Automatically adjusts its sensitivity by means of drift compensation and smoothing algorithms. The detector shall send trouble alarm if it is incapable of compensating for existing conditions.

D. Test button tests all sensors in the detector.

E. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:

1. Primary status.
2. Device type.
3. Present sensitivity selected.
4. Sensor range (normal, dirty, etc.).

F. Sensors: The detector shall be comprised of four sensing elements including a smoke sensor, a carbon monoxide sensor, an infrared sensor, and a heat sensor.

1. Smoke sensor shall be photoelectric type as described in "System Smoke Detectors" Article.
2. Carbon monoxide sensor shall be as described in "Carbon Monoxide Detectors" Article.
3. Heat sensor shall be as described in "Heat Detectors" Article.
4. Each sensor shall be separately listed according to requirements for its detector type.

2.9 HEAT DETECTORS

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

1. GE UTC Fire & Security; A United Technologies Company.
2. Notifier.
3. Siemens Industry, Inc.; Fire Safety Division.
4. SimplexGrinnell LP.

B. General Requirements for Heat Detectors: Comply with UL 521.

1. Temperature sensors shall test for and communicate the sensitivity range of the device.

C. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F (57 deg C) or a rate of rise that exceeds 15 deg F (8 deg C) per minute unless otherwise indicated.

1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

2.10 AIR-SAMPLING SMOKE DETECTOR

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

1. Ansul by Johnson Controls Company.
2. Fenwal Protection Systems; A UTC Fire & Security Company.
3. Fike Corporation.
4. Notifier.

B. General Description:

1. Air-sampling smoke detector shall be laser based using a piping system and a fan to transport the particles of combustion to the detector.
2. Provide two levels of alarm from each zone covered by the detector and two supervisory levels of alarm from each detector.
3. The air being sampled shall pass through filters to remove dust particulates greater than 20 microns before entering the detection chamber.
4. Detectors shall have the capability via RS 485 to connect up to 100 detectors in a network.
5. Detectors shall communicate with the fire-alarm control unit via addressable, monitored dry contact closures, RS 485, and interface modules. Provide a minimum of six relays, individually programmable remotely for any function.
6. Pipe airflow balancing calculations shall be performed using approved calculation software.

C. Detector:

1. Detector, Filter, Aspirator, and Relays: Housed in a mounting box and arranged in such a way that air is drawn from the detection area and a sample passed through the dual-stage filter and detector by the aspirator.
2. Obscuration Sensitivity Range: 0.005 - 6 percent obs/ft.
3. Four independent, field-programmable, smoke-alarm thresholds per sensor pipe and a programmable scan time delay. The threshold set points shall be programmable.

    a. The four alarm thresholds may be used as follows:

        1) Alarm Level 1 (Alert): Activate a visual and an audible supervisory alarm.
        2) Alarm Level 2 (Action): Activate shutdown of electrical/HVAC equipment and activate a visual and an audible supervisory alarm.
        3) Alarm Level 3 (Fire 1): Activate building alarm systems and initiate call to fire response unit.
        4) Alarm Level 4 (Fire 2): Activate suppression system or other countermeasures.

b. Final Detection System Settings: Approved by Architect.
c. Initial Detection Alarm Settings:

1) Alarm Level 1 (Alert): 0.08 percent obs/ft.
2) Alarm Level 2 (Action): 1.0 percent obs/ft.
3) Alarm Level 3 (Fire 1): 2.0 percent obs/ft.
4) Alarm Level 4 (Fire 2): 4.0 percent obs/ft.

4. Power Supply:

a. Regulated 24-V dc, monitored by the fire-alarm control unit, with battery backup.
b. Battery backup shall provide 24 hours' standby, followed by 30 minutes at maximum connected load.

5. Detector shall also transmit the following faults:

a. Detector.
b. Airflow.
c. Filter.
d. System.
e. Zone.
f. Network.
g. Power.

6. Provide four in-line sample pipe inlets that shall contain a flow sensor for each pipe inlet. The detector shall be capable of identifying the pipe from which smoke was detected.
7. Aspirator: Air pump capable of allowing for multiple sampling pipe runs up to 650 feet (200 m) in total, (four pipe runs per detector) with a transport time of less than 120 seconds from the farthest sample port.
8. Air-Sampling Flow Rates Outside Manufacturer's Specified Range: Result in a trouble alarm.
9. Provide software-programmable relays rated at 2 A at 30-V dc for alarm and fault conditions.
10. Provide built-in event and smoke logging; store smoke levels, alarm conditions, operator actions, and faults with date and time of each event. Each detector (zone) shall be capable of storing up to 18,000 events.
11. Urgent and Minor Faults. Minor faults shall be designated as trouble alarms. Urgent faults, which indicate the unit may not be able to detect smoke, shall be designated as supervisory alarms.

D. Displays:

1. Include display module within each detector.
2. Each display shall provide the following features at a minimum:

a. A bar-graph display.
b. Four independent, high-intensity alarm indicators (Alert, Action, Fire 1, and Fire 2), corresponding to the four alarm thresholds of the indicated sector.
c. Alarm threshold indicators for Alert, Action, and Fire 1.

d. LED indication that the first alarm sector is established.
e. Detector fault and airflow fault indicators.
f. LED indicators shall be provided for faults originating in the particular zone (Zone Fault), faults produced by the overall smoke-detection system, and faults resulting from network wiring errors (Network Fault).
g. Minor and urgent LED fault indicators.

E. Sampling Tubes:

1. Smooth bore with a nominal 1-inch (25-mm) OD and a 7/8-inch (21-mm) ID. Sampling pipe with between 5/8- and 1-inch (15- and 25-mm) ID can be used in specifically approved locations when recommended by manufacturer.
2. Pipe Material: CPVC and complying with UL 1887, "Safety Fire Test of Plastic Sprinkler Pipe for Visible Flame and Smoke Characteristics."
3. Joints in the sampling pipe shall be airtight. Use solvent cement approved by the pipe manufacturer on all joints except at entry to the detector.
4. Identify piping with labels reading: "Aspirating Smoke Detector Pipe - Do Not Paint or Disturb" along its entire length at regular intervals according to NFPA 72.
5. Support pipes at not more than 60-inch (1520-mm) centers.
6. Fit end of each trunk or branch pipe with an end cap and drilled with a hole appropriately sized to achieve the performance as specified and as calculated by the system design.

F. Sampling Holes:

1. Sampling holes of 5/64 inch (2 mm), or other sized holes per manufacturer's written instructions, shall be separated by not more than the maximum distance allowable for conventional smoke detectors. Intervals may vary according to calculations.
2. Follow manufacturer's written recommendations to determine the number and spacing of sampling points and the distance from sampling points to ceiling or roof structure and to forced ventilation systems.
3. Each sampling point shall be identified by an applied decal.

2.11 NOTIFICATION APPLIANCES

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

1. GE UTC Fire & Security; A United Technologies Company.
2. Siemens Industry, Inc.; Fire Safety Division.
3. SimplexGrinnell LP.
4. System Sensor.

B. General Requirements for Notification Appliances: Connected to notification-appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.

1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.

C. Visible Notification Appliances: Xenon strobe lights complying with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- (25-mm-) high letters on the lens.

1. Rated Light Output:

a. 15 30 75 110 177cd.
b. 15/30/75/110 cd, selectable in the field.

2. Mounting: Wall mounted unless otherwise indicated.
3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
4. Flashing shall be in a temporal pattern, synchronized with other units.
5. Strobe Leads: Factory connected to screw terminals.
6. Mounting Faceplate: Factory finished, red.

D. Voice/Tone Notification Appliances:

1. Comply with UL 1480.
2. Speakers for Voice Notification: Locate speakers for voice notification to provide the intelligibility requirements of the "Notification Appliances" and "Emergency Communications Systems" chapters in NFPA 72.
3. High-Range Units: Rated 2 to 15 W.
4. Low-Range Units: Rated 1 to 2 W.
5. Mounting: surface mounted and bidirectional.
6. Matching Transformers: Tap range matched to acoustical environment of speaker location.

E. Exit Marking Audible Notification Appliance:

1. Exit marking audible notification appliances shall meet the audibility requirements in NFPA 72.
2. Provide exit marking audible notification appliances at the entrance to all building exits.
3. Provide exit marking audible notification appliances at the entrance to areas of refuge with audible signals distinct from those used for building exit marking.

2.12 MAGNETIC DOOR HOLDERS

A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.

1. Electromagnets: Require no more than 3 W to develop 25-lbf (111-N) holding force.
2. Wall-Mounted Units: Flush mounted unless otherwise indicated.
3. Rating: 24-V ac or dc.

4. Rating: 120-V ac.

B. Material and Finish: Match door hardware.

2.13 REMOTE ANNUNCIATOR

A. Description: Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing.

1. Mounting: Flush cabinet, NEMA 250, Type 1.

B. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

2.14 ADDRESSABLE INTERFACE DEVICE

A. General:

1. Include address-setting means on the module.
2. Store an internal identifying code for control panel use to identify the module type.
3. Listed for controlling HVAC fan motor controllers.

B. Monitor Module: Microelectronic module providing a system address for alarm-initiating devices for wired applications with normally open contacts.

C. Integral Relay: Capable of providing a direct signal to elevator controller to initiate elevator recall and to circuit-breaker shunt trip for power shutdown.

1. Allow the control panel to switch the relay contacts on command.
2. Have a minimum of two normally open and two normally closed contacts available for field wiring.

D. Control Module:

1. Operate notification devices.
2. Operate solenoids for use in sprinkler service.

2.15 DIGITAL ALARM COMMUNICATOR TRANSMITTER

A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632.

B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture two telephone line(s) and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on either line is interrupted for longer than 45

seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.

C. Local functions and display at the digital alarm communicator transmitter shall include the following:

1. Verification that both telephone lines are available.
2. Programming device.
3. LED display.
4. Manual test report function and manual transmission clear indication.
5. Communications failure with the central station or fire-alarm control unit.

D. Digital data transmission shall include the following:

1. Address of the alarm-initiating device.
2. Address of the supervisory signal.
3. Address of the trouble-initiating device.
4. Loss of ac supply.
5. Loss of power.
6. Low battery.
7. Abnormal test signal.
8. Communication bus failure.

E. Secondary Power: Integral rechargeable battery and automatic charger.

F. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

2.16 RADIO ALARM TRANSMITTER

A. Transmitter shall comply with NFPA 1221 and 47 CFR 90.

B. Description: Manufacturer's standard commercial product; factory assembled, wired, and tested; ready for installation and operation.

1. Packaging: A single, modular, NEMA 250, Type 1 metal enclosure with a tamper-resistant flush tumbler lock.
2. Signal Transmission Mode and Frequency: VHF or UHF 2-W power output, coordinated with operating characteristics of the established remote alarm receiving station designated by Owner.
3. Normal Power Input: 120-V ac.
4. Secondary Power: Integral-sealed, rechargeable, 12-V battery and charger. Comply with NFPA 72 requirements for battery capacity; submit calculations.
5. Antenna: Omnidirectional, coaxial half-wave, dipole type with driving point impedance matched to transmitter and antenna cable output impedance. Wind-load strength of antenna and mounting hardware and supports shall withstand 100 mph (160 km/h) with a gust factor of 1.3 without failure.

6. Antenna Cable: Coaxial cable with impedance matched to the transmitter output impedance.
7. Antenna-Cable Connectors: Weatherproof.
8. Alarm Interface Devices: Circuit boards, modules, and other auxiliary devices, integral to the transmitter, matching fire-alarm and other system outputs to message-generating inputs of the transmitter that produce required message transmissions.

C. Functional Performance: Unit shall receive alarm, supervisory, or trouble signal from fire-alarm control unit or from its own internal sensors or controls and shall automatically transmit signal along with a unique code that identifies the transmitting station to the remote alarm receiving station. Transmitted messages shall correspond to standard designations for fire-reporting system to which the signal is being transmitted and shall include separately designated messages in response to the following events or conditions:

1. Transmitter Low-Battery Condition: Sent when battery voltage is below 85 percent of rated value.
2. System Test Message: Initiated manually by a test switch within the transmitter cabinet, or automatically at an optionally preselected time, once every 24 hours, with transmission time controlled by a programmed timing device integral to transmitter controls.
3. Transmitter Trouble Message: Actuated by failure, in excess of one-minute duration, of the transmitter normal power source, derangement of the wiring of the transmitter, or any alarm input interface circuit or device connected to it.
4. Local Fire-Alarm-System Trouble Message: Initiated by events or conditions that cause a trouble signal to be indicated on the building system.
5. Local Fire-Alarm-System Alarm Message: Actuated when the building system goes into an alarm state. Identifies device that initiated the alarm.
6. Local Fire-Alarm-System, Supervisory-Alarm Message:

2.17 NETWORK COMMUNICATIONS

A. Provide network communications for fire-alarm system according to fire-alarm manufacturer's written requirements.

B. Provide network communications pathway per manufacturer's written requirements and requirements in NFPA 72 and NFPA 70.

C. Provide integration gateway using Modbus for connection to building automation system.

2.18 DEVICE GUARDS

A. Description: Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.

1. Factory fabricated and furnished by device manufacturer.
2. Finish: Paint of color to match the protected device.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.

1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.

B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EQUIPMENT INSTALLATION

A. Comply with NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."

1. Devices placed in service before all other trades have completed cleanup shall be replaced.
2. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.

B. Manual Fire-Alarm Boxes:

1. Install manual fire-alarm box in the normal path of egress within 60 inches (1520 mm) of the exit doorway.
2. Mount manual fire-alarm box on a background of a contrasting color.
3. The operable part of manual fire-alarm box shall be between 42 inches (1060 mm) and 48 inches (1220 mm) above floor level. All devices shall be mounted at the same height unless otherwise indicated.

C. Smoke- or Heat-Detector Spacing:

1. Comply with the "Smoke-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for smoke-detector spacing.
2. Comply with the "Heat-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for heat-detector spacing.
3. Smooth ceiling spacing shall not exceed 30 feet (9 m).
4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Annex A or Annex B in NFPA 72.

5. HVAC: Locate detectors not closer than 60 inches (1520 mm) from air-supply diffuser or return-air opening.
6. Lighting Fixtures: Locate detectors not closer than 12 inches (300 mm) from any part of a lighting fixture and not directly above pendant mounted or indirect lighting.

D. Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover.

E. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct. Tubes more than 36 inches (9100 mm) long shall be supported at both ends.

1. Do not install smoke detector in duct smoke-detector housing during construction. Install detector only during system testing and prior to system turnover.

F. Air-Sampling Smoke Detectors: If using multiple pipe runs, the runs shall be pneumatically balanced.

G. Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location. Do not install smoke detectors in sprinklered elevator shafts.

H. Remote Status and Alarm Indicators: Install in a visible location near each smoke detector, sprinkler water-flow switch, and valve-tamper switch that is not readily visible from normal viewing position.

I. Audible Alarm-Indicating Devices: Install not less than 6 inches (150 mm) below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille. Install all devices at the same height unless otherwise indicated.

J. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches (150 mm) below the ceiling. Install all devices at the same height unless otherwise indicated.

K. Device Location-Indicating Lights: Locate in public space near the device they monitor.

L. Antenna for Radio Alarm Transmitter: Mount to building structure where indicated. Use mounting arrangement and substrate connection that resists 100-mph (160-km/h) wind load with a gust factor of 1.3 without damage.

3.3 PATHWAYS

A. Pathways above recessed ceilings and in nonaccessible locations may be routed exposed.

1. Exposed pathways located less than 96 inches (2440 mm) above the floor shall be installed in EMT.

B. Pathways shall be installed in EMT.

C. Exposed EMT shall be painted red enamel.

3.4 CONNECTIONS

A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Section 087100 "Door Hardware." Connect hardware and devices to fire-alarm system.

1. Verify that hardware and devices are listed for use with installed fire-alarm system before making connections.

B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 36 inches (910 mm) from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.
1. Smoke dampers in air ducts of designated HVAC duct systems.
2. Magnetically held-open doors.
3. Electronically locked doors and access gates.
4. Alarm-initiating connection to elevator recall system and components.
5. Supervisory connections at valve supervisory switches.
6. Supervisory connections at elevator shunt-trip breaker.

3.5 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 270553 "Identification for Communications Systems."

B. Install framed instructions in a location visible from fire-alarm control unit.

3.6 GROUNDING

A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

B. Ground shielded cables at the control panel location only. Insulate shield at device location.

3.7 FIELD QUALITY CONTROL

A. Field tests shall be witnessed by authorities having jurisdiction.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.

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

1. Visual Inspection: Conduct visual inspection prior to testing.

    a. Inspection shall be based on completed record Drawings and system documentation that is required by the "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
    b. Comply with the "Visual Inspection Frequencies" table in the "Inspection" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.

2. System Testing: Comply with the "Test Methods" table in the "Testing" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
4. Test audible appliances for the private operating mode according to manufacturer's written instructions.
5. Test visible appliances for the public operating mode according to manufacturer's written instructions.
6. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" section of the "Fundamentals" chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

E. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.

F. Fire-alarm system will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

H. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.

I. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.8 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include preventive maintenance, repair or

replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

1. Include visual inspections according to the "Visual Inspection Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
2. Perform tests in the "Test Methods" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
3. Perform tests per the "Testing Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

3.9 DEMONSTRATION

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

END OF SECTION 284621.11

SECTION 31 10 00 SITE CLEARING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Temporary construction fence is specified in Section 015000 “Temporary Facilities and Controls.”

C. Division 31, Section 312000 “Earth - Moving” for soil materials, excavating, backfilling, and site grading.

1.2 SUMMARY

A. Section Includes:

1. Protecting existing vegetation to remain.
2. Removing existing vegetation.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Removing above- and below-grade site improvements.
6. Temporary erosion- and sedimentation-control measures.

1.3 DEFINITIONS

A. Remove: Detach items from existing construction and dispose of them off-site unless indicated to be salvaged or reinstalled.

B. Remove and Salvage: Carefully detach from existing construction, in a manner to prevent damage, and deliver to Owner ready for reuse.

C. Remove and Reinstall: Detach items from existing construction, prepare for reuse, and reinstall where indicated.

D. Remove and Dispose: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged. Disposal of all demolished material shall be at the Contract’s expense.

E. Existing to Remain: Existing items of construction that are not to be permanently removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

F. Subsoil: All soil beneath the topsoil layer of the soil profile and typified by the lack of organic matter and soil organisms.

G. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.

H. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil and is the zone where plant roots grow.

I. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.4 MATERIAL OWNERSHIP

A. Except for stripped topsoil and other materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.

1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.5 SUBMITTALS

A. Existing Conditions: Documentation of existing trees and plantings, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.

1. Use sufficiently detailed photographs or videotape.

2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plants designated to remain.

B. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

C. Product Data: For each type of the following manufactured products required:

1. Geotextiles, filter fabrics, inlet protection, and silt fence.

1.6 QUALITY ASSURANCE

A. Preinstallation Conference: Conduct conference at Project site.

B. Tree Removals: Before any trees or shrubs are removed, the Contractor shall arrange a conference on-site with the Owner’s Designated Representative to identify trees and shrubs which are to be removed, as well as those which are to be protected. No cutting or removal shall commence without a clear understanding of the existing trees to be preserved.

1.7 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 Owner and authorities having jurisdiction.

2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

B. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises.

C. The contractor shall exercise extreme care when performing construction operations in proximity to site elements to remain, especially site walls and fencing. Damages to existing conditions to remain on and off the property shall be repaired to the Owner’s satisfaction at no additional cost to the Owner.

D. Utility Locator Service: Notify Dig Safely New York (1-800-962-7962) and the proper local authorities or respective utility company having jurisdiction for area where Project is located before site clearing.

E. Do not commence site clearing operations until temporary erosion- and sedimentation-control and protection fencing measures are in place.

F. The following practices are prohibited within protection zones:

1. Storage of construction materials, debris, or excavated material.

2. Parking vehicles or equipment.

3. Erection of sheds or structures.

4. Impoundment of water.

5. Excavation or other digging unless otherwise indicated.

G. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

H. Soil Stripping, Handling, and Stockpiling: Perform only when the topsoil is dry or slightly moist.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 312000 "Site Earthwork"

1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

B. Silt Fence: Silt fence fabric shall be on the NYSDOT Approved Material List for geotextiles, approved for use with silt fence, unsupported with 1.2m spacing. Stakes shall be 2-inch square x 36-inch long hardwood stakes.

C. Inlet protection: Provide Silt Sack Drop Inlet Protection for paved areas and Filter Fabric Inlet Projection for non-paved areas as detailed on the Construction Drawings.

1. Projection Filter Fabric shall have an equivalent opening size of 40-85.

2. Stakes shall be 2”x4”x3’ minimum length composed of wood or metal and placed as detailed on Construction Drawings.

3. Silt Sack Drop Inlet shall be rated for 200 gpm/sqft with a removal efficiency of 82% when filtering a USDA Sandy Loam sediment load and manufactured to fit the opening of the catch basin or drop inlet. Drop inlet shall be comprised of a corrosion resistant steel frame and replaceable woven polypropylene geotextile filter bag. Silt sack fabric shall conform to following properties:

Grab Tensile:	237x294 pounds; ASTM D 4632.
Grab Elongation:	9x24 percent; ASTM D 4632
Puncture:	716 pounds; ASTM D 4533
Trapezoidal Tear:	79x76 pounds; ASTM D 4533
U.V. Resistance (Strength Retained):	99 percent; ASTM D 4355
Apparent Opening Size:	20 U.S. Sieve Number; ASTM D 4751
Permittivity:	3.396 sec.-1; ASTM D 4491.
Flow Rate:	100.6 gallons per minute/S.F.; ASTM D 4491

D. Protection Fence: Provide 4-foot high, orange polyethylene warning fence with metal posts, to serve as tree protection fence as shown on the Contract Drawings. Fences may not be moved without the specific permission of the Owner’s Designated Representative.

E. Stabilized Construction Entrance and Stabilized Access Drive: Provide as detailed on the Construction Drawings.

1. Stone: 50/50 mixture of NYSDOT Standard Specifications for Item No. 3 and No. 4 stone

2. Geotextile fabric: As specified in Section 312000, Earthwork-Site, installed on subbase.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped before starting selective demolition operations.

B. Review record documents of existing construction provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in record documents.

C. Survey existing conditions and correlate with requirements indicated to determine extent of selective site demolition required.

D. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Owner's Representative.

3.2 PREPARATION

A. General:

1. The Contract Limit Line (Limit of Work) is to be strictly adhered to.

2. Demolish indicated structures and appurtenances in an orderly and careful manner.

3. Cease operations and notify the Owners Designated Representative immediately if adjacent structures appear to be endangered. Do not resume operations until corrective measures have been taken.

B. Perimeter Security Fencing: Placement of fencing as indicated on the Contract Documents. Relocation of fencing as approved by Owners Designated Representative.

C. Install tree protection fence in accordance with project plans, details, and requirements of this section.

D. Contractor shall implement erosion control measures as shown on the plans and as job conditions dictate. Intent is to minimize erosion and pollutants at the source, capture sediment at regular intervals and prevent sediment intrusion into storm sewer pipes, structures, and waterways. Work includes, but is not limited to, mulching, temporary silt fences, filter fabric, expeditious grading, prompt turf establishment, sediment dikes, and maintenance of same.

E. The Contractor shall initiate stabilization measures as soon as practicable in portions of the site where construction activities have temporarily or permanently ceased, but in no case more than 14 days after the construction activity in that portion of the site has temporarily or permanently ceased. If disturbed soils surfaces are to be left exposed for a period of greater than 14 days, stabilize the soil with temporary seeding and/or mulch to limit erosion. Where the initiation of stabilization measures by the 14th day after construction activity temporarily or permanently ceased is precluded by snow cover or frozen ground conditions, stabilization measures shall be initiated as soon as practicable. The onset of seasonally adverse weather is not intended as an excuse for not implementing the necessary erosion controls. The Contractor shall use foresight in

his activities to only disturb areas that he can stabilize before adverse weather conditions prevail. The Contractor is encouraged to schedule his work such that final land surface restoration closely follows initial disturbance to the maximum extent possible in order to limit bare soil exposure and dependence on the temporary systems discussed above.

F. Protect and maintain benchmarks and survey control points from disturbance during construction.

G. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.3 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings, the SWPPP, and requirements of authorities having jurisdiction.

B. Provide Stabilized Construction Entrances at all locations where construction traffic leaving the site presents the potential for sediment track-out. Remove accumulated sediment and install new stone as required to prevent track-out.

C. Surrounding roads shall always be kept clean of dirt and debris. Contractors shall utilize a mechanical means of sweeping road daily or as necessary to keep public roads free of soil, tracking or debris.

D. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

E. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

F. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

G. Filter fabric drop inlet protection installation (non-paved areas):

1. Cut fabric from a continuous roll to eliminate joints. If joints are needed, they will be overlapped to the next stake.

2. Space stakes evenly around inlet 3 feet apart and drive a minimum 18” deep spans greater than 3 feet may be bridged with the use of wire mesh behind the filler fabric for support.

3. Fabric shall be embedded 1-foot minimum below ground and backfilled. It shall be securely fastened to the stakes and frame.

4. A 2” x 4” wood frame shall be completed around the crest of the fabric for over flow stability.

3.4 PROTECTION FENCING

A. General: Protect areas depicted on the Contract Drawings. Repair or replace grassed areas to remain that are damaged by construction operations, in a manner approved by the Owner's Designated Representative.

3.5 EXISTING UTILITIES

A. Locate, identify, disconnect, and seal or cap utilities indicated to be removed.

1. Arrange with utility companies to shut off indicated utilities.

B. Locate, identify, and disconnect utilities indicated to be abandoned in place. Plug ends of pipes with silt tight caps.

C. Mark location of disconnected utilities. Identify and indicate capping locations of remaining utilities on Project Record Documents.

D. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Owner's Designated Representative not less than three days in advance of proposed utility interruptions.

2. Do not proceed with utility interruptions without Owner's Designated Representatives written permission.

E. Excavate for and remove underground utilities indicated to be removed.

3.6 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.

1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches and compact each layer to a density equal to adjacent original ground.

3.7 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Stockpile topsoil away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

1. Limit height of topsoil stockpiles to 72 inches.

2. Do not stockpile topsoil within protection zones.

3. Dispose of surplus topsoil subject to the approval of the Owner's Designated Representative. Surplus topsoil is that which exceeds quantity indicated to be stockpiled or reused.

C. Topsoil that meets the requirements of these specifications may be used for new landscaped areas:

1. Strip topsoil to whatever depths encountered in a manner to prevent intermingling with underlying subsoil or other objectionable material. Remove heavy growths of grass from areas before stripping.

a. Where existing trees are indicated to remain, leave existing topsoil in place within drip lines to prevent damage to root system.

2. Stockpile topsoil in storage piles in areas indicated or directed. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion. Do not stockpile topsoil within protection zones. Limit stockpiles to 72 inches high.

3. Dispose of unsuitable or excess topsoil as specified for disposal of waste material only after approval of the Owners Designated Representative.

4. Some quantity of topsoil may be available on site. Contractor shall augment on site supply as necessary to meet the specified requirements for installation of topsoil without additional cost to the Owner.

3.8 SITE SELECTIVE DEMOLITION

A. General: Demolish and remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

1. All items requiring removal shall be removed to full depth, including base material and footings or foundations, unless otherwise noted.

2. Use methods required to complete the Work within limitations of governing regulations and as follows:
a. Proceed with selective demolition systematically.

b. Dispose of demolished items and materials promptly.

3. Fill depressions caused by demolition operations with structural fill, (satisfactory soil material may be used in lawn areas), unless further excavation or earthwork is indicated.
a. Place fill material in horizontal layers not exceeding a loose depth of 8 inches and compact each layer to a density equal to adjacent original ground and in accordance with the Geotechnical Report.

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.

1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically and protect until proposed abutting materials are installed.

2. Paint cut ends of steel reinforcement in concrete to remain with two coats of antirust coating, following coating manufacturer's written instructions. Keep paint off surfaces that will remain exposed.

C. Removed and Salvaged Items:

1. Salvage all items indicated on the drawings. Do not commence removal operations until a clear understanding of the items to be salvaged and the items to be removed and disposed of is obtained.

2. Clean salvaged items.

3. Pack or crate items after cleaning. Identify contents of containers.

4. Store items in a secure area until delivery to Owner.

5. Transport items to Owner's storage area, to be designated by Owner.

6. Protect items from damage during transport and storage.

D. Removed and Reinstalled Items:

1. Clean and repair items to functional condition adequate for intended reuse.

2. Pack or crate items after cleaning and repairing. Identify contents of containers.

3. Protect items from damage during transport and storage.

4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

E. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Owner’s Representative, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

F. Clean all salvaged items.

3.9 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. General: Except for items or materials indicated to be salvaged, reinstalled, or otherwise indicated to remain Owner's property, the Contractor shall remove all demolished materials, waste materials including trash and debris, and all other material

not part of the finished work from the Project site, transport and and legally dispose of them in an EPA-approved landfill.

1. Remove surplus soil material, unsuitable topsoil and subsoil, obstructions,
2. Do not allow demolished materials to accumulate on-site.
3. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas. If debris is spilled outside of the limit of construction, the Contractor shall promptly remove the debris and clean the surface to the satisfaction of the Owner's Representative.
4. Comply with requirements specified in Division 01 Section "Construction Waste Management and Disposal."
5. Disposal of all demolished material shall be at the Contract's expense.

B. Burning: Do not burn demolished materials.

C. Disposal: Transport demolished materials off Owner's property and legally dispose of them.

3.10 CLEANING

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

3.11 FINAL STABILIZATION

A. Final stabilization is defined as all soil disturbing activities at the site have been completed, and that a uniform perennial vegetative cover with a density of at least 80% over the entire pervious surface has been established or equivalent stabilization measures (such as the use of mulches or geotextiles) have been employed on all unpaved areas and areas not covered by permanent structures.

3.12 REMOVAL OF TEMPORARY EROSION AND SEDIMENT CONTROL MEASURES

A. Remove erosion control devices when final stabilization has occurred for the respective areas of the site and are no longer needed.

END OF SECTION 311000

SECTION 31 20 00 – SITE EARTHWORK

PART 1- GENERAL

1.1 SECTION INCLUDES

A. This Section includes furnishing all labor, materials, equipment and services required to complete and make fully functional, the work indicated on the Contract Drawings and as described in the Contract Documents. This Section includes, but is not limited to the following:
   1. Trench excavation material and labor
   2. Protection of adjacent work
   3. Backfilling with approved native or imported materials.
   4. Barricades and protection devices
   5. Storage and excavated materials
   6. Dewatering
   7. Placement and compaction
   8. Field quality control
   9. Disposal of unused materials
   10. Site grading
   11. Sub-base preparation and base course for paving.
   12. Geotextiles and filter fabrics
   13. Surface restoration
   14. Maintenance

1.2 RELATED DOCUMENTS

A. Erosion control items are specified in Division 31 Specification, Section 311000, Site Clearing.

B. Earthwork requirements for sub-grade, excavation, backfilling, sub-base and sub-surface drainage within building envelope is specified in Specification Section “Earthwork for Structures”.

C. Topsoil stripping is specified in Division 31, Specification Section 311000, “Site Clearing”.

D. Underdrainage is specified in Division 33, Specification Section 334100, “Storm Drainage System”.

E. Final Grading, together with placement and preparation of topsoil for turf and planting, is specified in Division 32 Specification Section 329200, “Turf”.

1.3 SUBMITTALS

A. General: Submit manufacturers/suppliers’ information for all the items included in this specification in accordance with Conditions of Contract and Division 1 Specification Sections:

1.4 DEFINITIONS

A. Excavation consists of removal of material encountered to subgrade elevations indicated and subsequent disposal of materials removed.

B. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction of Owners Designated Representative. Unauthorized excavation, as well as remedial work directed by Owners Designated Representative, shall be at Contractor's expense.

C. Backfill and compact unauthorized excavations as specified for authorized excavations of same classification, unless otherwise directed by Owners Designated Representative.

D. Additional Excavation: When excavation has reached required subgrade elevations, notify the Owners Designated Representative, who will make inspection of conditions. If Owners Designated Representative determines that bearing materials at required subgrade elevations are unsuitable, continue excavation until suitable bearing materials are encountered and replace excavated material as directed by Owners Designated Representative.

E. Subgrade: Undisturbed/unexcavated earth or compacted soil layer immediately below subbase, drainage fill, or topsoil materials.

F. Structure: Buildings, foundations, slabs, tanks, curbs or other manmade stationary features occurring above or below ground surface.

G. Subbase: Compacted material of required type and thickness as detailed specifically for this project and located immediately above subgrade in roadways, sidewalks, etc.

H. Structural Fill: Site sands which are cleansed of any organic or deleterious materials and brought to near their optimum moisture content and imported bank-run sand or sand and gravel which conforms to limits of gradation specified.

1.5 QUALITY ASSURANCE

A. Codes and Standards: Perform excavation work in compliance with applicable requirements of authorities having jurisdiction.

B. Standard Specifications: Unless otherwise noted, follow the standards for Construction and Materials (by the New York State Department of Transportation's [NYSDOT] Office of Engineering most recent edition).

1.6 COORDINATION AND PROJECT CONDITIONS

A. Notify Dig Safely New York (1-800-962-7962) and the proper local authorities or respective utilities companies having jurisdiction for area where Project is located before beginning earth moving operations.

B. In addition to Dig Safely New York notifications, the Contractor shall retain the services of a utility locating service that shall be responsible for locating and

documenting all underground utilities within the limits of construction. Utility locations shall include their horizontal and vertical location. Utilities shall be located via test pits, ground penetrating radar, ground fault and short detection, and time domain reflection methods. Construction shall not commence until all utilities within the limits of construction have been identified and documented.

C. If utilities are indicated to remain in place, provide adequate means of support and protection during earthwork operations.

D. Should uncharted, or incorrectly charted, piping or other utilities be encountered during excavation, consult Owners Designated Representative immediately for directions. Cooperate with Owner and utility companies in keeping respective services and facilities in operation.

E. The contractor will be responsible for repair to any existing utilities caused by earthwork operations. Repair damaged utilities in conformance to Specifications and to the satisfaction of the Owners Designated Representative.

F. Do not interrupt existing utilities serving facilities occupied by Owner or others, except when permitted in writing by the Owners and then only after acceptable temporary utility services have been provided.

G. Provide minimum of 48-hour notice to Owner and receive written notice to proceed before interrupting any utility.

H. Use of Explosives: Use of explosives is not permitted under this section.

I. Protection of Persons and Property: Barricade open excavations occurring as part of this work and post with warning lights.

J. Operate warning lights as recommended by authorities having jurisdiction.

K. Protect structures, utilities, sidewalks, pavements and other facilities from damage caused by settlement, lateral movement, undermining, washout and other hazards created by earthwork operations.

L. All site grading from initial stripping activities through final construction shall be performed to assure that drainage is provided at all times. Existing soils will rapidly soften and swell if allowed to saturate through ponding.

M. Weather Limitations: Contractor shall not perform earthwork operations during frozen subgrade conditions. For aggregate subbase courses, the Contractor shall comply with the temperature restrictions as contained in NYSDOT Specification Section 304 Subbase Course.

N. Subsurface Information: Soil borings have been taken within the project area. Mapping and logs are included in the Contract Drawings.

PART 2 – PRODUCT

2.1 MATERIALS

A. Crushed stone at utility trenching, storm structures and drainage stone shall consist of a 50/50 mixture of material conforming to the NYSDOT Standard Specifications for No. 1 and No. 2 Stone (Table 703-4), approved by the Owners Designated Representative.

B. Granular Sub-base: (for pavement bases) shall consist of materials conforming to the NYSDOT Standard Specifications for Item No. 304.12, Type 2, ASTM 33, approved by the Owners Designated Representative.

C. Tree Box Filter Media: shall consist of a mixture of 60-75% ASTM C-33 sand and 25%-40% of topsoil conforming to NYSDOT Section 713-01 for Roadside Mix or Specialty Planting mix.

D. Select Fill shall consist of bank-run sand or sand and gravel, which conforms to the limits of gradation tabulated below and is free of recycled concrete, asphalt, bricks, glass and pyritic shale rock.

Sieve Size	Percent Finer
6”	100
No. 10	30 to 95
No. 40	10 to 70
No. 200	5 to 10

E. Geotextile Fabric: Manufacturer’s woven geotextile fabric of high tenacity polypropylene yarn, with the following properties as follows:

Grab Tensile:	200 pounds; ASTM D 4632
Grab Elongation:	15 percent; ASTM D 4632
CBR Puncture Strength:	700 pounds; ASTM D 6241
Trapezoidal Tear:	75 pounds; ASTM D 4533
U.V. Resistance (Strength Retained):	70 percent; ASTM D 4355
Permittivity:	0.05 sec.-1; ASTM D 4491.
Flow Rate:	4 gallons p/min/s.f.; ASTM D 4491

F. Geotextile Separation Fabric: Geotextile on the NYSDOT Approved Material list for application of separation, with the following properties:

Grab Tensile:	160 pounds; ASTM D 4632.
Grab Elongation:	50 percent; ASTM D 4632.
Puncture:	410 pounds; ASTM D 6241.
Trapezoidal Tear:	60 pounds; ASTM D 4533.
U.V. Resistance (Strength Retained):	70 percent ASTM D 4355
Apparent Opening Size:	70 mm. U.S. Sieve Number, ASTM D 4751.
Permittivity:	1.5 sec.-1; ASTM D 4491.
Flow Rate:	110 gallons per minute/s.f.; ASTM D 4491.

G. Satisfactory soil materials are defined as those complying with ASTM D2487 soil classification groups GW, GP, GM, SM, SW and SP with less than 10% passing No. 200 sieve.

H. Unsatisfactory soil materials are defined as those complying with ASTM D2487 soil classifications groups GC, SC, ML, MH, CL, CH, OL, OH and PT.

I. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep, colored as follows:
   1. Red: Electric
   2. Yellow: Gas, oil, steam, and dangerous materials.
   3. Orange: Telephone and other communications.
   4. Blue: Water systems.
   5. Green: Sewer systems.

PART 3 – EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

B. Protect subgrades and prepare soil against freezing temperatures or frost. Provide protective insulating materials as necessary.

C. All existing storm structures in the vicinity of the work are to receive inlet sediment protection until the ground surface is stabilized.

D. Stripping of surficial vegetation and topsoil is specified in the Division 31 Section 311000 “Site Clearing.”

3.2 STABILITY OF EXCAVATIONS

A. General: Comply with applicable codes, ordinances and requirements of agencies having jurisdiction and in accord with 29 CFR Part 1926 of the Occupational Safety and Health Standards Excavations, Final Rule.

B. Slope sides of excavations to comply with local codes, ordinances and requirements of agencies having jurisdiction including O.S.H.A. Shore and brace where sloping is not possible because of space restrictions or stability of material excavated. Maintain sides and slopes of excavations in safe condition until completion of backfilling.

C. Shoring and Bracing: Provide materials for shoring and bracing, such as sheet piling, uprights, stringers and cross braces, in good serviceable condition. Provide and

install as required to ensure the safety of persons and property and in compliance with all local, State and Federal regulations.

D. Trenches may be widened to provide stable slopes in lieu of sheeting; however, this will not change specified pay limits. Remove sheeting as backfill progresses when safe from collapse.

E. Excavations shall also be in accordance with recommendations of the Geotechnical Evaluation Report.

3.3 DEWATERING

A. Prevent surface water and subsurface or groundwater from flowing into excavations and from flooding project site and surrounding area.

B. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey rainwater and water removed from excavations to collecting or runoff areas in conformance with the SWPPP. Do not use trench excavations as temporary drainage ditches.

C. Excavation shall be maintained in dry condition and no foundation materials, pipe or concrete shall be placed in water. Dewatering shall be done in approved manner, such that subgrade can be trimmed, foundation materials, pipe or concrete placed dry, without disturbing bearing materials and water from excavation shall be disposed of so that it will cause no injury to property or inconvenience to public.

D. Care should be taken to shut down dewatering equipment slowly to avoid uplift and softening of materials supporting pipe, appurtenances and foundations.

E. All excavated subgrades shall be crowned and sloped to direct water to their periphery.

3.4 STORAGE OF EXCAVATED MATERIALS

A. Stockpile excavated materials acceptable for backfill and fill where directed. Place, grade and shape stockpiles for proper drainage.

B. Locate and retain soil materials away from edge of excavations. Do not store within drip line of trees indicated to remain.

C. Dispose of excess excavated soil material and other excavated materials in a legal manner. Remove and dispose of unsuitable backfill or fill materials when determined by Owners Designated Representative as not acceptable for use as backfill or fill.

D. Provide proper erosion and sediment controls to contain.

3.5 EXCAVATION FOR WALKS, DRIVES, AND PAVEMENTS

A. Excavate trenches or areas to uniform width down to virgin soil, sufficiently wide to provide ample working room. Remove all existing material and debris, including organics.

3.6 TRENCH EXCAVATION FOR PIPES AND CONDUITS

A. Excavate trenches to uniform width, sufficiently wide to provide ample working room. Minimum width to be pipe and conduit diameter plus one foot.

B. Excavate trenches to depth required to establish indicated slope and invert elevations and to support bottom of pipe and conduit on undisturbed soil. Excavate trenches to allow installation of top of pipe and conduit below frost line or as detailed on the Contract Drawings.

C. Shape bottom of trench to fit bottom of pipe for ninety degrees, i.e., bottom 1/4 of pipe circumference. Fill depressions with tamped sand backfill. At each pipe joint, dig bell holes to relieve pipe bell of loads to ensure continuous bearing of pipe barrel on bearing surface.

D. New trenching will not be permitted when earlier trenches need backfilling or labor is needed to restore surfaces of areas to a safe and proper condition.

3.7 COLD WEATHER PROTECTION

A. Protect excavation bottoms and sides against freezing when atmospheric temperature is less than thirty-five degrees (35^{O}) Fahrenheit.

3.8 BACKFILL AND FILL

A. Prior to placing fills or base materials beneath pavement areas, the subgrade surface should be thoroughly compacted using a steel drum roller with a static weight of at least five (5) tons. The Owners Designated Representative shall observe the proof rolling of the material.

B. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by the Owners Designated Representative, without additional compensation.

C. Fill in landscape areas shall be placed in lifts not more than twelve inches (12") compacted thickness, compacted to 85-90% of Modified Proctor Density (ASTM D1557) or as directed by the Owners Designated Representative.

D. Lawn Areas: fill materials shall consist of satisfactory soil materials as specified.

E. Pipe bedding shall be as detailed on the Construction Drawings and shall be compacted to minimum 95 percent of Modified Proctor Density (ASTM D1557) using minimum of six passes of mechanical tamper.

F. Trench Backfill: In all pipe trenches suitable selected material shall be filled in around pipe and to height as per Construction Drawings. This fill shall be brought up evenly

on both sides of pipe in 12" lifts. Each layer shall be tamped and thoroughly consolidated to provide proper support and bearing for pipe and so as not to disturb line and grade of pipe.

G. Pipe Crossings: Where new storm and sanitary sewers cross each other or water lines, the trench shall be excavated down to the previously laid pipe and backfilled with compacted crushed stone to insure adequate support.

H. Backfill excavations as promptly as work permits, but not until completion of the following:
   1. Acceptance of construction below finish grade.
   2. Removal of shoring/bracing and backfilling of voids with satisfactory materials. Cut off temporary sheet piling driven below bottom of structures. Remove in manner to prevent settlement of structure or utilities or leave in place if required.
   3. Removal of trash and debris from excavation.

3.9 PLACEMENT AND COMPACTION

A. General: Backfill material shall be placed and compacted in loose lifts per dimensions listed above.
   1. In pavement and curb areas, each lift of backfill material shall be thoroughly compacted with minimum of six (6) overlapping passes of approved mechanical rolling, or tamping equipment to a minimum of 95 percent of its maximum Modified Proctor Density (ASTM D-1557).
   2. In general lawn areas and other areas not covered above, each lift of backfill material shall be thoroughly compacted to between 80-85 percent of its maximum Modified Proctor Density (ASTM D-1557).
   3. In infiltration areas, fill shall not be placed at the bottom of the practice. Native ground shall not be compacted. The owners designated representative shall be notified after fine grading of infiltration areas and shall perform field permeability tests in accordance with the New York State Stormwater Management Design Manual, January 2015. If in the opinion of the Owners Designated Representative the subsoil is deemed over compacted the area shall be decompacted at no additional cost to the Owner.

3.10 FIELD QUALITY CONTROL – BY OWNERS DESIGNATED REPRESENTATIVE

A. Quality Control Testing During Construction: Allow testing service to inspect, test, and approve each subgrade and fill layer before further backfill or construction work is performed. Contractor shall coordinate his work with Owner Designated Representative sufficiently in advance to schedule testing services.

B. Testing agency shall perform field density tests in accordance with ASTM D 6938 (Nuclear) for Soils and Materials, and ASTM D 3017 (Nuclear) for moisture content as applicable. Tests will be performed at the following locations and frequencies:
   1. Subgrade:
      a. Paved Areas: At subgrade and at each compacted backfill layer (lift), perform at least one field density test of subgrade for every 200 square feet (S.F.) of concrete pavement area, but in no case fewer than three (3) tests. Perform no less than one field density test for every 2,500 square

feet (S.F.) of asphalt pavement area, but in no case fewer than three (3) tests.

b. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 150 feet or less of trench length, but no fewer than two tests.

c. Turf Area: In each compacted fill layer (lift), perform no less than one field density test for every 3,000 square feet (S.F.), but in no case fewer than three (3) tests.

2. Subbase:

a. Paved Areas: At each compacted subbase layer (lift), perform at least one field density test of subgrade for every 200 square feet (S.F.) of concrete pavement area, but in no case fewer than three (3) tests. Perform no less than one field density test for every 2,500 square feet (S.F.) of asphalt pavement area, but in no case fewer than three (3) tests.

C. If, in the opinion of the Owners Designated Representative, based on testing service reports and inspection, subgrade or fills that have been placed are below specified density, perform additional compaction and testing until specified density is obtained, at no additional cost to Owner.

D. Contractor and Owner shall develop a testing schedule and Contractor shall insure coordination to ensure testing lab is available on-site at the times necessary for work to be performed.

3.11 GRADING

A. General: Uniformly grade areas within limits of grading under this section including adjacent transition areas. Smooth finish surface within specified tolerances, compact with uniform levels or slopes between such points and existing grades or points where elevations are indicated.

B. Grading Outside Building Lines: Grade areas adjacent to building lines to drain away from structures and to prevent ponding. Finish surfaces free from irregular surface changes and as follows:

C. Lawn or Unpaved Areas: Finish areas to receive 4 inches minimum topsoil to within not more than 0.10 foot above or below required subgrade elevations. On-site sources to be supplemented with off-site sources as necessary to meet requirements of this specification.

D. Pavements: Shape surface of areas under pavement to line, grade, and cross-section, with finish surface not more than ½ inch above or below required subgrade elevation.

E. Compaction: After grading, compact subgrade surfaces to the depth and indicated percentage of maximum or relative density for each area classification.

3.12 PAVEMENT SUBBASE COURSE

A. General: Subbase course consists of placing subbase material, gravel, in layers of specified thickness, over approved proof-rolled subgrade surface. Compacted subgrade to extend minimum 4 inches beyond subbase course. Subbase course to extend minimum 4 inches beyond pavement edge where no curb is present.

B. Grade Control: During construction, maintain lines and grades including crown and cross-slope of pavement wearing course.

C. Placing: Place pavement subbase course material on prepared subgrade thickness. Maintain optimum moisture content for compacting subbase material during placement operations.

D. When compacted pavement subbase course is indicated to be six inches (6") thick or less, place material in single layer. When indicated to be more than six inches (6") thick, place material in equal layers, except no single layer more than six inches (6") or less than three inches (3") in thickness when compacted.

3.13 SURFACE RESTORATION

A. Where details of surface restoration for lawns, pavement, etc., are not shown on plans or specified elsewhere, all surfaces shall be restored to their original condition.

3.14 EROSION CONTROL

A. Provide erosion control methods in accordance with requirements of the SWPPP and authorities having jurisdiction or as shown on plans and specifications to prevent erosion and sedimentation during earthwork operations.

3.15 MAINTENANCE

A. Protect newly graded areas from traffic and erosion. Keep free of trash and debris.

B. Settling: Where settling is measurable or observable at excavated areas during general project repair and re-establish grades in settled, eroded and rutted areas to specified tolerances.

C. Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify surface, reshape and compact to required density prior to further construction.

D. Warranty period, remove surface (pavement, lawn or other finish), add backfill material, compact and replace surface treatment of any defective areas found within 1 year from the date of substantial completion. Restore appearance, quality and condition of surface or finish to match adjacent work and eliminate evidence of restoration to greatest extent possible.

END OF SECTION

SECTION 31 23 16 - ROCK REMOVAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings 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. Rock removal.
2. Seismic monitoring.
3. Quantity measurement and verification.

B. Related Requirements:

1. Division 1 Specification Sections for restrictions on the use of the premises.
2. Division 2 Specification Sections, including, but not limited to the Sections indicated below.
3. Section 31 10 00 “Site Clearing” for removing brush and vegetation; trunk and stump grubbing; stripping and stockpiling topsoil; and removing pavements and base material.
4. Section 31 20 00 “Earthwork - Site” for backfill and compaction requirements; excavating and backfilling for structures, utilities, walks, and pavements; and preparing subgrades for structures, utilities, walks, and pavements.

1.3 ROCK REMOVAL DEFINITIONS

A. Work described in this section qualifies as rock removal and applies to the rock removal allowance.

1. Verification of sound rock: Demonstrate to the Owner’s Representative 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: Prior to removing rock by blasting, excavate test pits in earth, where directed, down to rock for the purpose of determining top of rock elevations. 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 Owner’s Representative. Backfill test pits prior to blasting as directed. Unless otherwise indicated or directed, excavate test pits as follows:
   a. For structures, including, but not limited to utility structures, walls, and foundations: One pit for each structure or one pit for each 1000 square feet, whichever is greater.

b. For paved areas: 3 pits for each 2,500 square feet.

c. For utility trenches: One pit for each 50 linear feet.

B. The Contractor's allowance for rock removal is all inclusive, and shall include test pits, measurement and verification; rock removal, rock handling and processing, rock transport, rock hauling, and rock disposal; overhead, profit, and all other expenses incidental to the Work.

C. The allowance for additional rock removal is over and above the cost of earth excavation. No deduction from the bid sum will be taken for reduced quantities of earth excavation resulting from additional rock removal.

D. Measurement: Rock quantities will be determined by measuring rock in place prior to removal. Measurements shall be taken of the actual rock cut, as required for the Work, or to the specified measurement limits, whichever is smaller.

1.4 REFERENCES

A. Comply with the applicable requirements of the Code of Federal Regulations Title 29 - Labor, Part 1926 Safety and Health Regulations for Construction (OSHA).

1.5 DEFINITIONS

A. Common Excavation: Excavation and disposal of all materials that can be excavated, transported, and unloaded using heavy ripping equipment and wheel tractor-scrapers with pusher tractors or that can be excavated and dumped into place or loaded onto hauling equipment by excavators equipped with attachments (shovel, bucket, backhoe, dragline, or clam shell) appropriate to the material type, character, and nature of the materials. For the purpose of this classification, the following definitions shall apply:

1. Heaving ripping equipment is defined as a rear-mounted, heavy duty, single-tooth, ripping attachment mounted on a track type tractor having a power rating of at least 250 flywheel horsepower unless otherwise specified.

2. Wheel tractor-scraper is defined as a self-loading (not elevating) and unloading scrapper having a struck bowl capacity of at least 12 cubic yards.

3. Pusher tractor is defined as a track type tractor having a power rating of at least 250 flywheel horsepower equipped with appropriate attachments.

B. Rock Excavation: Excavation of all hard, compacted, or cemented conglomerate materials that require blasting or the use of ripping and excavating equipment larger than defined for common excavation. The excavation and removal of isolated boulders or rock fragments larger than 1 cubic yard encountered in materials otherwise conforming to the definition of common excavation shall be classified as rock excavation. The presence of isolated boulders or rock fragments larger than 1 cubic yard is not in itself sufficient cause to change the classification of the surrounding material.

C. Unclassified Excavation: Excavation and disposal of all materials, of any description, including rock material, encountered during the course of construction, regardless of their nature or the manner in which they are removed.

D. Unauthorized Rock Removal:

1. The removal of rock material below required elevation indicated on the Drawings or beyond lateral dimensions indicated or specified without specific written direction by the Owner's Representative.

2. The removal of rock material prior to performing the required measurement verification required to determine quantities.

E. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material greater than 1 cu. yd. or more in volume that exceed a standard penetration resistance of 100 blows/2 inches when tested by a geotechnical testing agency, according to ASTM D 1586.

1.6 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:

a. Name, and employer's name, business address and telephone number.

b. Names and addresses of the required number of similar projects which meet the experience criteria.

C. Measurement data for quantities of rock removal.

1.7 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 Owners 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, the Contractor's rock removal subcontractor, the person supervising the rock removal operations, and the Owner's Representative.

PART 2 - PRODUCTS

2.1 EQUIPMENT

A. Furnish one seismograph, with manufacturer's operating instructions, to measure particle velocity during blasting operations. The seismograph shall be capable of making a permanent record of blasting operations.

1. Deliver permanent records of blasting operations to the Owners Representative. Records will become the property of the Owner.

B. Backfill excavation with structural fill as specified in Section 31 20 00, “Earthwork - Site”.

PART 3 - EXECUTION

3.1 EXAMINATION

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, deterioration, and conditions detrimental to installation of new work. Provide a written summary to the Owner’s Representative.

B. The blasting method shall limit the peak particle velocity, as measured at the closest adjacent structures and utilities, to a peak particle velocity of less than 1.5 inches per second. Contractor shall utilize seismic monitoring equipment to monitor the peak particle velocity rates indicated.

C. Do not perform blasting operations within 10 feet of existing buildings or structures, except as otherwise indicated.

3.2 ROCK REMOVAL

A. Remove rock as required by the Drawings and as necessary for the installation of the Work. Make sufficient clearance, within the limits specified, for the proper execution of the Work.

3.3 FIELD QUALITY CONTROL

A. Provide the Owner’s Representative with the recorded top of rock elevations, measurements, and quantities of rock to be removed prior to the performance of any rock removal operations.

B. Notify the Owners Representative at least 3 business days in advance of all phases of blasting operations.

C. Allow time for visual inspection of bottom of rock cut required for the Work.

3.4 DISPOSAL OF EXCESS AND UNSUITABLE MATERIALS

A. Transport excess and removed rock materials off of project property.

3.5 ADJUSTING

A. Unauthorized Rock Removal:

1. Horizontal Direction: Backfill and compact unauthorized rock removal in the horizontal direction as specified for authorized excavation of the same classification, unless otherwise directed.

2. Vertical Direction: Immediately report unauthorized rock removal in the vertical direction to the Owner's Representative. Correct unauthorized rock removal in the vertical direction to the satisfaction of the Owner's Representative.

3.6 CLEANING

A. Where footings and walls will rest entirely on rock, clean rock surfaces free of soil, loose rock, and organic material.

END OF SECTION 31 23 16

SECTION 321216 - ASPHALT PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Hot-mix asphalt paving.
2. Pavement markings.

B. Related Requirements:

1. Section 312000 "Site Earthwork" for subgrade preparation, fill material, separation geotextiles, unbound-aggregate subbase and base courses, and aggregate pavement shoulders.

1.3 SUBMITTALS

A. Product Data for each type of product specified.
1. Include technical data, performance properties and installation instructions.
2. Certification, by New York State Department of Transportation, of approval of each hot-mix asphalt design proposed for the Work.
3. Material Test Reports: Indicate and interpret test results for compliance of materials with requirements indicated.

B. Qualification Data: For paving-mix manufacturer and testing agency.

C. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Codes and Standards: Provide hot-mix asphalt pavement according to the materials, workmanship, and other applicable requirements of the New York State Department of Transportation (NYSDOT) Standard Specifications, Construction and Materials. For convenience NYS DOT Standard Specification sections and item numbers are provided, however, are subject to change as new editions are released.

B. Manufacturer Qualifications: A paving-mix manufacturer registered with and approved by New York State Department of Transportation.

C. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of New York State Department of Transportation for asphalt paving work.
   1. For convenience, references to NYSDOT Standard Specification section and numbers are provided. These section and numbers correspond to the September 1, 2022 NYSDOT Standard Specifications.

D. Installer Qualifications: Engage an experienced installer who has completed hot-mix asphalt paving similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

   1. Installer must have a minimum of 10 years +experience with asphalt installations similar in scope.

E. All final, interim and temporary markings and patterns shall be placed as shown on the plans and in accordance with New York State Manual of Uniform Traffic Control Devices.

F. Warranty period, remove and replace failed pavement sections found within 1 year from the date of substantial completion.

1.5 FIELD CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure. Temperature limitations shall be in accordance with NYSDOT (latest addition) or only be placed when the pavement surface temperatures meet the following criteria, whichever is more stringent:

Compacted Lift Thickness	Minimum Surface Temperatures
≤1 inch	50° F
1 inch to 3 inches	45° F
> 3”	40° F

B. Pavement Markings: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F for alkyd materials or 55 deg F for water-based materials, and not exceeding 95 deg F. The relative humidity shall not exceed 85%.

C. Tack coat shall not be applied on wet pavement surface or when pavement surface temperatures is below 40° F.

PART 2 - PRODUCTS

2.1 AGGREGATES

A. General: Use materials and gradations that have performed satisfactorily in previous installations.

B. Coarse Aggregate: Sound; angular crushed stone or crushed gravel complying with ASTM D692-88 and NYSDOT 401-2.02 Coarse Aggregate Type F3 for top course and Type F9 for binder course.

C. Fine Aggregate: Material conforming to sections 401-2.02 of the NYSDOT standard specifications.

D. Mineral Filler: Material conforming to NYSDOT 703-08 of standard specifications.

2.2 ASPHALT MATERIALS

A. Hot-Mix Asphalt: Dense-graded, hot-laid, hot-mix asphalt plant mixes complying with the following requirements:

1. Provide mixes including performance grade (PG) approved by NYSDOT for the geographical area where Project is located.
2. Binder Course: NYSDOT Item 402.19, 19 binder course hot mix asphalt
3. Top Course: NYSDOT Item 402.09, 9.5 top course hot mix asphalt

B. Tack Coat: Complying with NYSDOT Standard Specifications table 702-7 for Diluted Tack Coat and table 702-8 for Straight Tack Coat.

C. Water: Potable.

2.3 PAVEMENT MARKINGS

A. Manufacturers: Subject to compliance with requirements, provide pavement marking paints selected from NYSDOT Approved Material List.

B. Pavement-Marking Paint: Alkyd-resin type, lead and chromate free, ready mixed, complying with AASHTO M248, Type N; color complying with FS TT-P-1952.

1. Color:
   - Traffic Arrows: White
   - Stop Bar: White
   - Car parking spaces: White
   - Crosswalk: White

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that subgrade is dry and in suitable condition to begin paving.

3.2 PREPARATION

A. Protection: Provide protective materials, procedures, and worker training to prevent asphalt materials from spilling, coating, or building up on curbs, driveway aprons, manholes, and other surfaces adjacent to the Work.

B. Proof-roll subgrade per specification 312000 “Site Earthwork”. Proceed with paving only after unsatisfactory conditions have been corrected.

3.3 SURFACE PREPARATION

A. Ensure that prepared subgrade has been proof-rolled and is ready to receive paving. Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces.

B. Tack Coat: Apply in accordance with NYSDOT Standard Specifications to contact surfaces of previously constructed asphalt, newly constructed asphalt or Portland cement concrete, surfaces abutting or projecting into hot-mixed asphalt pavement, and milled surfaces. Distribute at rate according to Table 407-1 of the NYSDOT Standard Specifications.
    1. Tack coat shall only be applied on prepared clean pavement.
    2. Shall be uniformly applied.
    3. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.
    4. Paving over tack coat shall not commence until the emulsion has broken (turned from brown to black) and is tacky when touched.
    5. Diluted Tack Coat shall be used for conventional asphalt pavements and is to be applied between all lifts of asphalt courses. Diluted tack coat is to be applied on top of milled pavement surfaces and on top of concrete base.
    6. Straight Tack Coat shall be used for conventional pavement overlay, only if existing pavement is not milled. Straight tack shall also be used on slopes exceeding 5%.
    7. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.

3.4 HOT-MIX ASPHALT PLACEMENT

A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand in areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.

1. Place hot-mix asphalt base course and binder course in number of lifts and thicknesses indicated.
2. Spread mix at a minimum temperature of 250 deg F.
3. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes unless otherwise indicated.
4. 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 the first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Overlap mix placement about 1 to 1-1/2 inches from strip to strip to ensure proper compaction of mix along longitudinal joints.
2. Complete a section of asphalt base course and binder course before placing asphalt surface course.

C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.5 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.

1. Clean contact surfaces and apply tack coat to joints.
2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.
3. Offset transverse joints, in successive courses, a minimum of 24 inches.
4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method in accordance with AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations."
5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
6. Compact asphalt at joints to a density within 2 percent of specified course density.

3.6 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.

1. Complete compaction before mix temperature cools to 185 deg F.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:

1. Average Density: achieve pavement density 95 percent of reference maximum theoretical density according to ASTM D 2950, but not less than 92 percent or greater than 97 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.

3.7 INSTALLATION TOLERANCES

A. Pavement Thickness: Compact each course to produce thickness indicated within the following tolerances:

1. Base Course and Binder Course: Plus or minus 1/2 inch.
2. Surface Course: Plus 1/4 inch , no minus.

B. Pavement Surface Smoothness: Compact each course to produce surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:

1. Base Course and Binder 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.
4. All new paving shall drain as shown on grading plan, if standing water is observed following a rainstorm, the areas not draining will be removed, repaired

or replaced as directed by the Owners Designated Representative. The costs for such work will be born by the Contractor.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined in accordance with ASTM D3549/.

C. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.

D. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement in accordance with ASTM D979/D979M or AASHTO T 168.

1. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared in accordance with ASTM D2041/D2041M, and compacted in accordance with job-mix specifications.
2. In-place density of compacted pavement will be determined by testing core samples in accordance with ASTM D1188 or ASTM D2726/D2726M.
    a. Field density of in-place compacted pavement may also be determined by nuclear method in accordance with ASTM D2950/D2950M and coordinated with ASTM D1188 or ASTM D2726/D2726M.

E. Replace and compact hot-mix asphalt where core tests were taken.

F. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.9 WASTE HANDLING

A. General: Handle asphalt-paving waste in accordance with approved waste management plan required in Section 017419 "Construction Waste Management and Disposal."

END OF SECTION 321216

SECTION 321313 – PORTLAND CEMENT CONCRETE

PART I - GENERAL

1.1 RELATED DOCUMENTS:

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

1.2 SUMMARY:

A. Extent of Portland cement concrete work is depicted on the Contract Drawings including, but not limited to, the following:

1. Curbs.
2. Walkways.
3. Play equipment foundations
4. Joint materials and sealants.

B. Prepared subbase is specified in Division 31, Section 312000, “Site Earthwork”.

C. Cast-in-place concrete for all concrete work related to the building is specified in Division 3 Section 033000, “Cast-in-Place Concrete”.

1.3 SUBMITTALS:

A. Product Data: Submit data for proprietary materials and items, including reinforcement and forming accessories, admixtures, patching compounds, joint systems including sealants, curing compounds, and other materials referenced in this section.

B. Shop Drawings: Reinforcement: Submit original shop drawings for the fabrication, bending, and placement of concrete reinforcement. Comply with ACI 315 Manual of Standard Practice for Detailing Reinforced Concrete Structures showing bar schedules, diagrams of bent bars and arrangement of concrete reinforcement. Include special reinforcement required for openings through concrete structures.

C. Laboratory Test Reports: Submit laboratory test reports for concrete mix design and quality control testing during construction, including the following items:

1. Proportions by weight of all ingredients in mix.
2. Solid volume calculations of all ingredients.
3. Air content (percentage).
4. Mix unit weight (pounds per cubic foot).
5. Water-cement ratios.

6. Trial mix compressive strengths in pounds per square inch at seven (7) and twenty-eight (28) days.

D. Cold Weather Concrete Placement, Cure Protection Plan and/or Frost Protection Plan.

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

A. Build mockups of full-thickness sections of concrete paving to demonstrate the standard concrete color and broom finish.

B. Each mockup shall demonstrate each type of joint including sealant; each surface finish, color, and texture including; curing; and standard of workmanship

C. The Contractor shall assume that after the first mockup is provided, an additional 2 mockups may be required to determine final selections.

D. Build mockups in a location near actual location of finish product, and as directed and approved by Owner's representative. Size of mock-up shall be adequate to include all adjacent/related finishes, color and jointing in a single panel, and not less than 5 feet by 5 feet.

E. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

F. Mockups shall remain in place until completion and approval of concrete paving applications, unless otherwise directed by Owner's Representative.

1.5 QUALITY ASSURANCE:

A. Codes and Standards: Comply with provisions of following codes, specifications, and standards, except where more stringent requirements are shown or specified:

1. ACI 301 - Specifications for Structural Concrete for Buildings.
2. ACI 305R - Hot Weather Concreting.
3. ACI 306 - Cold Weather Concreting.
4. ACI 309R - Guide for Consolidation of Concrete.
5. ACI 318 - Building Code Requirements for Reinforced Concrete.
6. ASTM C94 - Standard Specifications for Ready-Mixed Concrete.
7. ASTM C150 - Standard Specification for Portland Cement Concrete.
8. ASTM C260 - Standard Specifications for Air-Entraining Admixtures for Concrete.
9. ASTM C494 - Standard Specifications for Chemical Admixtures for Concrete.
10. Concrete Reinforcing Steel Institute (CRSI)- Manual of Standard Practice.
11. NYSDOT – Standard Specification for Construction Materials.

B. Concrete Testing Service: The Owner will engage an independent testing laboratory/agency to perform material evaluation tests. The Owner's Designated Representative will approve concrete mixes.

C. Materials and installed work may require testing and retesting at any time during progress of work. Tests, including retesting of rejected materials for installed work, shall be done at Contractor's expense.

D. Verification of required design mix: provide verification as per Division 1 Specifications.

E. Installer Qualifications, General Concrete:

1. The installer shall provide a qualified foreman or supervisor who has a minimum of ***ten*** years' experience with concrete work, and who has successfully completed at least five installations of high quality and similar in scope to that required.

F. As outlined in the sections below, periodic review of work by the Owner's Designated Representative is required prior to advancement of the work. Inspections include, but are not limited to:

1. Proof rolling of subgrade.
2. Construction of formwork.
3. Placement of reinforcing.
4. Installation of embedded items.

G. Special Inspections: Refer to Division 01 Specification Section 014100, Special Inspections and Structural Testing, for Schedule of Special Inspections.

1.5 PROJECT CONDITIONS:

A. Traffic Control: Maintain access for vehicular and pedestrian traffic and as required for other construction activities. Coordinate all street and sidewalk closings with the municipal Department of Public Works.

B. Utilize flagmen, barricades, warning signs and warning lights as required.

C. Coordinate with requirements of Division 1 Specification Sections.

D. Protection of foundations against freezing: Cover completed work at foundations level with sufficient temporary or permanent cover as required to protect foundations and adjacent subgrade against possibility of freezing; maintain cover for time period as necessary and acceptable to the Owners Designated Representative.

E. Protect adjacent finish materials against spatter during concrete placement.

F. Form Coatings: Provide commercial formulation form-coating compounds that will not bond with, stain, nor adversely affect concrete surfaces, and will not impair subsequent treatments of concrete surfaces.

G. For all work within the street right-of-ways, coordinate street and sidewalk closures and work with the municipal Department of Public Works.

PART 2 - PRODUCTS

2.1 MATERIALS:

A. General: All acceptable products and materials products submitted for use and incorporation into this project must be on the New York State Department of Transportation (NYSDOT) Material Bureau's Approved Lists for Materials and Equipment for use on New York State Department of Transportation Projects, most recent publication date.

2.2 FORM MATERIALS:

A. General: Steel, wood, or other suitable material of size, configuration and strength to resist movement during concrete placement and to retain horizontal and vertical alignment until removal. Use straight forms, free of distortion and defects.

1. Use flexible spring steel forms or laminated boards to form radius bends as required.
2. Coat forms with a non-staining form release agent that will not discolor or deface the surface of new concrete.
3. Form Coatings: Provide commercial formulation form-coating compounds that will not bond with, stain, nor adversely affect concrete surfaces, and will not impair subsequent treatments of concrete surfaces.

2.3 REINFORCING MATERIALS:

A. Steel Reinforcing Bars: ASTM A 615, Grade 60, deformed steel.

B. Steel Welded Wire Fabric: ASTM A 185, welded steel wire fabric, flat sheets only.

C. Supports for Reinforcement: Bolsters, chairs, spacers, and other devices for spacing, supporting, alignment, and fastening reinforcing bars and welded wire fabric in place. Use galvanized wire bar type supports complying with CRSI specifications.

1. For slabs-on-grade including concrete pavements, use steel reinforcing supports with sand plates or horizontal runners where base material will not support chair legs. The use of concrete bricks, or stone cobbles, rock, soil, non-coated or non-galvanized ferric metals other than specified herein, aluminum metals, dissimilar metals, or similar items to support reinforcement is not acceptable and is strictly prohibited. Submit to the Owners Designated Representative for review method of reinforcing support to be used in work.

D. Joint Dowel Bars: Plain steel bars, ASTM A 615, Grade 60. Cut bars true to length with ends square and free of burrs.

2.4 CONCRETE MATERIALS:

A. Cement: Portland Cement, ASTM C150, Type I.

1. Use one brand of cement throughout the project, unless otherwise acceptable to the Owners Designated' Representative.

B. Fly Ash: ASTM C618, Type C or Type F.

C. Normal Weight Aggregates: ASTM C 33, and as specified herein. Provide sound, non-reactive, well graded aggregates from a single source for exposed concrete.

1. For exterior exposed surfaces, do not use fine or coarse aggregates containing spalling-causing deleterious substances.
2. Local aggregates not complying with ASTM C 33, but which have shown by special test or actual service to produce concrete of adequate strength and durability may be used when acceptable to the Owners Designated Representative; provide copies of certified tests to the Owners Designated Representative for review.

D. Water (Potable): Clean and free from oil, acid and injurious materials and amounts of vegetable matter, alkalis and salts.

E. Ready-Mix Concrete: ASTM C94.

2.5 EXPOSED AGGREGATE:

A. Hard, sound, and durable; double washed and cleaned; free of materials with deleterious reactivity to cement or that cause staining or spalling; from a single source of varying colors, with gap-graded coarse aggregate as follows:
1. Aggregate Size: 3/8 to 5/8 inch nominal
2. Aggregate Source, Shape and Color: Multi-color, rounded river gravel. Color shall include a blended range of browns, grey, blue, pink and creams with some white. Shape shall be primarily rounded. Flat or sliver shaped pieces shall not be used. Source as provided by contractor, and as approved by Owner's Representative.

2.6 SURFACE RETARDER

A. Water based top-surface retarder designed to retard the setting (hydration) of the upper layer of cement paste, producing an exposed-aggregate appearance of the concrete surface.
1. Product: Dayton Superior "Top Cast" Surface Retarder, or approved equal, of one or more of the following Grade(s), as required to achieve intended aesthetic effect:
a. Standard Exposed Aggregate Finish: 1/8"-1/4" exposure, Product Code 25, Beige Package.

2.7 JOINT MATERIALS:

A. Joint Fillers for Exterior Concrete Paving:

1. General: Provide joint fillers of thickness and width indicated.
2. Preformed Sponge Rubber Joint Filler comprised of preformed strips of complying with ASTM D1752 and Federal Specification HH-F-431F.

B. Joint Sealants for Exterior Concrete Paving: Provide manufacturer's standard, non-modified, two-part, urethane sealant, complying with ASTM C 920, Type M, Grade P, Class 25, uses T, M, A and, as applicable to joint substrates indicated, O.

2.8 CONCRETE ADMIXTURES:

A. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.

1. Available Products: Subject to compliance with requirements, products, which may be incorporated in the work, include, but are not limited to, the following:
   a. “Air-Mix”; Euclid Chemical Co. 19213 Redwood Rd., Cleveland OH 44110
   b. “Sika Aer”; Sika Corp. 201 Polito Ave. Lyndhurst, NJ 07071
   c. “MB-VR or MB-AE”; BASF Construction Chemicals 23700 Chagrin Blvd, Cleveland OH 44122

B. Water-Reducing Admixture: ASTM C 494, Type A, and containing not more than 0.1 percent chloride ions.

1. Available Products: Subject to compliance with requirements, products which may be incorporated in the work include, but are not limited to, the following:
   a. “WRDA Hycol”; W.R. Grace. 7500 Grace Dr., Columbia, MD 21044
   b. “Eucon WR-75”; Euclid Chemical Co., 19213 Redwood Rd., Cleveland OH 44110
   c. “Pozzolith Normal”; BASF Construction Chemicals 23700, Chagrin Blvd., Cleveland OH 44122 or approved equal.

C. High-Range Water Reducing Admixture (Super Plasticizer): ASTM C 494, Type F or Type G and containing not more than 0.1 percent chloride ions.

1. Available products: Subject to compliance with requirements, products, which may be incorporated in the work, include, but are not limited to, the following:
   a. “WRDA 19” or “Daracem”; W.R. Grace
   b. “PSP”; Protex Industries Inc.
   c. “Super P”; Anti-Hydro., International Inc.
   d. or approved equal.

D. Water-Reducing, Non-Chloride Accelerator Admixture: ASTM C 494, Type E, and containing not more than 0.1 percent chloride ions.

1. Available products: Subject to compliance with requirements, products, which may be incorporated in the work, include, but are not limited to, the following:
   a. “Accdequard 80”; Euclid Chemical Co.
   b. “Pozzolith High Early”; BASF Construction Chemicals
   c. “Sika Set,” Sika Corp.
   d. or approved equal.

E. Water-Reducing, Retarding Admixture: ASTM C 494, Type D, and containing not more than 0.1 percent chloride ions.

1. Available Products: Subject to compliance with requirements, products which may be incorporated include, but are not limited to, the following:
   a. “Edoco 20006a”; Edoco by Dayton Superior
   b. “Pozzolith Retarder”; BASF Construction Chemicals
   c. “Eucon Retarder 75”; Euclid Chemical Co.
   d. or approved equal

F. Prohibited Admixtures: Calcium chloride thyocyanates or admixtures containing more than 0.1 percent chloride ions are not permitted.

2.9 RELATED MATERIALS:

A. Moisture-Retaining Cover: Provide one or more of the following, complying with ASTM C 171.

1. Waterproof paper.
2. Polyethylene film.
3. Polyethylene-coated burlap.

B. Bonding Compound: Polyvinyl acetate or acrylic base.

1. Available Products: Subject to compliance with requirements, products, which may be incorporated in the work, include, but are not limited to, the following:
   a. “J-40 Bonding Agent”; Dayton Superior Corp.
   c. “Everbond”; L&M Construction Chemicals.
   d. “SBR Latex,” Euclid Chemical Co.
   e. Approved equivalent

C. Epoxy Adhesive: ASTM C 881, two component material suitable for use on dry or damp surfaces. Provide material “Type”, “Grade”, and “Class” to suit project requirements.

1. Available Products: Subject to compliance with requirements, products, which may be incorporated in the work, include, but are not limited to, the following:
   a. “Thiopoxy”; W.R. Grace.
   b. “Edoco 2118 Epoxy Adhesive”
   c. “Sikadur Hi-Mod”; Sika Chemical Corp.
   d. Approved equivalent

D. For exposed aggregate: Water based, non-yellowing copolymer curing and sealing compound, VOC compliant, complying with ASTM C-309, Type 1, Classes A & B.

E. Slip-Resistive Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of fused aluminum-oxide granules or crushed emery aggregate containing not less than 50 percent aluminum oxide and not less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials.

F. Cure and Seal Compound: Shall be water-based, acrylic polymer, Type I, Class A (non-yellowing) compound complying with the requirements of ASTM C 1315.

1. Available Products: 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. “VOCOMP-25”, W.R. Meadows, POB 338, Hampshire, IL 60140-0038

b. “Super Diamond Clear VOX”, Euclide Chemical Co., 19213 Redwood Rd., Cleveland, OH 44110

c. “Cure & Seal 25% J22UV”; Dayton Superior, 7777 Washington Village Dr. Dayton, OH 45459

2.10 PROPORTIONING AND DESIGN OF MIXES:

A. Prepare design mixes for each type and strength of concrete by either laboratory trial batch or field experience methods as specified in ACI 301. If trial batch method used, use an independent testing facility acceptable to the Owners Designated Representative for preparing and reporting proposed mix designs.

B. Limit use of fly ash to not exceed fifteen (15) percent of cement by weight.

C. Submit written reports to the Owner’s Designated Representative of each proposed mix for each class of concrete at least 20 business days prior to start of work. Do not begin concrete production until mixes have been reviewed and approved by the Owner’s Designated Representative.

D. Design mixes to provide normal weight concrete with the following properties, (Note: Water-to-cement ratios are given in the absence of laboratory trial batch or filed experience) as indicated on the Contract Drawings and schedules:

1. Compressive strength (F’c) = 4,000 pounds minimum per square inch (PSI) 28-day compressive strength; Water-to-Cement (W/C) ratio of 0.44 maximum by absolute weight, unless otherwise noted and based on documented laboratory trial batch data and comprehensive laboratory testing.
1. Compressive strength (F’c), below grade athletic and play equipment, site furnishings, and fencing footings and thrust blocks = 3000 pounds minimum per square inch (PSI) at 28-days.
2. Minimum cement content = 650 pounds of cement or cement and fly ash combination per cubic yard (#/CY).
3. Required aggregate size = 1 inch for 5-inch-thick slabs; 3/4 inch for 4 inch thick slabs. This aggregate size shall be used to the greatest extent possible.
4. Slump 6 inch maximum, when concrete mix incorporates midrange plasticizers or superplasticizers.

E. Adjustment to Concrete Mixes: Mix design adjustments may be requested by Contractor when characteristics of materials, job conditions, weather, test results, or

other circumstances warrant; at no additional cost to Owner and as accepted by the Owner's Designated Representative. Laboratory test data for revised mix design and strength results must be submitted to and accepted by the Owner's Designated Representative before use in work.

F. Admixtures: The use of high range water-reducing admixture (superplasticizer) shall be limited to concrete to be placed in heavily reinforced members, narrow frames and pumped concrete. Superplasticizer shall not be used in concrete for slabs-on-grade.

1. Use non-chloride accelerating admixture in concrete slabs placed at ambient temperatures below 50 degrees.
2. Use water reducing admixture to reduce water requirement in the mixed design and to improve workability.
3. Use air-entraining admixture in exterior exposed concrete, unless otherwise indicated. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having total air content with a tolerance of plus-or minus 1.5 percent within following limits:
4. Concrete slabs exposed to freezing and thawing, deicer chemicals, or subjected to hydraulic pressure:
   a. 4.5 percent for 1 1/2 -inch maximum aggregate.
   b. 4.5 percent for 1-inch maximum aggregate.
   c. 5.0 percent for 3/4 -inch maximum aggregate.
   d. 5.5 percent for 1/2 -inch maximum aggregate.

5. Use admixtures for water-reducing and set-control in strict compliance with manufacturer's directions.

G. In the absence of trial batch data, Water-to-Cement (W/C) ratio shall not exceed 0.35 maximum by absolute weight.

H. Use of water reducing admixtures is permitted. Provide dosage at the low to normal rate in accordance with manufacturer's requirements.

I. On-site addition of water to the concrete, in excess of the water content required by the concrete mix design, shall be permitted only as approved by the on-site testing agency and Owner's Designated Representative.

2.11 ANTI-SLIP METAL NOSING

A. Cast-Metal Units: Cast aluminum cross hatched units with an integral-abrasive, as-cast finish consisting of aluminum oxide, silicon carbide, or a combination of both. Provide units in lengths necessary to accurately fit openings or conditions.
   1. Length shall extend to not more than 4 inches and not less than 3 inches from end of stair tread.
   2. Nosing shall be a solid color having visual contrast of dark-on-light or light-on-dark.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Nystrom
   2. American Safety Tread Co., Inc.

3. Wooster Products, Inc.
4. Approved equivalent.

C. Source Limitations: Obtain units from single source from single manufacturer.
D. Type: Short Nose, 2-3/8” inches wide with ¼-inch lip and integral anchor for embedment into concrete.
1. Provide taped top to protect unit from concrete during installation.

2.12 DETECTABLE WARNING PLATE
A. Detectable Plate
1. Specifications: glass and carbon reinforced composite detectable warning plate with fiberglass reinforced truncated domes. Truncated domes shall be in accordance with the American with Disabilities Act (ADA) Regulations for Detectable Warnings in regard to dome diameter, height and center to center spacing.
2. Finish and Color: integral color uniform throughout plate. Standard manufacturers color: gray.
3. Sizes to be from manufacturer’s standard sizes and shall be sized to fill drop curb as shown on Construction Drawings.
4. Model “Cast-in-Place Inline Dome Pattern Tactile Warning Surface” as manufactured by ADA Solutions, Inc. PO Box 3, North Billerica, MA 01862, telephone 800-372-0519, or approved equal

2.10 CONCRETE MIXING:

A. Provide batch ticket for each ready-mix concrete batch discharged and used in work indicating project identification, name and number, date, batch time, ready-mix manufacturer vehicle number, mix type, mix time, admixture type(s), and quantities of cement, aggregate, water and admixture used.

B. Ready-Mix Concrete: Comply with requirements of ASTM C 94, and as herein specified.

PART 3 - EXECUTION

3.1 SURFACE PREPARATION:

A. Remove loose material from compacted subbase surface immediately before placing the concrete.

B. Proof-roll in accordance to Section 312000, “Earthwork-Site,” to the satisfaction of the Owner’s Designated Representative, prepared subbase surfaces to check for unstable areas and need for additional compaction. Do not begin paving work until such conditions have been corrected and are ready to receive paving.

C. Coordinate the installation of joint materials and vapor retarders with placement of forms, reinforcing steel, inserts, anchorage’s, sealants and other features and items necessary for the work specified herein.

D. Adhere to safety standards and regulations of federal, state and local regulatory agencies having jurisdiction.

3.2 FORM CONSTRUCTION:

A. Set forms to required grades and lines, braced and secured. Install forms to allow continuous progress of Work and so that forms can remain in place at least 24 hours after concrete placement.

B. Check completed formwork for grade and alignment to following tolerances:

1. Top of forms not more than 1/8 inch in 10 feet.
2. Vertical face on longitudinal axis, not more than 1/4 inch in 10 feet.

C. Clean forms after each use and coat with form release agent as required to ensure separation from concrete without damage.

D. Design, erect, support, brace and maintain formwork to support vertical and lateral, static, and dynamic loads that might be applied until such loads can be supported by concrete structure. Construct formwork so concrete elements are of correct size, shape, alignment, elevation, slope, and position. Maintain formwork construction tolerances complying with ACI 347, when determined applicable by Owner's Designated Representative.

E. Design formwork to be readily removal without impact, shock, or damage to cast-in-place concrete surfaces and adjacent materials.

F. Construct forms to sizes, shapes, lines, and dimensions shown, and to obtain accurate alignment, location, grades, level and plumb work in finished elements. Provide openings, offsets, keyways, recesses, chamfers, bulkheads, anchorage's and inserts, and other features required in work. Use selected materials to obtain required finishes. Solidly butt joints of forms and provide back-up at joints to prevent leakage of cement paste.

G. Fabricate form for easy removal without hammering or prying against concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways, and the like, to prevent swelling and for easy removal.

H. Chamfer exposed corners and edges as indicated, using wood, metal, PVC, or rubber chamfer strips fabricated to produce uniform smooth lines and tight edge joints.

I. Provisions for Other Trades: Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of opening, recesses, and chases form trade providing such items. Accurately place and securely support items built into forms.

J. Cleaning and Tightening: Thoroughly clean forms and adjacent surfaces to receive concrete. Remove all trash, chips, wood, sawdust, dirt, discarded tie wire, ice, snow, water or other debris deemed unacceptable to the Owner's Designated Representative just before concrete is placed. Re-tightening forms and bracing after concrete placement as is required to eliminate mortar leaks and maintain proper alignment.

3.3 PLACING REINFORCEMENT:

A. Comply with Concrete Reinforcing Steel Institute's (CRSI) recommended practice for Placing Reinforcing Bars, for details and methods of reinforcement placement and supports, and as herein specified.

B. Clean reinforcement of loose rust and mill scale, earth, ice, snow, water and other materials which reduce or destroy bond with concrete.

C. Gas flame cutting and bending of reinforcing steel is strictly prohibited. All cutting of reinforcing steel shall be done by acceptable equipment specifically designed for shearing method. Bending shall be done by acceptable equipment specifically designed for cold bending method. All cutting and bending of reinforcing steel shall be done in a fabrication shop. Reinforcing steel which has been cut and/or bent utilizing gas flame shall be removed and replaced with acceptable material by the Contractor at no additional expense to the Owner.

D. Accurately position, support, and secure reinforcement against displacement operations. Locate support reinforcing by metal chairs, runners, bolster, spacers, and hangers, as required and as directed by the Owner's Designated Representative.

E. Place reinforcement to obtain at least minimum coverage's for concrete protection as denoted on the Contract Drawings and as specified herein. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces; all wire ties shall have 1 1/2 -inch minimum concrete coverage.

F. Install welded wire fabric in as long lengths as practicable. Lap adjoining pieces at least 12 inches and lace splices with tie-wire. Offset end laps in adjacent widths to prevent continuous laps in either direction. For slabs-on-grade, including all sidewalks, welded wire fabric shall be accurately positioned and supported with sand chairs or bolsters. Pulling up the wire fabric with rakes, or by any other method, in lieu of support devices will not be allowed.

G. Install reinforcing steel with lap splices or acceptable mechanical splicing devices as indicated on the Contract Drawings and in accordance with ACI 318 provisions.

3.4 INSTALLATION OF EMBEDDED ITEMS:

A. General: Set and build into work anchorage devices and other embedded items required for other work that is attached to, or supported by, cast-in-place concrete. Use setting Drawings, diagrams, instructions, and directions provided by suppliers of

items to be attached thereto and at the direction of the Owner's Designated Representative.

B. Edge Forms and Screed Strips for Slabs: Set edge forms or bulkheads and intermediate screed strips for slabs to obtain required elevations and contours in finished slab surface. Provide and secure units sufficiently strong to support types of screed strips by use of strike-off templates or accepted compacting type screeds.

3.5 PREPARATION OF FORM SURFACES:

A. Clean re-used forms of concrete matrix residue, repair and patch as required to return forms to acceptable surface condition.

B. Coat contact surfaces of forms with a form-coating compound before reinforcement is placed.

C. Thin form-coating compounds only with thinning agent of type, amount, and under conditions of form-coating compound manufacturer's directions. Do not allow excess form-coating material to accumulate in forms or to come into contact with in-place concrete surfaces against which fresh concrete will be placed. Apply in compliance with manufacturer's instructions.

D. Coat steel forms with a non-staining, rust-preventative form oil or otherwise protect against rusting. Rust-stained steel framework is not acceptable.

3.6 CONCRETE PLACEMENT:

A. Do not place concrete unless testing laboratory/agency and the Owner's Designated Representative has had ample time to inspect and approve reinforcing steel and formwork installation and workmanship for adherence to the requirements as shown on the Contract Drawings, specified herein and as specified in other specification sections; failure to adhere to this requirement may result in said concrete being rejected by the Owner's Designated Representative and removed at no additional expense to the Owner, unless the Contractor can demonstrate to the satisfaction of the Owners Designated Representative that concrete work has meet or exceeded the minimum standards set forth herein this and other specification sections.

B. Preplacement Inspection: Before placing concrete, inspect and complete formwork installation, reinforcing steel, and items to be embedded or cast-in. Notify other crafts to permit installation of their work; cooperate with other trades in setting such work. Moisten wood forms immediately before placing concrete where form coatings are not used. Prior to concrete placing, permit the Owners Designated Representative full access to work with sufficient amount of time as necessary to verify workmanship of all required installations.

C. Apply acceptable temporary protective covering to lower four feet (4') of finished walls and other improvements adjacent to poured slabs and similar conditions, and guard against spattering during placement.

D. General: Comply with ACI 304 Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete, and as herein specified.

E. Deposit concrete continuously or in layer of such thickness that no concrete will be placed on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as herein specified. Deposit concrete as nearly as practicable to its final location to avoid segregation.

F. Consolidate placed concrete by mechanical vibrating equipment of sufficient size, vibratory output and quantity, supplemented by hand-spading, rodding or tamping. Use equipment and procedures for consolidation of concrete in accordance with ACI 309.

G. Do not use vibrators to transport concrete in vertically, horizontally and/or diagonally directions inside of forms. Insert and withdraw vibrators vertically at uniformly spaced locations not farther than visible effectiveness of machine. Place vibrators to penetrate placed layer; limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing segregation of mix.

H. Vibrate and consolidate concrete in forms to assure monolithic homogeneous concrete section within forms and to prevent voids and “bug holes” on exposed surfaces. Avoid over-vibration of fluidization of concrete to prevent aggregate segregation. Vibration shall not be used to move concrete to its final positions within forms in lieu of moving chute or placement conduit or other acceptable placement method.

I. Placing Concrete Slabs: Deposit and consolidate concrete slabs in a continuous operation, within limits of contraction joints, until the placing of a panel or section is completed.

1. Consolidate concrete during placing operations so that concrete is thoroughly worked around reinforcement and other embedded items and into corners. Prevent voids and “honeycombing” within concrete members.
2. Bring slab surfaces to correct level with straightedge and strike off. Use bull floats or darbies to smooth surface, free of humps or hollows. Do not disturb slab surfaces prior to beginning finishing operations.
3. Maintain reinforcing in proper position during concrete placement operations.

J. Do not place concrete until subbase and forms have been checked for line and grade. Moisten subbase if required to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

K. Place concrete by methods that prevent segregation of mix. Consolidate concrete along face of forms and adjacent to transverse joints with internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand-spreading and consolidation. Consolidate with care to prevent dislocation of reinforcing, dowels, and joint devices.

L. Use bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

M. Deposit and spread concrete in a continuous operation between transverse joints as far as possible. If interrupted for more than one-half hour, install a construction joint.

N. Cold Weather Placing: Protect concrete work from physical damage or reduced strength which could be caused by frost, freezing actions, or low temperatures, in compliance with ACI 306 and as herein specified.

1. When air temperature has fallen to or is expected to fall below 40 degrees F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 degrees F, and not more than 80 degrees F, at point of placement.
2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or frozen subbase or on subgrade and subbase containing frozen materials.

3. Do not use calcium chloride, salt, and other materials containing antifreeze agents or chemical accelerators, unless otherwise in mix designs accepted by the Owners Designated Representative.

O. Hot Weather Placing: When hot weather conditions exist that would seriously impair quality and strength of concrete, place concrete in compliance with ACI 305 and as herein specified.

1. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90 degrees F. Mixing water may be chilled, or chopped ice may be used to control temperature provided water equivalent of ice is calculated to total amount of mixing water.
2. Covering reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature.
3. Fog spray forms, reinforcing steel, and subgrade just before concrete is placed.
4. Use water-reducing retarding admixture (Type D) when required by high temperatures, low humidity, or other adverse placing conditions.

P. Construct and cure cast-in-place concrete curbing in accordance with minimum requirements of New York State Department of Transportation (NYSDOT) Standard Specifications. Provide raked (tooled) contraction joints at 5 feet maximum spacing and expansion joints at 20 feet maximum spacing. Raked (tooled) contraction joint depths shall be at least 3/4-inch, and installed transversely across top and vertical faces of curb. Install expansion joints at all curb corners and intersections and at locations where curb is restrained by fixed objects.

3.7 JOINTS (GENERAL REQUIREMENTS):

A. General: Construct expansion, weakened-plane contraction (crack control), and construction joints true to line with face perpendicular to surface of concrete.

Construct transverse joints at right angles to the curb centerline, unless otherwise indicated or specified herein.

A. When joining existing structures, place transverse joints to align with previously placed joints, unless otherwise indicated.

B. Weakened-Plane (Control) Joints: Provide weakened-plane (control) joints along cast-in-place curbs and sidewalks, sectioning concrete into areas as depicted on the Contract Drawings, but locating joints spaced at no more than 5 feet on-center in any direction, unless otherwise depicted. Construct weakened-plane joints in upper portion of concrete work for a depth equal to at least 1/4 concrete pavement thickness, as follows:

1. Tooled Joints: Form weakened-plane joints in fresh concrete by grooving top portion with a recommended cutting tool and finishing edges with a jointer. Following the initial curing period, install specified joint sealant.

C. Construction Joints: Place construction joints at end of placements and at locations where placement operations are stopped for more than one-half hour, except where such placements terminate at expansion joints. Provide grooved top portion and sealant in same manner as done at control joints.

1. Construct joints as shown or, if not shown, use standard metal keyway-section forms.
2. Where load transfer-slip dowel devices are used, install so that one end of each dowel bar is free to move.

D. Expansion Joints: Provide specified premolded joint filler for expansion joints abutting concrete curbs, catch basins, manholes, inlets, structures, walks, and other fixed objects, unless otherwise indicated.

1. Locate expansion joints at 20 feet on-center maximum spacing along cast-in-place concrete curbs, and at 20 feet on-center maximum spacing along cast-in-place concrete sidewalks and at every 200 square feet in cast-in-place concrete pavement, unless otherwise indicated on the Contract Drawings and herein specified.

E. Extend joint fillers full width and depth of joint, not less than 1/2-inch, nor more than 1-inch below finished surface where joint sealer is indicated. If no joint sealer, place top of joint filler flush with finished concrete surface. Furnish joint fillers in one-piece lengths for full width being placed wherever possible. Where more than one length is required, lace or clip joint filler sections together.

1. Protect top edge of joint filler during concrete placement with a metal cap or other temporary material. Remove protection after concrete has been placed on both sides of joint.

F. In pavement, place construction joints at the end of concrete placements and at locations where placement operations are stopped for more that one-half hour, except

where such pours terminate at expansion joints. Construct joints as shown or, if not shown, use standard metal keyway sections.

G. For traffic bearing joints in concrete paving 2 parts polyurethane sealant complying with FS-TT-S-00227, Class A Type 1 (self leveling), unless otherwise recommended by manufacturer. Provide Sonolastic Pavement Joint Seal by Sonneborn/Contech, or approved equal. Refer to the Contract Drawings for typical locations.

H. For joint filler in paving joints and where concrete abuts existing fixed construction, provide specified premolded sponge rubber filler and sealant. Traffic bearing joints to be constructed in strict accordance with manufacturers recommendations.

I. Install dowel bars and support assemblies at stair-slab joints and where indicated. Lubricate or asphalt-coat one-half of dowel length to prevent concrete bonding to one side of joint.

3.8 JOINT SEALER PREPARATION:

A. Surface Cleaning of Joints: Thoroughly clean-out joints, to the satisfaction of the Owner’s Designated Representative, using compressed air or other approved means immediately before installing joint sealers to comply with recommendations of joint sealer manufacturers:

B. Remove all foreign material from joint substrates which could interfere with adhesion of joint sealer, including dust, paints, except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer; old joint sealers; oil; grease; waterproofing; water repellants; water; snow and ice; surface dirt and frost.

C. Clean concrete, by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealers. Remove loose particles remaining from above cleaning operations by vacuuming or blowing out joints with oil-free compressed air.

D. Remove laitance and form release agents from concrete.

E. Joint Priming: Prime joint substrates where indicated or where recommended by joint sealer manufacturer based on preconstruction joint sealer-substrate tests or prior experience. Apply primer to comply with joint sealer manufacturer's recommendations. Confine primers to areas of joint sealer bond, do not allow spillage or migration onto adjoining surfaces.

F. Masking Tape: Use masking tape where required to prevent contact of sealant with adjoining surfaces which otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.9 INSTALLATION OF JOINT SEALERS:

A. General: Comply with joint sealer manufacturers' printed installation instructions applicable to products and applications indicated, except where more stringent requirements apply.

B. Install bond breaker tape between sealants and joint fillers, compression seals, or back of joints where adhesion of sealant to surfaces at back of joints would result in sealant failure.

3.10 INSTALLATION OF SEALANTS:

A. General: Install sealants by proven techniques that result in sealants directly contacting and fully wetting joint substrates, completely filling recesses provided for each joint configuration, and providing uniform, cross-sectional shapes and depths relative to joint widths which allow optimum sealant movement capability.

B. Tooling of Nonsag Sealants: Immediately after sealant application and prior to time skinning or curing begins, tool sealants to form smooth, uniform beads of configuration indicated, to eliminate air pockets, and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents which discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

1. Provide flush joint configuration per Figure 6B in ASTM C 962, where indicated.
2. Use masking tape to protect adjacent surfaces of recessed tooled joints.

C. Cleaning: Clean off excess sealants or sealant smears adjacent to joints as work progresses by methods and with cleaning materials approved by manufacturers of joint sealers and of products in which joints occur.

D. Protection: Protect joint sealers during and after curing period from contact with contaminating substances or from damage resulting from construction operations or other causes so that they are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealers immediately and reseal joints with new materials to produce joint sealer installations with repaired areas indistinguishable from original work.

3.11 CONCRETE FINISHING:

A. After striking-off and consolidating concrete, smooth surface by screeding and floating. Use hand methods only where mechanical floating is not possible. Adjust floating to compact surface and produce uniform texture.

B. After floating, test surface for trueness with a 10 foot long straightedge. Distribute concrete as required to remove surface irregularities, and refloat repaired areas to provide a continuous smooth finish.

C. Surface Smoothness: Test finished surface course for smoothness, using 10-foot straightedge applied parallel with and at right angles to center line of paved area. Surfaces will not be acceptable if exceeding the following tolerances for smoothness:

1. Wearing Course Surface: 1/8 inch.
2. All new paving will drain as shown on grading plan, if standing water is observed following a rainstorm, the areas not draining will be removed, repaired or replaced as directed by the Owners Designated Representative. The costs for such work will be born by the Contractor.

D. Work edges of slabs, gutters, back top edge of curb, and formed joints with an edging tool, and round to 1/2-inch radius, unless otherwise indicated. Eliminate tool marks on concrete surface.

E. After completion of floating and when excess moisture or surface sheen has disappeared, complete troweling and finish surface as follows:

F. On inclined slab surfaces, provide a coarse, non-slip finish by scoring surface with a stiff-bristled broom, perpendicular to line of traffic.

G. Do not remove forms unless as per paragraph 3.14. After form removal, clean ends of joints and point-up any minor honeycombed areas. Remove and replace areas or sections with major defects, as directed by the Owner’s Designated Representative.

H. Finishes as follows:
1. Concrete curbs: Trowel finish.
2. Concrete pavements: Broom finish by drawing a fine-hair broom across concrete surface perpendicular to line of traffic.

3.13 EXPOSED AGGREGATE FINISH

A. Seeded Exposed-Aggregate Finish: Immediately after initial floating, spread a single layer of aggregate uniformly on paving surface. Tamp aggregate into plastic concrete and float finish to entirely embed aggregate with mortar cover of 1/16 inch.
1. Spray-apply chemical surface retarder to paving according to manufacturer's written instructions.
2. Cover paving surface with plastic sheeting, sealing laps with tape, and remove sheeting when ready to continue finishing operations.
3. Without dislodging aggregate, remove mortar concealing the aggregate by lightly brushing surface with a stiff, nylon-bristle broom. Do not expose more than one-third of the average diameter of the aggregate and not more than one-half of the diameter of the smallest aggregate.
4. Fine-spray surface with water and brush. Repeat cycle of water flushing and brushing until cement film is removed from aggregate surfaces to depth required.
5. The finished surface of the slab shall be completely covered with aggregate with a uniform appearance, as determined by the Owner’s Representative.

3.13 CONCRETE CURING AND PROTECTION:

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

B. Begin final curing procedures immediately following initial curing and before concrete has dried. Continue final curing for at least 14 days. Avoid rapid drying at end of final curing period.

C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.

D. Curing Method: Perform curing of concrete by moist curing, by moisture-retaining cover curing, and by combinations thereof, as herein specified.

1. Provide moisture curing by following methods at Contractor’s option:
   a. Continuous water-fog spray.
   b. Covering concrete surface with specified absorptive cover, thoroughly saturating cover with water and keeping continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with minimum 12-inch lap over adjacent absorptive covers.
2. Provide moisture-cover curing as follows:
   a. Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width with sides and ends lapped at least 12-inch and sealed by waterproof tape of adhesive. Immediately repair any holes or tears during curing period using ocer material and waterproof tape.

E. Curing of Slabs-on-Grade: After completion of finishing operations, "wet cure" the slab for a minimum of 14 days in accordance with Moisture Curing method above. Maintain water depth constant throughout moisture curing operations. Obtain water through agreement with Owner when determined acceptable by Owners Designated Representative.

1. Curing Formed Surfaces: Cure formed concrete surfaces by moist curing with forms in place for full curing period or until forms are removed. If forms are removed, continue curing by methods specified above, as applicable.

F. Curing Unformed Surfaces: Cure unformed surfaces, such as slabs, floor topping, and other flat surfaces by application of appropriate curing method.

G. Curing and Sealing Compound: Apply compound per the manufacturer’s written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.14 REMOVAL OF FORMS:

A. Formwork may be removed after cumulatively curing at not less than 50 degrees F (10 degrees C) for at least 24 hours after placing concrete, provided concrete is sufficiently hard to not be damaged by form removal operations, and provided curing and protection operations are maintained.

3.15 RE-USE OF FORMS:

A. Clean and repair surfaces of forms to be re-used in work. Split, frayed, delaminated, or otherwise damaged form facing material will not be acceptable for exposed surfaces. Apply new form coating compound as specified for new formwork.

B. When forms are extended for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close joints. Align and secure joint to avoid offsets. Do not use “patched” forms for exposed concrete surfaces, except as acceptable to the Owners Designated Representative.

3.16 MISCELLANEOUS CONCRETE ITEMS:

A. Filling-In: Fill-in holes and openings left in concrete elements for passage of work by other trades, unless otherwise shown or directed, after work of other trades is in place. Mix, place, and cure concrete as herein specified, to blend with in-place construction. Provide other miscellaneous concrete filling shown or required to complete work.

3.17 INSTALLATION OF NOSINGS

A. Center nosings on tread widths. Provide a single nosing per tread unless otherwise approved on shop drawings.

B. Install in strict accordance with manufacturer instructions. Align nosings flush with riser faces and level with tread surfaces.

C. Finish condition shall appear smooth and seamless, with no gaps between nosing and concrete.

3.18 DETECTABLE PANEL INSTALLATION

A. Install detectable warning panels at curb ramps in accordance with manufacturer’s specifications and these Contract Drawings

B. Attach panels together as per manufacturers specifications and as necessary to form required sizes.

C. Pour concrete in accord with Specification Section “Portland Cement Concrete”.

D. Set panels in wet concrete at detailed location and orientation. Utilize lifting devices as necessary and as per manufacturers specifications.

E. Press assembly into wet concrete to final finished elevation and detailed grade. Panels are to be set flush with adjacent concrete pavement.

F. Finish concrete pavement around panels as specified and per details.

G. Contractor shall take precautions to keep wet concrete from the top surface of the detectable panels. Any splatters are to be cleaned immediately prior to drying.

3.18 CONCRETE SURFACE REPAIRS:

A. Patching Defective Areas: Repair and patch defective areas with epoxy-based cement mortar having color, durability and strength matching or exceeding substrate concrete immediately after removal of forms, when acceptable to the Owners Designated ’s Representative.

B. Cut out honeycomb, rock pockets, voids over 1/4 -inch in any dimension, down to solid concrete but, in no case to depth of less than 1-inch. Make edges of cuts perpendicular to the concrete surface. Thoroughly clean perpendicular to the concrete surface. Thoroughly clean area of debris and loose material, dampen with water, and brush-coat the area to be patched with specified bonding agent. Place patching mortar after bonding compound has dried.

C. For exposed-to-view surfaces, blend specified cement and patching mortar so that, when dry, patching mortar will match color surrounding. Provide test areas at inconspicuous location to verify mixture and color match before proceeding with patching. Compact mortar in place and strike-off slightly higher than surrounding surface.

D. Repair of Formed Surfaces: Remove and replace concrete having defective surfaces if defects cannot be repaired to satisfaction of the Owners Designated Representative. Surface defects, as such, include color and texture irregularities, cracks, spalls, air bubbles, honeycomb, rock pockets; fins and other projections on surface; and stains and other discoloration’s that cannot be removed by cleaning. Flush out form ties holes, fill with dry pack mortar, or precast cement cone plugs secured in place with bonding agent.

E. Repair concealed formed surfaces, where possible, that contain defects that affect the durability of concrete. If defects cannot be repaired, remove and replace concrete.

F. Repair finished unformed surfaces that contain defects, which affect durability of concrete. Surface defects, as such, include crazing, cracks in excess of 0.01-inch wide or which penetrate to reinforcement or completely through non-reinforced sections regardless of width, spalling, pop-outs, honeycomb, rock pockets, and other objectionable conditions.

G. Correct low areas in unformed surfaces during or immediately after completion of surface finishing operations by cutting out low areas and replacing with fresh concrete. Finish repaired areas to blend into adjacent concrete.

H. Repair defective areas, except random cracks by cutting out and replacing with fresh concrete. Remove defective areas to sound concrete with clean, square cuts and expose reinforcing steel with at least 3/4-inch clearance all around. Dampen concrete surfaces in contact with specified patching concrete and apply bonding compound. Mix specified patching concrete of same materials to provide concrete of same type or class as original concrete. Cure in same manner as adjacent concrete.

I. Repair isolated random cracks by dry-pack method. Groove top of cracks and cut-out holes to sound concrete and clean of dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding compound. Mix dry-pack, consisting of one part specified cement to 2-1/2 parts fine aggregate passing a No. 16 mesh sieve, using only enough water as required for handling and placing. Place dry pack after bonding compound has dried. Compact dry-pack mixture in place and finish to match adjacent concrete. Keep patched area continuously moist for not less than 5 days.

J. Repair methods not specified above may be used, subject to acceptance of the Owners Designated Representative.

3.19 QUALITY CONTROL TESTING DURING CONSTRUCTION:

A. The Owner shall employ an independent testing laboratory/agency to perform tests and to submit test result reports.

B. Sampling and testing for quality control during placement of concrete shall include the following:

1. Sampling Fresh Concrete: ASTM C 172, except modified for slump to comply with ASTM C 94.
2. Slump: ASTM C 143; minimum of one test at point of discharge for each ready mix truck load of concrete for each type of concrete; minimum of one test at the concrete pump (if employed) for each ready mix truck load for each type of concrete; additional tests when concrete consistency seems to have changed.
3. Yield: ASTM C 138; minimum of one test at point of discharge for each ready-mix load of concrete.
4. Air content: ASTM C 173, volumetric method for lightweight or normal weight concrete; ASTM C 231 pressure method for normal weight concrete; minimum of one for each ready-mix load of concrete for each type of concrete; additional tests when concrete consistency appears to have changed.
5. Concrete Temperature: Test hourly when air temperature is 40 degrees F and below, and when 80 degrees F and above; and each ready-mix load of concrete.
6. Compression Test Specimen: ASTM C 31; minimum of one set of four (4) standard cylinders for each compressive strength test. Mold and store cylinders for laboratory cured test specimens except when field-cure test specimens are required.
7. Compressive Strength Tests: ASTM C 39; minimum of one set for each day’s concrete placement exceeding 5 cubic yards, plus additional sets for each 25 cubic yards over and above the first 25 cubic yards of each concrete class placed in any one day; one specimen tested at 7 days, two specimens tested at 28 days, and one specimen retained in reserve for later testing.

8. When frequency of testing will provide less than 5 strength tests for a given class of concrete, conduct testing from at least 5 randomly selected batches or from each batch if fewer than 5 are used.
9. When compressive strength of field-cured cylinders is less than 85 percent of compressive strength of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete. Compressive strength level of concrete will be considered satisfactory if averages of sets of 3 consecutive compressive strength test results equal or exceed specified compressive strength, and no individual strength test result fall below specified compressive strength by more than 500 Pounds per Square Inch.

C. Test results will be reported in writing to the Owners Designated Representative and Contractor within 24 hours after tests. Reports of compressive strength tests shall contain the project identification name and number, date of concrete placement, name of concrete testing service, ready-mix company vehicle number, concrete type and class, location of concrete batch in structure, design compressive strength at 28 days, concrete mix proportions and materials; compressive breaking strength and type of break for both 7 day tests and 28 day tests.

D. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by the Owners Designated Representative but shall not be used as the sole basis for acceptance or rejection.

E. Additional Tests: The independent testing laboratory/agency will make additional tests of in-place concrete when test results indicate specified concrete compressive strengths and other characteristics have not been attained in the concrete. The testing laboratory/agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed. Contractor shall pay for such tests, at no additional cost to Owner, when unacceptable concrete is verified or Contractor has failed to have the Owner's independent testing laboratory/agency conduct concrete testing during concrete work placement.

3.20 PROTECTIONS:

A. Protect concrete from damage until the acceptance of work. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials as they occur.

B. Sweep concrete pavement and wash free of stains, discolorations, dirt, and other foreign material just before final inspection.

END OF SECTION 321313

SECTION 321400 - UNIT PAVING

PART 1 - GENERAL

1.1. SECTION INCLUDES
A. Installation of masonry unit paving

1.2. RELATED SECTIONS
A. Section 312000 – Earth Moving
B. Section 321313 – Portland Cement Concrete

1.3. SUBMITTALS
A. Comply with requirements of Section 013300 – Submittal Procedures and as modified below.
B. Product Data: Submit manufacturer's name, specifications and installation instructions for each item specified.
C. Furnish samples of each unit paver type to be installed as part of the project. Upon request of the Owners Representative, submit samples demonstrating the manufacturer's full range of colors available.
D. Quality Control Submittals
   1. Qualifications Certification: Submit written certification or similar documentation signed by the applicable subcontractor, prime contractor and/or manufacturer (where applicable) indicating compliance with the "Qualifications" requirements specified below in the "Quality Assurance" section of this specification.
   2. Experience Listing: Submit a list of completed projects using the products proposed for this project, including owner's contact information and telephone number for each project, demonstrating compliance with applicable "Installer Qualifications" requirements specified in the "Quality Assurance" section of this specification.
E. Contract Closeout Submittals: Comply with the requirements of Section 017700.

1.4. QUALITY ASSURANCE
A. Installer Qualifications: Experienced firm with not less than five successfully completed unit paver installations using the products specified.
B. Single Source Responsibility: Obtain each color, type and variety of unit paver from a single source. Materials shall be available and be consistent in quality, appearance and physical properties without delaying the progress of the work.
C. Field Constructed Mock-up: Construct a 3' X 3' mock-up for each paving pattern required as part of the project and obtain the Owner's Representative approval prior to beginning unit paving installation work.

1.5. PROJECT CONDITIONS
A. Field Measurements: Prior to commencing work specified in this section, verify accuracy of layout and grading. Verify that all subgrade and base course aggregate conditions are as specified.
B. Cold Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost.

C. Pavers shall not be installed during heavy rain or snowfall.
D. No concrete pavers shall be laid over frozen materials or on an improperly prepared base.
E. At the end of each work period, protect unrestrained edges with plywood or similar materials.

1.6. SEQUENCING AND SCHEDULING
A. Proceed with and complete unit paver installation as rapidly as portions of the site become available, working within seasonal limitations for the work required.

PART 2 - PRODUCTS

2.1 MATERIALS
A. Masonry Unit Paver Border: Solid concrete, interlocking paving units made from normal weight aggregates complying with ASTM C 936. For convenience, details and specifications have been based on “Ledgestone Smooth Permeable with ArmorTec, Crusader Collection” by Cambridge Pavers, Inc., Lyndhurst, N.J. (201) 933-5000.
1. Pattern Laying Type: Soldier.
2. Paver Type: Nominal 6”x9”
a. Minimum Average Compressive Strength: 8,000 psi
b. Maximum Absorption: 5%
c. Freeze Thaw Resistance: 50 freeze thaw cycles
d. Size: 6” X 9” X 3.125”
e. Color: Onyx/Natural
B. Masonry Unit Paver Field: Solid concrete, interlocking paving units made from normal weight aggregates complying with ASTM C 936. For convenience, details and specifications have been based on “Ledgestone Smooth Permeable with ArmorTec, Crusader Collection” by Cambridge Pavers, Inc., Lyndhurst, N.J. (201) 933-5000.
1. Pattern Laying Type: Herringbone bond
2. Paver Type: Nominal 6”x9”
a. Minimum Average Compressive Strength: 8,000 psi
b. Maximum Absorption: 5%
c. Freeze Thaw Resistance: 50 freeze thaw cycles
d. Size: 6” X 9” 3.125”
e. Color: Onyx/Natural
C. Paver Edge Restraint. Shall be a durable, corrosion-resistant edging system designed to provide lateral support and prevent movement or spreading of permeable pavers under pedestrian traffic.
1. Manufactured from heavy-duty. UV stabilized recycled HDPE or equivalent material.
2. Suitable for exterior installation and long-term ground contact.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Installer Verification of Conditions: Examine conditions under which unit pavers are to be installed with the materials and components specified in this section. Affected Prime Contractors, the Owner’s Representative and

the Architect shall be notified in writing of any conditions detrimental to the proper and timely installation of the work.

1. When the installer confirms conditions as being acceptable to ensure proper and timely installation of the work and to ensure requirements of applicable warranties or guarantees can be satisfied, submit written confirmation to the Architect. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to the installer.

3.2 PREPARATION

A. Strip the site of the unit paver installation of all topsoil, organic materials, oversized rocks debris and unstable or unconsolidated materials to the grades indicated on the Contract Documents.

B. Do not overcompact subgrade. Decompact as necessary to allow for infiltration.

3.3 INSTALLATION

A. Unit Paver Installation
   1. Pavers with excessive chips, cracks, voids discolorations or other defects shall not be installed.
   2. Pattern: The unit pavers shall be set in the approved pattern as noted on the Contract Documents.
   3. Color Blending: Paving units shall be installed from a minimum of three bundles simultaneously drawing the paver vertically rather than horizontally.
   4. Alignment: String lines or chalk lines on bedding sand shall be used to hold all pattern lines true.
   5. Cutting: Gaps at the edge of the paving surface shall be filled with manufactured edge pavers or with pavers cut to fit. Cutting should be accomplished to leave a clean edge to the traffic surface using a mechanical hydraulic guillotine cutter or masonry saw.
   6. Install edge restraint. Top of restraint shall be hidden.
   7. Fill paver joint openings with ASTM No. 9 stone. Sweep stone to fill joints.
   8. Sweeping Clean: Upon completion of cutting, the area must be swept clean of all debris to facilitate inspection and to ensure pavers are not damaged during compaction.
   9. Inspection of Installed Pavers: After sweeping and prior to compaction, the paved area must be inspected to ensure satisfactory color blending. Pavers shall be moved as required to achieve good color distribution.

B. Paver Inspection: Any unit pavers which are structurally damaged during compaction shall be immediately removed and replaced.

C. Tolerances in Surface Profile
   1. All surfaces and pavement structures shall be true to the lines, levels, grades, thickness and cross sections as shown on the Contract Documents.
   2. All pavements shall be finished to lines and levels to ensure positive drainage at all drainage outlets and channels.

3. The final surface elevation of the paving stones shall be 1/8 inch to 1/4 inch above adjacent drainage inlets, concrete collars or channels.
4. The pavement surface shall not deviate by more than 3/8” inch in 10 feet from a straight edge laid in any direction.

3.4 ADJUSTING AND CLEANING

A. Sweep clean all paved areas of excess sand, dirt or debris.
B. Pick up and remove from the site all surplus materials, equipment and debris resulting from the work.
C. Repairs and Protection of Unit Pavers
   1. Repair or replace broken or defective unit pavers as directed by the Architect.
   2. Protect unit pavers from damage until acceptance of the pavement construction.

END OF SECTION 321400

SECTION 321816 - PLAYGROUND PROTECTIVE SURFACING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Section 31 2000 “Site Earthwork” for geosynthetics, subgrade and subbase preparation.

C. Section 11 68 00 “Play Equipment and Structures” for playground information.

1.2 SUMMARY

A. Section Includes:

1. Playground surfacing meeting recommendations set forth by the United States Consumer Product Safety Commission and ASTM Standards for play surface resilience and accessibility.

1.3 REFERENCES

A. ASTM F 1292 - Standard Specification for Impact Attenuation of Surface Systems Under and Around Playground Equipment.

B. ASTM D 412 – Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension

C. ASTM D 624 – Standard Test Method for Tear Strength of conventional Vulcanized Rubber and Thermoplastic Elastomers.

D. ASTM C 1028 – Standard Test Method for Determining the Static Coefficient of Friction of Ceramic Tile and other Like Surfaces by the Horizontal Dynamometer Pull Meter Method.

E. ASTM D 2047 – Standard Test Method for Static Coefficient of Friction of Polish-Coated Flooring Surfaces as Measured by the James Machine.

F. ASTM E 303 – Standard Test Method for Measuring Surface Frictional Properties Using the British Pendulm Tester

G. ASTM D 2859 – Standard Test Method for Ignition Characteristics of finished Textile Floor Covering Materials.

H. ASTM F 1551 – Standard Test Methods for Comprehensive Characterization of Synthetic Turf Playing Surfaces and Material: Suffix – DIN 18-035 Part 6: Water Permeability of Synthetic Turf systems and Permeable Bases.

I. US Consumer Product Safety Commission (CPSC) Handbook for Playground Safety.

1.4 DEFINITIONS

A. Definitions in ASTM F2223 apply to Work of this Section.

B. Critical Height: Standard measure of shock attenuation according to ASTM F2223; same as "critical fall height" in ASTM F1292. According to ASTM F1292, this approximates "the maximum fall height from which a life-threatening head injury would not be expected to occur."

C. SBR: Styrene-butadiene rubber.

D. Unitary Surfacing: A protective surfacing of one or more material components bound together to form a continuous surface; same as "unitary system" in ASTM F2223.

1.5 ACTION SUBMITTALS

A. Product Data and Installation Instruction: For each type of product.

B. Shop Drawings: For each type of protective surfacing.

1. Include plans, sections, placement and penetration details, and attachment to substrates.
2. Include accessories and edge terminations.
3. Include fall heights and use zones for equipment and structures, coordinated with the critical heights for protective surfacing.

C. Samples for Verification: For each type of protective surfacing and exposed finish.

1. Include Samples of accessories to verify color and finish selection.
2. Poured-in-Place Seamless Surfacing: Minimum 6 by 6 inches.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data Installer Qualifications: A list of ten (10) playground surfacing projects completed with a similar product within the last five (5) years. List shall include names of project representatives and respective telephone numbers. Projects shall have been contracted and installed by the company bidding the job.

B. Product Certificates: For each type of unitary surfacing product.

C. Field quality-control reports.

D. Sample Warranty: For manufacturer's special warranty.

E. Laboratory Test Reports: materials certificates certifying each material item complies with or exceeds, specified requirements.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For playground protective surfacing to include in maintenance manuals.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by the manufacturer.

B. Installer Certification: The Manufacturer must provide written certification that the installer is an approved applicator of the playground surfacing system.

C. Impact Attenuation: When installed, the poured in place rubber surfacing, when tested according to ASTM F 1292, shall have a G-max of less than 200 and a Head Injury Criteria of less than 1000.

D. Accessibility: When properly installed and compacted, resilient surfacing shall pass ASTM F 1951-99, Standard Specification for Determination of Accessibility of Surface Systems Under and Around Playground Safety.

E. IPEMA Certification: Manufacturer must provide proof of IPEMA certification of conformance to ASTM F 1292-04 and ASTM F 2075-04.

F. Testing Certification - Test results from an independent testing laboratory must be submitted for Impact Attenuation per ASTM 1292-04. Impact attenuation test results shall meet or exceed Consumer Product Safety Commission Guidelines for impact attenuation (G-max and Head Injury Criterion). The test results must be administered and evaluated under the same test with results shown for three drops at each 32 degrees, 72 degrees and 120 degrees F. The resultant yield must be less than 200 G’s and less than 1,000 H.I.C.

1.9 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in manufacturer’s original, unopened, undamaged containers with identification labels intact.

B. Store Poured-in-Place materials in accordance with manufacturer’s instructions and protected from exposure to harmful environmental conditions and a minimum temperature of 40 degrees F and a maximum temperature of 90 degrees F.

1.10 PROJECT CONDITIONS

A. Material Temperature: Ensure material temperature is a minimum of 50 degrees F (10 degrees C) at time of installation.

B. Air Temperature: Install surfacing when ambient temperature is a minimum of 40 degrees F and rising and a maximum of 90 degrees F for a minimum of 24 hours before, during, and after installation.

1.11 WARRANTY

A. Special Warranty: Manufacturer and Installer agree to repair or replace components of protective surfacing that fail in materials or workmanship within specified warranty period.

1. Submit standard warranty document executed by authorized company official. Manufacturer's warranty is in addition to, and not a limitation of, other rights Owner may have under contract documents.
2. Failures include, but are not limited to, the following:

a. Reduction in impact attenuation as measured by reduction of critical fall height.
b. Deterioration of surfacing and other materials beyond normal weathering through deterioration and excess fading/UV degradation.
c. Vandalism will not be covered.

3. When defective material or workmanship is discovered which require repair or replacement, all such repair work shall be done by the contractor at their own expense after written notification is given of such required repairs. If the contractor fails to comply with the requirement of the above guarantee within a reasonable time after notification is given, the repairs will be made by others at the contractor's expense.

a. Any unsafe conditions that arise shall be secured and maintained by the installer until all required repairs or replacements have been completed to a safe and satisfactory condition.
b. All resurfacing will conform in kind and quality to the specifications set forth in the plans and specifications and will be free of defects in workmanship and material.

4. Warranty Period

a. Poured-in-Place Surfacing: 5 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain protective surfacing materials from single source from single manufacturer.

2.2 POURED-IN-PLACE SURFACING PERFORMANCE REQUIREMENTS

A. Impact Attenuation: Critical fall height tested according to ASTM F1292.

B. Gmax: Less than 100

C. Head Injury Criteria: Less than 500

D. Flammability (ASTM D2859): Pass

E. Tensile Strength (ASTM D412): 89.4 psi

F. Tear Resistance (ASTM D624): machine 5.26 lbs, cross machine 6.22lbs

G. Water Permeability (ASTM F1551): 2245.5 inches/hour.

2.3 POURED-IN-PLACE SURFACING

A. Description: Manufacturer's standard, site-mixed and applied, two-layer material with wearing layer over cushioning layer, with combined, overall thickness as required, tested for impact attenuation according to ASTM F1292 and for accessibility according to ASTM F1951.

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. Basis of Design: Rubberecycle, LLC
b. Surface America, Inc.
c. Landscape Structures Inc.

2. Wear Course: Granulated EPDM rubber granules mixed with 100% solids MDI polyurethane binder.
3. Base Course: compacted SBR shredded rubber
4. Binder: Weather-resistant, UV-stabilized, flexible, nonhardening, 100 percent solids polyurethane.
5. Critical Height: Match the critical height of any new and equipment to remain per that manufacturer’s recommendations.
6. Overall Thickness: Not less than as required for critical height indicated.
7. Top Layer Color(s): Provide owners representative manufacturers full range of colors for selection.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer and Owner’s Representative present, for compliance with requirements for subgrade elevations, slope, and drainage and for other conditions affecting performance of the Work.

1. Verify that substrates are sound and without high spots, ridges, holes, and depressions.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Install and prepare concrete footings, concrete edging, subbase and underdrains.

B. Prepare substrates to receive surfacing products according to protective surfacing manufacturer's written instructions.

3.3 INSTALLATION OF SEAMLESS SURFACING

A. Do not proceed with installation until all applicable site work, including substrate preparation, playground equipment installation and other relevant work has been completed.

B. Install poured-in-place playground safety surfacing in accordance with manufacturer’s instructions at locations indicated on the Drawings.

C. Ensure prepared substrate is dry and clean.

D. Install edges in accordance with manufacturer’s edge detail instructions and as indicated on the Drawings.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests.

B. Perform the following tests with the assistance of a factory-authorized service representative:

1. Perform "Installed Surface Performance Test" according to ASTM F1292 for each protective surfacing type and thickness in each playground area.
2. Perform installed-surface-performance tests at no less than one series of tests for each 1000 sq. ft**.** of each type and thickness of in-place protective surfacing or part thereof.

C. Playground protective surfacing will be considered defective if it does not pass tests. Correct deficiencies and provide written certification of compliance and/or passing the test.

D. Provide written report of findings to Owner and Architect.

3.5 PROTECTION

A. Prevent traffic over surfacing for not less than 48 hours after installation or until cured per the manufacturer’s instructions, whichever is longer.

END OF SECTION 321816

SECTION 323113 - CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Excavation for fence post bases
B. Concrete anchorage for posts
C. Installation of chain link fences
D. Installation of chain link gates
E. Installation of cantilevered slide gate

1.02 RELATED SECTIONS

A. Section 321216 – Asphalt Paving
B. Section 321313 – Concrete Paving

1.03 REFERENCES

A. Comply with ASTM A 53 for requirements of Schedule 40 piping.
B. ASTM F1184 – Standard Specification for Industrial and Commercial Horizontal Slide Gates, Type II, Class 2.
C. American Welding Society AWS D1.2 Structural Welding Code.

1.04 DEFINITIONS

A. Height of Fence: Distance measured from the top of the concrete footing to the top of the fabric.

1.05 SUBMITTALS

A. Comply with the requirements of Section 013300 – Submittal Procedures and as modified below.

B. Product Data: Submit manufacturer’s name, specifications and installation instructions for each item specified.

C. 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 the specifications.

D. Cantilevered Slid Gate Delegated Design: Drawings and details provided on contract drawings are for informational purposes only and represent design and fabrication requirements. The contractor shall provide erection drawings to be stamped by a qualified professional Engineer licensed to practice in the State of New York. The erection drawings are to contain a clause stating that the professional Engineer who stamped the erection drawings is responsible for all designed assemblies and components including but not limited to the post and

footing design for all components, gate mounting (hanger assembly), fasteners and connections required for this project.

E. Cantilevered Slide Gate Certification of Performance Criteria:
   1. Manufacturer of gate system shall provide certification stating the gate system includes the following material components that provide superior performance and longevity. Alternate designs built to minimum standards that do not include these additional structural features shall not be accepted.
      a. Gate track system shall be keyed to interlock into gate frame member (providing 200% additional strength when compared to weld only keyless systems). When interlocked with and welded to the “keyed” frame top member, gate track forms a composite structure.
      b. Gate shall have a minimum counterbalance length of 50% opening width which provides a 36% increase in lateral resistance (when compared to ASTM minimum of 40% counterbalance).
      c. Entire gate frame (including counterbalance section) shall include 2 adjustable stainless or galvanized steel cables (minimum 1/4”) per bay to allow complete gate frame adjustment (maintaining strongest structural square and level orientation).
      d. Gate truck assemblies shall be tested for continuous duty and shall have precision ground and hardened components. Bearings shall be pre-lubricated and contain shock resistant outer races and captured seals.
      e. Gate truck assemblies shall be supported by a minimum 5/8” plated steel bolt with self aligning capability, rated to support a 2,000 # reaction load.
      f. Hanger brackets shall be hot dipped galvanized steel with a minimum 3/8” thickness that is also gusseted for additional strength.
      g. Gate top track and supporting hangar bracket assemblies shall be certified by a licensed professional engineer to withstand a 2,000 lb. vertical reaction load without exceeding allowable stresses.

F. Quality Control Submittals

   1. Qualifications Certification: Submit written certification or similar documentation signed by the applicable subcontractor, prime contractor and/or manufacturer (where applicable) indicating compliance with the “Qualifications” requirements specified below in the “Quality Assurance” section of this specification.
   2. Experience Listing: Submit a list of completed projects using the products proposed for this project, including owner’s contact information and telephone number for each project, demonstrating compliance with applicable “Qualifications” requirements specified in the “Quality Assurance” section of this specification.

G. Closeout Procedures: Comply with the requirements of Section 017700.

1.06 QUALITY ASSURANCE

A. Comply with the standards of the Chain Link Fence manufacturer's Institute, including (unless otherwise indicated):

1. Specification for Metallic Coated Steel Chain Link Fence Fabric
2. Industrial Steel Specification for Fence Rails, Posts, Gates and Accessories
3. ASTM F-567 - Standard Practice for Installation of Chain Link Fence for installation unless otherwise indicated on the Contract Documents.

B. Qualifications

1. Provide metal fences and gates as a complete unit produced by a single manufacturer, including necessary erection accessories, fitting and fasteners. Products shall be provided by a company specializing in commercial quality chain link fencing with at least five years experience.

C. Regulatory Requirements

1. Obtain written permission from applicable agencies prior to the start of construction. Submit one copy of the permit as specified in "Submittals-Quality Control Submittals" above.

1.07 PROJECT CONDITIONS

A. Field Measurements: Establish and maintain required lines and elevations for grade control.

1.08 WARRANTY

A. Cantilever gate system shall be warranted by the manufacturer against manufacturing defects for a period of (1) one year from the date of substantial completion. The truck assembly shall be warranted against manufacturing defects by the manufacturer for a period of (5) five years from the date of substantial completion.

1.09 SEQUENCING AND SCHEDULING

A. Proceed with and complete chain link fence and gate installation as rapidly as portions of the site become available, working within seasonal limitations for the work required.

PART 2 PRODUCTS

2.01 MATERIALS

A. Framework Standards

1. Steel Pipe: Cold rolled steel pipe meeting the requirements of ASTM A-569 with a minimum yield strength of 50,000 psi.

2. Interior Coating: In line applied zinc rich coating with zinc powder loading of a minimum 90% by weight applied after fabrication conforming to ASTM B 6 high grade and Special High Grade Zinc.
3. Exterior Coatings

    a. Base Coat: Minimum .9 ounces zinc per square foot.
    b. Intermediate Coat: Minimum 15 microgram chromate conversion per square inch.
    c. Top Coat: Minimum 0.3 mil cross link polyurethane acrylic exterior coating.
    d. PVC exterior coating: Fusion bonded polyvinyl chloride similar to Brighton Colorbond Fence System by Merchant Metals, Brighton, Michigan. Color to be black unless specifically noted otherwise on the Contract Documents.

4. Size of Pipe: As indicated.
5. Similar to SS-40 Pipe with Flo-Coat by Allied Tube and Conduit Corporation, Harvey, Illinois.

B. Framework and Footings for Fences 7’-0” To 9’-0” High

1. End Posts, Corner Posts and Pull Posts.

    a. Pipe: 3.00” O.D.
    b. Set pull posts at the midway point of all lines 500 feet or longer and at all changes of direction or grade of 15 degrees or more. Place pull posts at each radius point within the curved line where the internal angle is 30 degrees or more.
    c. Footing Size: 15” O.D. by 4’-0” deep.

2. Line Posts

    a. Pipe: 2.50” O.D.
    b. Space line posts at a maximum of 10 feet on center unless specifically noted otherwise on the contract documents.
    c. Footing Size: 12” O.D. by 4’-0” deep.

C. Post Brace: Provide manufacturer’s standard adjustable brace at gate posts and at both sides of corner and pull posts, with a horizontal brace located at the mid-height of the fabric. Unless otherwise specified, provide PVC coating to match color of adjacent fence components.

D. Top Intermediate and Bottom Rails

1. 1.66” O.D. pipe, weighing 1.84 pounds per linear foot. Install rails in the manufacturer’s longest lengths utilizing expansion couplings, approximately 6” long at each joint. Provide means for attaching the top rail securely to each gate post, corner post, pull post and end post.

    a. Provide intermediate rail for all fences over 6’-0” in height.

b. Provide bottom rail for ALL fences.
c. Unless otherwise specified, provide PVC coating to match color of adjacent fence components.

E. Swing Gate Posts

1. Single leaf of gate up to 6’ wide and less than 10’ in height: 2.875” O.D. pipe, 5.79 pounds per linear foot.
2. Single leaf of gate 6’ to 12’ wide or over 10’ in height: 4.00” O.D. pipe, 9.11 pounds per linear foot.

F. Swing Gate Framework

1. 1.90” O.D. pipe, 2.72 pounds per linear foot.
2. Assemble gate frames by welding. Install mid-height horizontal rails on gates over 10’-0” in height. When the width of a gate leaf exceeds 10’-0”, 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.

G. Swing Gate Hardware

1. Hinges: Non-lift type, offset to permit 180 degree swing and of a suitable size and weight to support the gate. Provide three (3) hinges for each leaf.
2. 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. A padlock eye shall be an integral part of the latch construction.
3. Holdbacks for Vehicular Gates: Type which automatically engages the gate leaf and holds the gate in the open position until manually released.
4. Unless otherwise specified, provide PVC coating to match color of adjacent fence components.

H. Chain Link Fabric

1. PVC Coated Fabric: Unless otherwise specified, provide 2” mesh, 6 gauge steel wires, with one piece fabric widths for fencing up to 12 feet high. The PVC coating is to be fused and adhered to galvanized wire in accordance with Federal Specification RR-F-191 H/ID, ASTM F-668 Class 2B, and ASTM F934. Coating thickness to be 7 mils (over 6 gauge wire).

   a. Manufacturer: Brighton Colorbond Fence System by Merchant Metals, Brighton, Michigan or similar.
   b. Color to be black unless specifically noted otherwise on the Contract Documents.

2. Selvages: Top and bottom selvages to be knuckled unless specifically noted otherwise on the Contract Documents. Unless otherwise specified, provide PVC coating to match color of adjacent fence components.

I. Post Caps:
   1. Weather tight closure cap, one cap per post.
   2. Furnish caps with openings to permit passage of rail.
   3. Fasteners: Tamper resistant cadmium plated steel screws.
   4. PVC Coated: Complying with the requirements of Brighton Colorbond Fence System by Merchant Metals, Brighton, Michigan.

J. Stretcher Bars: One piece equal to the full length of the fabric, minimum cross section 3/16" by ¾". Unless otherwise specified, provide PVC coating to match color of adjacent fence components.

K. Metal Bands (for securing stretcher bars): Steel, wrought iron or malleable iron. Unless otherwise specified, provide PVC coating to match color of adjacent fence components.

L. Hardware: Self locking bands, tie wires and similar accessories. All hardware ends to pipe rails and other fence components must be of solid construction that prevents access to wasps and similar insects.

   1. Aluminum Coated Hardware: Aluminum coating to be minimum of 0.40 ounces per square foot in accordance with ASTM F 626-96.
   2. PVC Coated Hardware: Complying with the requirements of Brighton Colorbond Fence System by Merchant Metals, Brighton, Michigan to match color of adjacent fence components.

M. Tension Wire: Is not permitted for any fencing.

N. Wire Ties: PVC finish steel wire complying with ASTM A809, 0.40 ounces per square foot.

   1. For tying fabric to line posts, rails, and braces: 9 gauge steel wire installed at 12" O.C.

O. Truss Rods: 3/8" diameter. Unless otherwise specified, provide PVC coating to match color of adjacent fence components.

P. Bolts and Nuts: ASTM A 307, Grade A. Unless otherwise specified, provide PVC coating to match color of adjacent fence components.

Q. Concrete: Portland cement concrete having a minimum compressive strength of 3000 psi at 28 days.

R. Cold Galvanizing Compound: Single component compound giving 93% pure zinc in a dried film and meeting the requirements of DOD-P-21035A (NAVY)

S. Shrink Resistant Grout: Factory packaged, non-catalyzed, ferrous aggregate mortar grouting compound for installation of posts in bedrock areas. Manufacturer's with products complying with the specifications include:

   1. Embeco 636 by Master Builders, Cleveland, Ohio (Tel.# 1-800-227-3350).

2. Ferrolith G-NC by Sonneborn/Chemrex, Inc., Maspeth, NY (Tel# 1-800-433-9517).

T. Privacy Slats
1. Fiber-Glass-Reinforced Plastic Slats: UV-light-stabilized fiber-glass-reinforced plastic, not less than 0.06 inch thick, sized to fit mesh specified for direction indicated.
2. Color: Black

2.02 Cantilever Slide Gate

A. The cantilever sliding gate system shall be Fortress Heavy Duty Cantilever Slide Gate manufactured by Tymetal Corp., 678 Wilbur Avenue, Greenwich, NY 12834 - (800) 328 – 4283 or (888) 978-4283, which is the basis of design and establishes the required quality of performance for the gate systems specified herein, or approved equivalent. Other manufacturers could include:

1. Ameristar, 60 Maple St., Mansfield, Mass. 02048 – (888) 333-3422
2. Gate Depot, 17526 Highway 12, Sonoma, CA 95476 – Toll Free: (888) 818-4283

B. Gate Frame:
1. The gate frame shall be fabricated from 6005A-T61 or 6005A-T5 aluminum alloy extrusions. The top member shall be a 3" x 5" aluminum structural channel/tube extrusion weighing not less than 3.0 lb/lf. To maintain structural integrity this frame member shall be "keyed" to interlock with the “keyed” track member. If fabricated as a single horizontal piece, the bottom member shall be a 2" x 5" aluminum structural tube weighing not less than 2.0 lb/lf. If fabricated in two horizontal pieces, the bottom member shall be a 5" aluminum structural channel weighing not less than 2.3 lb/lf. When the gate frame is manufactured in two horizontal pieces or sections, they shall be spliced in the field (the gate frame shall be fabricated in one or multiple sections depending on size requirements or project constraints).

C. Vertical Members (Chain Link):
1. The vertical members at the ends of the gate frame shall be “P” shaped in cross section with a nominal base dimension of no less than 2” x 2” and weighing not less than 1.6 lb/lf. Major 2” x 2” vertical members weighing not less than 1.1 lb/lf shall separate each bay and shall be spaced at less than gate height intervals.
2. Intermediate 1” x 2” vertical members weighing not less than .82 lb/lf shall alternate between 2” x 2” major members.

D. Gate Track:
1. The gate frame shall have a separate semi-enclosed “keyed” track, extruded from 6005A-T61 or 6005A-T5 aluminum alloy, weighing not less than 2.9 lb/lf. The track member is to be located on only one side of the top primary. Welds to be placed alternately along the top and side of the track at 9" centers with welds being a minimum of 2".

E. All welds on the gate frame shall conform to Welding Procedure Specification and Procedure Qualification Record to ensure conformance to the AWS D1.2 Structural Welding Code. All individual welders shall be certified to AWS D1.2 welding code.

F. Gate Mounting:
   1. The gate frame is to be supported from the track by two (2) swivel type, self-aligning, 4-wheeled, sealed lubricant, ball-bearing truck assemblies.
   2. The bottom of each support post shall have a bracket equipped with a pair of 3” UHMW guide wheels Wheel cover protectors shall be included with bottom guides to comply with UL325.
   3. Gap protectors shall be provided and installed, compliant with ASTM F 2200-05.

G. Diagonal Bracing:
   1. Diagonal "X" bracing of 1/4” diameter galvanized steel cable shall be installed throughout the entire gate frame.

H. The gate shall be completed by installation of approved filler as specified.
   1. Chain Link: 2” x 2” x 9 gauge aluminized steel chain link fabric shall extend the entire length of the gate (if operated gate, counterbalance must also have fabric to prevent reach through and comply with ASTM F2200) Fabric shall be attached at each end of the gate frame by standard fence industry tension bars and tied at each 2” x 2” vertical member with standard fence industry ties. ASTM F2200 requires attachment method that leaves no leading or bottom edge protrusions (cannot exceed 0.5 inch).

I. Posts**:**
   1. A single set of support posts shall be minimum 4" O.D. round SS40 or 4” x 4” x 3/16” wall square steel tubing, grade 500. Gate posts shall be galvanized or coated and supported in concrete footings as specified by the design team.

J. Finish:
   1. Gate to be mill finish aluminum or color coated with polyester powder as specified. If powder coated, the gate (including track member) and all accessories shall be pretreated chemically by sand blasting or other acceptable method to ensure proper coating adherence.

K. Gate Operation:
   1. Gate shall be manually operated.
   2. Force to open and close the gate shall not exceed 25 lbs.

PART 3 EXECUTION

3.01 EXAMINATION

A. Installer Verification of Conditions: Examine conditions under which chain link fences and gates are to be constructed with the materials and components specified in this section. Affected Prime Contractors, the Owner’s Representative and the Project Designer shall be notified in writing of any conditions detrimental to the proper and timely installation of the work.

   1. When the installer confirms conditions as being acceptable to ensure proper and timely installation of the work and to ensure requirements of applicable warranties or guarantees can be satisfied, submit written confirmation to the Project Designer. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to the installer.

3.02 PREPARATION

A. Clear and grub plant material along the fence line as required to eliminate growth interfering with the fence alignment. Remove all debris from the project property.

B. Do not begin installation of the fence until finish grading in area has been completed.

3.03 INSTALLATION

A. Space posts equidistant in the fence line at a maximum of 10 feet on center unless specifically noted otherwise on the Contract Documents.

B. Setting Post in Earth: Drill holes for fence footings. Set posts in the center of the hole and fill the hole with concrete. Plumb and align posts, vibrate or tamp concrete for consolidation. Finish concrete in a dome shape above the finish grade elevation to shed water. Do not attach fabric to posts until the concrete has cured a minimum of seven days.

C. Setting Posts in Rock: Drill holes into solid rock one inch wider than the post diameter, 18” deep for end, pull, corner and gate posts and 12” deep for line posts. Set posts into holes and fill annular space with shrink resistant grout.

D. Located 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 line posts.

E. Install top rail continuously through post tops or extension arms, bending to radius for curved runs. Install expansion couplings as recommended by the fencing manufacturer.

F. Install bottom and intermediate rails in one piece between posts and flush with the post on the fabric side using special offset fittings where necessary.

G. Brace corner posts, pull posts, end posts and gate posts to adjacent line posts with horizontal rails.

H. Diagonally brace corner posts, pull posts, end posts and gate posts to adjacent line posts with truss rods and turnbuckles.

I. Attach the fabric to the active playfield or security side of the fence. Maintain a 1 inch clearance above the finished grade except where indicated otherwise. Thread stretcher bars through the fabric using one bar for each gate and end post and two for each corner and pull post. Pull fabric tight so that the maximum deflection of the 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 at 15” O.C. Fasten fabric to steel framework with wire ties spaced 12” O.C. for line posts and 24” O.C. for rails and braces. Bend back wire

ends to prevent injury. Tighten stretcher bar bands, wire ties and other fasteners securely.

1. When the fabric height exceeds 12', overlap horizontal splices 6"at the intermediate rail and secure with wire ties spaced at 12" O.C.

J. Privacy Slats: Install slats vertically unless otherwise shown, securely locked in place.

K. Position bolts for securing metal bands and hardware so nuts are located opposite the fabric side of the fence. Tighten nuts and cut off excess threads so no more than 1/8" is exposed. Peen ends to prevent loosening or removal of nuts. 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 the fence manufacturer. Adjust hardware for smooth operation and lubricate where necessary.

M. Wire brush and repair welded and abraded areas with one coat of cold galvanizing compound.

N. Restore disturbed ground areas to their original condition. Topsoil and seed to match adjacent areas.

3.04 CANTILEVER SLIDE GATE INSTALLATION

A. Slide gate shall be installed in strict accordance with the company's printed instructions unless otherwise shown on the contract drawings.
B. The gate and installation shall conform to ASTM F 1184 standards for aluminum cantilever slide gates, Type II, Class 2. See 1.02 C.
C. The complete system shall be adjusted to ensure it is performing properly.
D. The system shall be operated for a sufficient period of time to determine that the system is in proper working order.

3.05 ADJUSTING AND CLEANING

A. Repairs and Protection of chain link fences and gates.

1. Repair or replace broken or defective chain link fences and gates as directed by the Project Designer.
2. Protect chain link fences and gates from damage until acceptance of the fencing construction.

END OF SECTION 323113

SECTION 323223 – SEGMENTAL RETAINING WALLS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Installation of concrete modular block retaining wall units mechanically stabilized with geogrid reinforcement and connected with fiberglass shear/alignment pins.
B. Leveling pad
C. Excavation and backfill
D. Drainage piping

1.2 RELATED SECTIONS

A. Section 312000 – Site Earthwork
B. Section 334000 – Storm Drainage System

1.3 REFERENCES

A. AASHTO M288 – Standard Specification for Geotextiles
B. ASTM C 1372 – Standard Specification for Segmental Retaining Wall Units
C. ASTM D 698 – Standard Method of Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3) 600 kN-m/m3)
D. ASTM D 3034 – Standard Specification for Sewer Pipe and Fittings; 2004
E. ASTM D 5262 – Standard Test Method for Evaluating the Unconfined Tension Creep Behavior of Geosynthetics
F. ASTM F 405 – Standard Specification for Corrugated Polyethylene Pipe and Fittings
G. ASTM C 140 – Sampling and Testing Concrete Masonry Units
H. ASTM C 145 – Solid Load Bearing Concrete Masonry Units
I. GRI-GG4 – Determination of Long Term Design Strengths of Geogrids; Geosynthetic Research Institute
J. GRI-GG5 – Determination of Geogrid (Soil) Pullout; Geosynthetic Research Institute
K. NCMA SRWU-1 – Test Method for Determining Connection Strength of SRW; National Concrete Masonry Association
L. NCMA – Design Guidelines for Segmental Retaining Walls; National Concrete Masonry Association

1.4 SUBMITTALS

A. Comply with the requirements of Section 013300 – Submittal Procedures and as modified below.
B. Product Data: Submit manufacturer’s name, specifications and installation instructions for each item specified.
C. Samples
    1. Submit a sample of the block color chosen for the project.
    2. Submit a sample of geogrid reinforcement.
D. Shop Drawings: Submit dimensioned plans, sections and design calculations prepared and stamped by a professional engineer registered in the state of the project location.
E. Manufacturer’s Certificates

1. Submit test reports to certify products meet or exceed the specified requirements.
2. Certify the maximum design tensile load of the geogrid meet or exceed the specified requirements.

F. Quality Control Submittals
1. Qualifications Certification: Submit written certification or similar documentation signed by the applicable subcontractor, prime contractor and/or manufacturer (where applicable) indicating compliance with the "Qualifications" requirements specified below in the "Quality Assurance" section of this specification.
2. Experience Listing: Submit a list of completed projects using the products proposed for this project, including owner's contact information and telephone number for each project, demonstrating compliance with applicable "Qualifications" requirements specified in the "Quality Assurance" section of this specification.

G. Contract Closeout Submittals: Comply with the requirements of Section 017700.

1.5 QUALITY ASSURANCE

A. Design Requirements: Generalized retaining wall details and approximate geosynthetic reinforcement size and capacity are shown on the Contract Documents to indicate suggested construction. The Prime Contractor supplying the segmental retaining wall system shall retain the services of a licensed professional engineer to design and detail the retaining wall system shown on the Contract Documents to meet the following criteria:
1. Loading: Design the segmental retaining wall and associated components to adequately support all applied dead loads, lateral earth pressures, surcharge pressures, seismic loads and all combinations thereof as required by the applicable codes.
2. Contractor Proposed Alternate Designs: Alternate designs shall be subject to approval by the Architect. Bids for modular retaining wall work are to be based on the details shown in the Contract Documents and not an alternate design with similar components. Design and construct alternate systems to meet the performance criteria as described above.

B. Installers Qualifications: A firm that can provide a list of five previously constructed successful projects of similar size and magnitude using the retaining wall system specified.

1.6 PROJECT CONDITIONS

A. Contractor to field confirm bottom of wall elevations (existing grade) prior to completing the delegated design and providing a submittal.

B. Field Measurements: Establish and maintain required lines and elevations for grade control.

C. Protection of Persons and Property
1. Fence off work areas at the perimeter of the segmental retaining wall installation and take measures necessary to protect the safety of construction personnel and property users.
2. Take precautions and provide necessary bracing and shoring to guard against the movement or settlement of slopes during wall construction.

1.7 SEQUENCING AND SCHEDULING

A. Proceed with and complete segmental retaining wall construction as rapidly as portions of the site become available, working within seasonal limitations for the work required.

PART 2 PRODUCTS

2.1 MATERIALS

A. Concrete Wall Modules: Split face, interlocking concrete modules designed to resemble layers of natural slate, natural gray color and shall have an integral sheer key connection offset to permit a minimum wall batter of 1H:8V.
   1. Standard Unit: 16” long X 12” deep X 6” high unit
   2. Corner Unit: 9” long X 12” deep X 6” high unit
   3. Coping Unit: Per manufacturer
   4. Closed End Coping Unit: Per manufacturer
   5. Compressive Strength: Minimum 5000 PSI at 28 days per ASTM C 90.
   6. Moisture Absorption Rate: 5% maximum.
   7. For convenience, details and specifications have been based on Versa-Lok Standard Units.

B. Construction Adhesive: Elastro resin based compounds manufactured for use as a concrete retaining wall adhesive similar to “RG Concrete Adhesive” by Techni-Seal, Inc., Boucherville, Quebec, Canada (Telephone #1-800-561-7325).

C. Base Leveling Pad Material: Compacted Base Course Type 2 Crushed Stone as specified in Section 312000 – Site Earthwork as indicated on the Contract Documents.

D. Unit Drainage Fill: Clean, well graded, one inch and under crushed stone or gravel meeting the following gradation requirements:
   1. 1” (25mm) sieve: 100% passing
   2. ¾” (19 mm) sieve: 75-100% passing
   3. No. 4 (4.75 mm) sieve: 0-10% passing
   4. No. 50 (300 micro-m) sieve: 0-5% passing

PART 3 EXECUTION

3.1 EXAMINATION

A. Installer Verification of Conditions: Examine conditions under which segmental retaining walls are to be constructed with the materials and components specified in this section. Affected Prime Contractors and the Owner’s Representative shall be notified in writing of any conditions detrimental to the proper and timely installation of the work.
   1. When the Installer confirms conditions as being acceptable, to ensure proper and timely installation of the work and to ensure requirements of applicable warranties or guarantees can be satisfied, submit written confirmation to the Architect. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to the Installer.

3.2 PREPARATION

A. Perform earthwork operations complying with required layout dimensions and subgrade topography. Over excavation will be at the sole cost of the Contractor.

B. Protect trees at top and bottom of new segmental retaining wall installation. Disturb tree roots within the minimum necessary excavation area.
C. Compact subgrade areas of the new segmental retaining wall area per Section 312000 – Earth Moving. If loose or unstable soils are encountered, undercut and remove unsuitable soils and replace with approved select granular material as directed by the Architect.

3.3 INSTALLATION
A. Install new segmental retaining wall system in strict compliance with the manufacturer's written specifications and the approved shop drawings.
B. Excavation
1. Excavate to the lines and grades shown on the construction drawings. Proof roll foundation area to determine if remedial work is required.
2. Take care not to disturb embankment and foundation materials beyond the lines shown.
C. Base Leveling Pad
1. Place a minimum 6" deep leveling pad with required select granular material to the lines and grades shown on the construction drawings. Extend the leveling pad a minimum of 6" beyond the front and back faces of the segmental retaining wall units.
2. Compact the leveling pad material to a minimum of 95% Standard Proctor or Minimum 90% Modified Proctor in accordance with ASTM D 698.
3. Prepare leveling bed to ensure full contact to the base surface of the concrete units.
D. Modular Unit Installation
1. Place the first course of the modular units on the leveling pad and check alignment and level. Use pins or molded surfaces of modular concrete units for alignment control. Do not attempt alignment from the front split surface due to the irregular nature of the finish.
2. Ensure that all units are in full contact with the base units and are properly seated.
3. Place fronts of units side by side and do not leave gaps between the units. Layout corners and curves in accordance with the manufacturer's recommendations.
4. Install sheer connectors, verifying required setback positions as required by the manufacturer.
5. Place and compact drainage fill within and behind the units. Place a minimum of one cubic foot per unit of drainage fill within the cores of the units, between units and behind units.
6. Place and compact backfill soil behind drainage fill.
7. Follow wall and drainage fill installation closely with backfill. Maximum stacked vertical height prior to drainage fill and backfill placement and compaction shall not exceed two courses.
E. Cap Installation: Glue cap units to underlying units with an all-weather adhesive recommended by the manufacturer.
1. Vertical Alignment: +/-1.5" over any 10-foot distance
2. Wall Batter: Within two degrees of design batter
3. Horizontal Alignment: +/-1.5" over any 10-foot distance; corners, bends, curves +/-3" to the alignment location
4. Maximum Horizontal Gap Between Units: ½"

3.4 ADJUSTING AND CLEANING

A. Disposal of Excess and Waste Materials: Remove and legally dispose of all excess material from the Owner's property.

B. Repairs and Protection of Segmental Retaining Walls

1. Repair or replace broken or defective segmental retaining walls as directed by the Architect.
2. Protect segmental retaining walls from damage until acceptance of wall construction.

END OF SECTION 323223

SECTION 323300 – SITE FURNISHINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The New York State Department of Transportation (NYSDOT) Standard Specifications, Construction and Materials, Latest Edition apply to this Section.

1.2 SUMMARY

A. This Section includes furnishing all labor, materials, equipment and services required to complete and make fully functional, the work indicated on the Contract Drawings and as described in the Contract Documents. Work includes, but is not limited to the following:

1. Table Seating
2. Basketball hoop system
3. Tree Grates
4. Wall mounted benches

B. Related Requirements:

1. Section 312000 "Earth Moving" for excavations, subgrade preparation, fill material and backfill.

1.3 SUBMITTALS

A. Product Data: Submit product data in the form of manufacturer’s technical data, specifications, qualification data and installation instructions or Shop Drawings of assembled items for each item specified in this section.

B. Shop Drawings: Show fabrication and installation details customized to the scope of work, of the size, type, and locations indicated in the Contract Drawings.

C. Samples for Verification:

1. Submit samples of all exposed factory-applied finishes required, in specified colors for verification purposes or demonstrating full range available for Owner's selection, as specified.

2. Submit color chart or sample of each item as follows in specified colors for verification purposes or color chart demonstrating full range of colors and finishes available for Owner's selection.

D. Informational Submittals

1. Maintenance Data: for each site amenity, including recommended methods for repairing damage to the finish.

2. Warranty Data: for each site amenity, provide manufacturer’s standard warranty information.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain each site amenity from a single source with resources to provide components of consistent quality in appearance and physical properties.

1.5 PROJECT CONDITIONS

A. Contractor shall note that site furnishings potentially have a long lead time. Submittals and orders should be made at the beginning of the project.

1.6 DELIVERY, STORAGE AND HANDLING

A. Upon delivery inspect each item for any damages. Store site amenities in undamaged, original packages and containers until ready for installation in a location protected from traffic. Handle all items with sufficient care to prevent any scratches or damage to the finish.

PART 2 - PRODUCTS

2.1 BASKETBALL GOALS

A. Basketball Equipment: Single post system 10’ tall complying with the following:
1. Ground Anchor: 6” square by 42” long structural steel tubing with 3/16” wall thickness and hinged ½” X 7¾” X 9½” steel mounting plate on top.
2. Pole: Offset design 6” square structural steel tubing with 3/16” wall thickness and hinged ½” X 7¾” X 9½” steel mounting plate at the bottom. The pole shall include a visual height indicator located on one side to verify rim height. Provide manufacture supplied pole padding.
3. Height Adjustment System: Internal compression height adjustment system contained inside the pole designed to operate in compression rather than tension allowing the unit to infinitely adjust between 5’ and 10’ in height through the use of a removable height adjustment crank handle which extends form the back of the mast approximately 36” from the base.
4. Extension Arms: 1½” X 3” X 11 gauge rectangular steel tubing.

5. Backboard: Regulation, rectangular, 42” X 72” X 3/8” fortified acrylic marked with a regulation border and target area. Support frame shall be 1½” square rectangular steel tubing. Steel rim mounting plate shall be ¼” X 7¼” 10”. The backboard shall extend a minimum of 72” from the pole at any height.
6. Rim: Double ring static rim constructed of high tensile alloy steel protected with baked on powder coat finis and nylon net.
7. Hardware: All fasteners, pivot pins and set collars to be zinc plated with additional ultra coat for corrosion resistance. All pivot points shall include nylon bushings eliminating steel to steel contact.
8. Finish: Minimum one coat of surface primer and minimum two coats of high gloss acrylic enamel paint.
9. Weight: 585 pounds.
10. 3000 lb. concrete mix for footing installation.

B. Manufacturer: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Basis of Design: THOR Platinum by Pro Dunk Hoops, www.produnkhoops.com , (888) 600-8545.
2. Goalrilla CV, www.goalrilla.com , (800) USA.GOAL.
3. Jaypro Sports, www.jaypro.com, (800) 243.0533.

2.2 TABLE SEATING

A. (10) Round coated steel table complying with the following:
1. Size: Five seat model with overall 36” round solid steel tabletop.
2. Seating Height: 18”
3. Table Height: 30”
4. Welding: Structural welding conforming to the requirements of AWS D 1.1, Structural Welding Code – Steel, 1998 edition as published by the American Welding Society.
5. Welding Process: Conform to the recommended practices and guidelines for gas metal arc welding as listed in AWS C5.6, Gas Metal Arc Welding, Recommended Practices as published by the American Welding Society.
6. Finish: All fabricated metal components shall be steel shotblasted, etched, phosphatized, preheated, and electrostatically powder-coated with TGIC polyester powder coatings. Products shall be fully cleaned and pretreated, preheated and coated while hot to fill crevices and build coating film. Coated parts shall then fully cured to coating manufacturer’s specifications.
7. Color: To be chosen by the Owner from the Manufacturer’s full range of available colors.
8. For convenience, details and specifications have been based on “A-365 from the ANTHRO-Sites ™ Collection.” as supplied by Victor Stanley, Dunkirk, Maryland (Tel. #301-855-8300).

B. (1) Round coated steel table complying with the following:
1. Size: Five seat model and side with wheelchair accommodation, with overall 42” round solid steel tabletop.

2. Seating Height: 18”
3. Table Height: 30”
4. Structural welding conforming to the requirements of AWS D 1.1, Structural Welding Code – Steel, 1998 edition as published by the American Welding Society.
5. Welding Process: Conform to the recommended practices and guidelines for gas metal arc welding as listed in AWS C5.6, Gas Metal Arc Welding, Recommended Practices as published by the American Welding Society.
6. Finish: All fabricated metal components shall be steel shotblasted, etched, phosphatized, preheated, and electrostatically powder-coated with TGIC polyester powder coatings. Products shall be fully cleaned and pretreated, preheated and coated while hot to fill crevices and build coating film. Coated parts shall then fully cured to coating manufacturer’s specifications.
7. Color: To be chosen by the Owner from the Manufacturer’s full range of available colors.
8. For convenience, details and specifications have been based on “A-A-424 from the ANTHRO-Sites ™ Collection.” as supplied by Victor Stanley, Dunkirk, Maryland (Tel. #301-855-8300).

2.3 WALL MOUNTED BENCHES

A. General: Provide the following manufacturer’s standard bench:

1. Products: Subject to compliance with requirements, provide the following:

   a. “EP 1991 Without Backrest” bench from Esplanade Collection, as provided by Equiparc, (800) 393-9264. Website www.equiparc.com, or approved equal.

2. Length: See contract drawings, bench segments to be installed in sequence with intermediate supports.

3. Mounting: Top of wall mount.

4. Materials: IPE solid stock, select South American hardwood.

5. Supports: Hot dipped galvanized steel and polyester powder coated

6. Finishes:

   a. IPE: unfinished, apply clear preservative oil

   b. Supports: Polyester powder coated, Color: Silver

7. Accessories: Stainless steel kwik bolts, Or drop-in anchors with stainless steel theft-proof bolts.

2.4 TREE GRATES

A. Manufacturer: Tree grates and frames shall be as supplied by IRONSMITH, Inc, 41-701 Corporate Way, Unit 3, Palm Desert, CA 92260 (800) 338-4766, or approved equivalent.

B. Tree grates shall be: OLYMPIAN, 60 inch square Model 6006 with expandable tree opening from 16-inch up to 36-inch or approved equivalent.

C. Tree grates material shall be cast gray iron from 100% recycled material. All tree grate castings shall be manufactured true to pattern and component parts, and shall fit together in a satisfactory manner. The castings shall be of uniform pattern and quality, free from blowholes, hard spots, shrinkage, distortion or other defects. Castings shall be cleaned by shot blasting.

D. Finish: Grates are to be powder coat texture black.

E. Matching steel angle Tree Grate Frame provided by Urban Accessories, Inc 465 E. Fifteenth St, Tacoma, WA 98421, (877) 487-0488, Type “P” or approved equivalent shall be provided with installation detail(s) per plans and manufacturer’s recommendations.

PART 3 - EXECUTION

3.1 PREPARATION

A. Prior to installation of any of the work of this section, the Contractor shall inspect the planned installation locations to ensure that conditions are not significantly different from those indicated on the Contract Drawings. All materials shall be inspected prior to installation to insure there is no damage.

B. Coordination:

1. Do not begin installation before final grading is completed, unless otherwise permitted. Coordinate installation of concrete base pads, footings and foundations, paving, and other site work with installation of site amenities and furnishings to ensure proper placement and completion of all work.

2. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions and directions for installation of anchorages, including concrete inserts, sleeves, anchor bolts and miscellaneous items having integral anchors that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to project site.

C. Stake alignment and locations for all site furnishings for review and approval by the Owners Designated Representative. Verify that all elements fit within the location provided and notify the Owners Designated Representative of any conditions not allowing installation.

3.2 INSTALLATION, GENERAL

A. Installation, General: Comply with manufacturer installation directions. Complete assembly to the extent not completed in the factory, using fasteners supplied by manufacturer, as per manufacturer's directions, and as detailed.

B. Provide forms where required for footings. Secure and brace forms, sleeves, reinforcing, or anchor bolts in position to prevent displacement during concrete pour. Place concrete immediately after mixing. Compact concrete in place by using vibrators. Moist-cure exposed concrete for not less than seven days or use non-staining curing compound.

C. Trowel exposed concrete surfaces to a smooth, dense finish, free of trowel marks, and uniform in texture and appearance. Provide positive slope for water runoff to perimeter of contract base.

D. Field Welding: Comply with AWS Code for procedures of manual shielded metal-arc welding, appearance and quality of welds made, methods used in correcting welding work and with the requirements for welds in Section 05500.

3.3 INSTALLATION BASKETBALL GOAL

A. All outdoor athletic equipment to be installed as per manufacturer’s specifications and as shown on the drawings in accordance with referenced standards pertaining to NFHS competition.

B. Install concrete foundation at the location and dimensions indicated and in accordance with Section 32 13 13, Portland Cement Concrete.

C. Install rebar as indicated per the delegated design stamped drawings.

D. Inspection: verify that concrete foundation work is correctly sized and positioned. Repair any defective foundation work as directed by the Owners Representative.

E. Install anchoring assembly in concrete foundation.

F. Backfill and compact excavation around foundation with granular subbase in accordance with Section 310000, Earthwork - site.

3.4 WALL MOUNTED BENCH INSTALLATION

A. Examine areas to receive benches. Verify that substrates are adequately prepared and stable securely anchor items covered under this section.

B. Protect benches from damage to finish during the project per the manufacturer’s recommendations. Do not place or slide parted on hard textured surfaces.

C. Install benches level and in accordance with manufacturer’s instructions at locations indicated on the contract drawings.

D. Finish Damage: Repair minor damages to finish in accordance with manufacturer’s instructions and as approved by the Director’s Representative.

E. Component Damage: Remove and replace damaged components that cannot be successfully repaired as determined by the Director's Representative.

F. Clean benches promptly after installation in accordance with manufacturer's instructions.

G. Do not use harsh cleaning materials or methods that could damage finish.

H. Protect installed benches to ensure that, except for normal weather, benches will be without damage to deterioration at time of Substantial Completion.

3.5 TREE GRATE INSTALLATION

A. Tree Grates: Install in locations noted on plans and according to manufacturer's written instructions. Set grate segments flush with adjoining surfaces. Shim from supporting substrate of Tree Grate Frame as needed for flush surface condition.

B. Install Tree Grate Frame flush and leveled with surrounding paving surface.
   1. Maintain flush and level condition at all times. Frames MUST NOT slope in more than one direction.
   2. Use spreaders or stakes to keep frame from being distorted by pressure during paving placement.
   3. Install frames per details on plans and manufacturer's recommendations.

C. Clean concrete and debris from frame prior to tree grate installation.

D. If needed, grind pads on underside of tree grates to be level and prevent rocking in frame.

E. DO NOT ALLOW water from new concrete to run off or wash onto tree grates to prevent damage from concrete exudates, lime, and efflorescence.

F. Touch up, repair or replace damaged products.

3.6 CLEAN-UP

A. General: Clean up excess material, packaging, etc. after the installation of site amenities and leave work area in a clean and safe condition.

B. All items shall be carefully cleaned, with dirt, stains or other defacements removed. All mortar spills and stains shall be removed. Any scratches in surfaces shall be repaired. Acceptability of repairs is at the discretion of the Owners Designated Representative.

3.7 PROTECTION AND MAINTENANCE

A. General: Protect finished and integrity of equipment until project closeout. Repair any damage that may occur so as to leave the amenity ready to use at project completion. Adequate protection is the responsibility of the Contractor until final acceptance of the project by the Owner.

B. Use touch up paint on any gouges or scratches in finishes. Owners Designated Representative shall be the sole judge of acceptability of touch ups in the field.

END OF SECTION 323300

SECTION 32 92 00 - TURF

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and General provisions of the Contract, including General and Supplementary Conditions apply to work of this Section.

B. Examine the Contract Documents for requirements that affect the work of this section. Other specification sections that directly relate to work of this section include, but are not limited to:

1. Section 312000 – Earthwork-Site
2. Section 329312 – Planting Soils

1.2 SUMMARY

A. Extent of landscape work includes, but is not limited to the following:

1. Landscape Grading.
2. Lawn establishment via seeding.
3. Lawn establishment via sodding.
4. Hydroseeding Slope Stabilization (permanent)

B. Subgrade Elevations: Excavation, filling and rough grading required to complete the Work will be included in this contract.

1.3 QUALITY ASSURANCE

A. All Landscape work including but not limited to seed and sod installations shall be performed by a single firm with at least 5 years of successful installation experience specializing in landscape work.

B. Adherence to applicable standards of the National Pollution Discharge Elimination System (NPDES) and fertilizer and pesticide use.

1.4 SUBMITTALS

A. Submit seed vendor's certified statement, for each grass seed mixture required, stating botanical and common name, percentage by weight, and percentages of purity, germination, and weed seed for each grass seed species.

B. Submit sod vendor's certified statement, for each grass mixture required, stating botanical and common name, percentage by weight.

C. Planting Schedule: Submit proposed planting schedule, indicating dates for each type of landscape work during normal seasons for such work in area of site. Correlate with specified

maintenance periods to provide maintenance from date of substantial completion. Once accepted, revise dates only as approved in writing, after documentation of reason for a request for delay.

1.5 JOB AND FIELD CONDITIONS

A. The Contractor is responsible for examining the existing site of the Work prior to the submission of bids in order to familiarize himself/herself with the character and condition of the site.

B. Proceed with and complete landscape work as rapidly as portions of site become available, working within seasonal limitations for each kind of landscape work required, as specified in Part 3.

C. The Contractor shall at all times take reasonable and adequate precautions to protect the existing improvements during the course of the project. The Contractor at the Contractor's expense shall correct any damage incurred.

D. All seeding and sodding shall be done when weather and soil conditions are suitable immediately after fine grading of topsoil is complete. Under extraordinary conditions, seeding may be done out of the above conditions at Owner's risk. However, only with Owner's written permission. Otherwise, Contractor is responsible.

D. When conditions are such, by reason of drought, high winds, excessive moisture, frozen ground, or other unsuitable factors, that satisfactory results are not likely to be obtained, work shall be halted. It shall not be resumed until desired results can be obtained or alternate or corrective measures and procedures can be used.

1.6 SPECIAL PROJECT WARRANTY

A. Warranty general lawn areas for 60 days after the date of substantial completion, against defects including death and unsatisfactory growth, except for defects resulting from neglect by Owner, abuse or damage by others, or unusual phenomena or incidents which are beyond the Contractor's control. If the warranty periods is not completed during the initial growing season, it shall be extended into the following season.

1.7 LAWN MAINTENANCE

A. Begin maintenance of lawns immediately after each area is planted and continue until acceptable lawn is established, but for not less than the following periods:

1. General Lawn (seeded) Areas: 60 days after date of Substantial Completion.

2. Sodded Areas: 60 days after date of Substantial Completion.

3. 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 next planting season.

B. Maintain and establish lawns by watering, fertilizing, weeding, mowing, trimming, replanting, and other operations. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth lawn.

C. Watering: Provide and maintain temporary piping, hoses, and lawn-watering equipment to convey water from sources and to keep lawns uniformly moist to a depth of 3 inches.

1. Water lawn at the minimum rate of 1 inch per week between natural rain and supplemental watering.

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 mowing. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet.

E. Post-fertilization: Apply fertilizer to lawn after first mowing and when grass is dry.

1. Use fertilizer that will provide actual nitrogen of at least 1 lb per 1000 sq. ft. of lawn area.

PART 2 - PRODUCTS

2.1 LAWN MATERIALS:

A. Grass materials: Provide fresh, clean, new-crop seed complying with tolerance for purity and germination established by Official Seed Analysts of North America. Provide seed mixture composed of grass species, proportions and minimum percentages of purity, germination, and maximum percentage of weed seed, as specified.

1. "Schedule of Grass Seed Mix" is attached at end of this section.

B. Sod Materials:

1. Sod shall be grown on mineral soil, be high quality, free of weeds, disease and insects, and of good color and density. Sod shall be machine cut at a uniform soil thickness necessary for plant viability during the harvest - transport - installation cycle. Individual pieces of sod shall be cut to the suppliers' standard width and length. Sod grass mix shall consist of the one hundred (100%) percent to be Kentucky Bluegrass, of at least three of the varieties that follow: Rambo, Princeton-105, Wildwood, Allure, Coventry, Champagne, Northstar, Cardiff, Nimbus, Raven, SR2100, Misty, America, Brilliant, Limosine, Conni, Liberator, Apollo, NuGlade, Total Eclipse, Unique, Impact, Midnight, Arcadia, and Serene.
2. Sod shall be machine cut at a uniform soil thickness of one half (1/2") inch to three quarter (3/4") inch, at the time of cutting. Measurement for thickness shall exclude top growth and thatch. Individual pieces of sod shall be cut to the supplier's standard width and length. Maximum allowable deviation from standard widths and lengths shall be five (5%) percent. Broken pads and torn or uneven ends will not be acceptable. Sod shall be at least on (1) year old and no more than (2) years old from time of original seeding.

3. Sod shall be furnished and installed in rolls, where applicable, measuring a minimum of two (2') feet in width, stored in rolls with the grass top side inverted so that the topsoil is to the exterior
4. Sod shall be harvested, delivered and installed within a period of twenty four (24) hours. Soil on sod pads shall be kept moist at all times.

2.2 FERTILIZERS

A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing agency.

B. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing agency.

2.3 EROSION CONTROL BLANKET (TEMPORARY)

A. Erosion Control Fabric: Provide rolled erosion control product, biodegradable erosion control blanket, designed for use on slopes as per NYSDOT Approved Material List for rolled erosion control products and soil stabilizers, Class 1, Type C (short term).

2.4 MISCELLANEOUS LANDSCAPE MATERIALS

A. Hydro-mulch shall be comprised of a 70% wood fiber and 30% (27% if tackifier is added) cellulose fiber blend. Tackifier (3%) shall be added to the slurry for 5:1 slopes and steeper. Slurry shall be free of foreign matter.

1. The material, when mixed into a liquid slurry, shall pass a free liquid quality control test (liquids separate from fibrous solids no greater than one inch in one minute's time as measured on a standard test board)
2. The binder shall not dissolve or disperse upon rewetting.
3. The matrix shall have no holes less than 1mm in size.
4. The matrix shall have no gaps between product and soil.
5. The matrix shall have minimum water holding capacity of 1000g/100g (1.2gal/lb) matrix per ASTM D7367.
6. The matrix shall have no germination or growth inhibiting factors and shall not form a water insensitive crust.
7. The matrix shall be comprised of materials which are 100% biodegradable and 100% beneficial to plant growth.

B. Manufacturer: Basis of Design by Conwed Fibers., www.conwedfibers.com, p1.800.508.8681, product EnviroBlend with and without Tack. or approved equivalent.
1. Terra Mulch, www.terra-mulch.com

C. Mulch: For lawn establishment shall be oat or wheat straw, free from weeds and mildew, foreign matter detrimental to plant life. Hay or chopped cornstalks are not acceptable

PART 3 - EXECUTION

3.1 GENERAL

A. Planting Season: The installation of lawns areas must occur between April 15 and June 15 or August 15 and October 1. Extension of this planting season can be only with the approval of the Owners Designated Representative.

3.2 PREPARATION

A. Perform earthwork operations as required to meet finish grades indicated on contract drawings. Place and compact areas as described in section 3120000 Earthwork Site. After performing earthwork operations, rototiller, chisel plow, or disk subgrade to a depth of 6”.

B. Install topsoil and finish grade as described in section 329313 Planting Soils.

C. Prior to planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

D. Restore lawn areas to specified condition if eroded or otherwise disturbed after fine grading and prior to planting.

3.4 RECONDITIONING EXISTING LAWNS

A. Recondition any existing lawn areas damaged by Contractor's operations including storage of materials and equipment and movement of vehicles. Also recondition existing lawn areas where minor regrading is required.

B. Provide fertilizer, seed and soil amendments as specified for new lawns and as required to provide a satisfactorily reconditioned lawn. Provide new topsoil as required to fill low spots and meet new finish grades.

C. Remove diseased and unsatisfactory lawn areas; do not bury into soil. Remove topsoil containing foreign materials resulting from Contractor's operations including oil drippings, stone, gravel and other loose building materials.

D. Where substantial lawn remains (but is thin), mow, rake, aerate if compacted, fill low spots, remove humps and cultivate soil, fertilize, and seed. Remove weeds before seeding or if extensive, apply selective chemical weed killers as required. Apply a seedbed mulch, if required, to maintain moist condition.

E. Water newly planted areas and keep moist until new grass is established.

3.5 SEEDING NEW LAWNS

A. Before seed is sown, scarify soil and rake until surface is smooth, friable, and of uniformly fine texture.

B. Apply fertilizer as recommended in soil test results.

C. Seed evenly at 5 lbs. per 1,000 square feet, applying seed in two half rate applications at 90 degree angles, lightly rake, roll with two hundred pound roller and water with fine spray. Method of seeding may be varied at discretion of Contractor. It is contractor's responsibility to establish a smooth, uniform turf composed of approved grasses.

D. Sow seed using a spreader or seeding machine. Do not seed when wind velocity exceeds 5 mi. per hr. Distribute seed evenly over entire area by sowing equal quantity in 2 directions at right angles to each other.

1. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
2. Do not use wet seed or seed that is moldy or otherwise damaged.
3. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.

E. Sow not less than the quantity of seed specified or scheduled.

F. Rake seed lightly into top 1/8 inch of soil, roll lightly, and water with a fine spray.

G. Protect seeded slopes 1:4 or greater against erosion with slope stabilizer, fabric, or other methods acceptable to the Owner.

H. Protect seeded areas against erosion by spreading specified lawn mulch after completion of seeding operations. Spread uniformly to form a continuous blanket not less than 1-1/2 inch loose measurement over seeded areas.

3.6 SOD BED PREPARATION

A. The minimum depth of topsoil in all natural turf field areas shall be six (4") inches after settling. Contractor is responsible for supplying all topsoil needed from off-site sources. Topsoil shall be spread with only tracked equipment with a low ground pressure. Under no circumstance shall trucks drive on top of spread topsoil. The soil shall not be worked when it is wet. Final compaction level shall be within 80% minimum and 85% maximum standard proctor density, as determined by ASTM D698. After initial soil placement and rough grading the soil may be cultivated to a depth of six inches with a rototiller, chisel plow, or disk.

B. The Contractor shall add additional fertilizer amendments shall be spread at a rate determined by a soil test report performed after any organic matter is added. The contractor should take their own samples and test trial samples with their planned amendments and base their bid on those results. The soil should then be cultivated to a depth of six inches.

C. Grade all turf areas to finish grades as indicated on the Drawings. When no grades are shown, areas shall have a smooth and continual grade between existing or fixed controls and elevations shown on plans. All finish grading shall be done with small tractors outfitted with flotation tires, or low ground pressure dozers. Finish grading machines shall be equipped with

laser machine control systems. All turf areas shall slope to drain. Finish grades and grade tolerances shall be established and approved by the Landscape Architect.

D. Finish grades shall be verified using laser operation survey instruments with a tolerance of +/- 1/2 inch.

3.7 SODDING

A. Before sod is installed scarify soil and rake until surface is smooth, friable, and of uniformly fine texture. Method of sodding may be varied at discretion of Contractor. It is contractor's responsibility to establish a smooth, uniform turf composed of approved grasses.

B. The soil surface on which the sod is laid shall be moist and shall be watered, if necessary. Remove netting from sod. The sod shall be laid smoothly, edge to edge, and where continuous or solid sodding is called for on the plans sod shall be laid with the longest dimension parallel to the contours. Sodding shall start at the base of the slopes and progress upwards in continuous parallel rows. Vertical joints between sods shall be staggered. Pull seams tight without stretching sod. Immediately after laying, sod shall be pressed firmly into contact with the sod bed by light rolling, or by other approved methods so as to eliminate all air pockets, provide true and even surfaces, insure knitting and protect all exposed sod edges, but without displacement of the sod or deformation of the sod surface.

C. Gaps between sod larger than 2" will not be excepted. Gap 2" and smaller shall be filled with approved topsoil.

D. Sod shall be cut and removed around all structure, irrigation heads and other at grade items.

E. Turf Planting Season: The installation of lawns must occur between April 15 and June 15 or August 15 and October 15. Planting out of this season can only be performed with the approval of the Owner's Designated Representative.

3.8 HYDROSEEDING NEW LAWNS:

A. All lawn areas shall be fully installed prior to substantial completion

B. Do not use wet seed or seed, which is moldy or otherwise damaged in transit or storage.

C. Seed, fertilizer, hydromulch, water and inoculate shall be thoroughly mixed in the hydroseeding mixing tank prior to application.

1. Permanent Lawn Area: Application rates are as follows:

Seed	200	pounds per acre
Fertilizer	1000	pounds per acre
Hydromulch	1200	pounds per acre
Water	500	gallons per acre minimum
Inoculate	4	times manufacturer's recommended rate

D. Apply slurry uniformly to all areas to be seeded. Rate of application as required to obtain specified seed sowing rate.

3.9 INSTALLATION OF EROSION CONTROL BLANKET

A. Before placing erosion control blanket, the Contractor shall certify that the subgrade has been properly compacted, graded smooth, has no depressions, voids, soft or uncompacted areas, is free from obstructions such as tree roots, protruding stones or other foreign matter, and is seeded and fertilized according to project specifications. The Contractor shall not proceed until all unsatisfactory conditions have been remedied. By beginning construction, the Contractor signifies that the preceding work is in conformance with this specification.

B. Contractor shall fine grade the subgrade by hand dressing where necessary to remove local deviations.

C. No vehicular traffic shall be permitted directly on the erosion control blanket.

D. Erosion control blanket shall be installed as directed by the Owners Designated Representative in accordance with Manufacturer's Installation Guidelines, Staple Pattern Guides, and Contract Documents. The extent of erosion control blanket shall be as shown on the project drawings.

E. Erosion control blanket shall be orientated in vertical strips and anchored with staples, as identified in the Staple Pattern Guide. Adjacent strips shall be abutted or overlapped to allow for installation of a common row of staples that anchor through the nettings of both blankets. Horizontal joints between erosion control blankets shall be sufficiently overlapped with the uphill end on top for a common row of staples so that the staples anchor through the nettings of both blankets.

F. Where exposed to overland sheet flow, a trench shall be located at the uphill termination. Erosion control blanket shall be stapled to the bottom of the trench. The trench shall be backfilled and compacted. Where feasible, the uphill end of the blanket shall be extended three feet over the crest of the slope.

3.10 FIELD MAINTENANCE AND INSPECTION

A. Maintenance Period: Begin maintenance of field lawns immediately after planted and continue until acceptable lawn is established, but for not less than the following periods:

1. Seeded Areas 60 days after date of Substantial Completion.

2. Sodded areas: 60 days after date of Substantial Completion.

B. If seeded or sodded in fall and not given full maintenance period, or if not considered acceptable at that time, continue maintenance the following spring until lawn is established and acceptable to the Owners Designated Representative.

C. Maintenance of the seeded and sodded areas shall begin immediately, and generally consist of watering, weeding, mowing and edging, resodding or replacement of dead grass, disease and insect pest control, repair of all erosion, and any other procedure consistent with good horticultural practice, necessary to insure normal, vigorous and healthy growth.

D. Maintenance shall also include all temporary protection fences, barriers, signs and all other work incidental to proper maintenance.

E. The Contractor shall be responsible for maintenance to establish a uniform stand of the approved grasses until acceptance. At the time of the any cutting, mow lawn with sharp mowing units. Do not remove more than one third (1/3) of the grass blade. All lawn/turf shall receive at least two (2) mowings before acceptance.

F. Watering: The contractor shall include cost for daily, and if necessary continuous watering of all grass areas during a normal 8-hour working day. The sod bed shall be maintained in a continuous moist condition, satisfactory for good germination and growth of grass, as specified. Sodded grass areas must be kept in a moist condition until acceptance. All water required for watering all turf/lawn areas shall be supplied by the Owner. The Contractor is responsible for providing all equipment, hoses, etc. for watering throughout the project and until final acceptance of turf/lawn by the Landscape Architect.

G. Reseeding shall be done the same as the original installation in a manner that will cause a minimum disturbance to the existing stand of grass. Any areas that have had topsoil washed away shall be filled to match specific grade with topsoil before reseeding.

H. Mowing with approved mowing equipment to a height of 1-1/2 inches whenever the average height of the grass becomes 3 inches. When the amount of cut grass is visible, it shall be removed to prevent destruction of the underlying turf.

I. The Contractor shall provide and water sufficiently and often enough to insure establishment and maintain vigorous appearance.

J. At the time of the second mowing, a complete fertilizer, approved by the Landscape Architect or their representative, shall be applied over the entire seeded area, at approved rates.

3.11 CLEANUP AND PROTECTION

A. During landscape work, keep pavements clean and work area in an orderly condition.

B. Protect landscape work and materials 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 by Owner at no additional cost to Owner.

C. Inspection: In progress inspections shall be made at regular intervals during execution of work on the project. A final inspection shall be made upon completion at the request of the Contractor.

3.12 INSPECTION AND ACCEPTANCE

A. Replace lawn areas which do not fulfill all the requirements of these Specifications or are in a declining or unimproved condition as determined by the Owner at the end of the warranty period. Reseed/resod rejected areas as quickly as possible, but during normal planting seasons.

3.13 FINAL ACCEPTANCE

A. Final acceptance will be granted in writing following completion of all inspections at the termination of all warranty periods.

B. Examination: Upon completion of the seeding work, submit written notice requesting examination. Submit request at least 7 calendar days prior to anticipated examination date.

C. Examination will include proper layout, material and installation, quality and maintenance, healthy growth and satisfactory turf conditions.

3.14 CAUSE FOR REJECTION OF SEEDED AREAS

A. Failure to show healthy growth and satisfactory turf condition, as determined by the Owners Designated Representative.

B. Damage or injury due to lack or proper protection during maintenance, as determined by the Owners Designated Representative.

C. Improper installation or maintenance includes weeds, and bare or burned areas.

D. Bare spots, larger than one square foot, over a maximum 3 percent or more of any 100 square feet.

E. Acceptance: Contractor will be notified promptly in writing of acceptance of or deficiencies in the seeding work. Acceptance is made exclusive of future replacement of material during the warranted period.

F. Replace unacceptable and rejected materials, correct defects, and damage and remove unacceptable and rejected materials from the site.

G. Arrange for and obtain Owners Designated Representative's examination and written acceptance of lawn areas at the end of the warranty period. Replace rejected materials, which do not comply with specified requirements and extend maintenance until reinspection and acceptance. Extend maintenance and warranty period as necessary to accommodate delays in completion of items that extend work into more than one planting season. Reinspect and replace work as specified above.

3.15 CAUSE FOR REJECTION OF SOD

A. Failure to show healthy growth and satisfactory turf condition, as determined by the Owners Designated Representative.

B. Damage or injury due to lack or proper protection during maintenance, as determined by the Owners Designated Representative.

C. Improper installation or maintenance includes weeds, and bare or burned areas.

D. Bare spots, larger than one square foot, over a maximum 3 percent or more of any 100 square feet.

E. Gaps larger than 1” wide between sod rolls and or pavement.

F. Inconsistent quality and color of sod.

G. Acceptance: Contractor will be notified promptly in writing of acceptance of or deficiencies in the sod work. Acceptance is made exclusive of future replacement of material during the warranted period.

H. Replace unacceptable and rejected materials, correct defects, and damage and remove unacceptable and rejected materials from the site.

I. Arrange for and obtain Owners Designated Representative's examination and written acceptance of lawn areas at the end of the warranty period. Replace rejected materials, which do not comply with specified requirements and extend maintenance until reinspection and acceptance. Extend maintenance and warranty period as necessary to accommodate delays in completion of items that extend work into more than one planting season. Reinspect and replace work as specified above.

3.15 SEED MIX SCHEDULES:

A. General Lawn Areas:

1. Use a seed mix with the following composition;
   Maxima I Creeping Red Fescue 24%
   SR 2100 Kentucky Bluegrass 24%
   Esquire Perennial Ryegrass 24%
   SR 4660ST Perennial Ryegrass 24%
2. Application Rate: Apply seed at a rate of 8 lbs. per 1,000 square feet.
3. Seed mix to be 95-98% pure, 99% weed seed free, and have a 90% germination rate.

END OF SECTION 329000

SECTION 329300 LANDSCAPE PLANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and General provisions of the Contract, including General and Supplementary Conditions apply to work of this Section.

1.2 SUMMARY

A. Extent of landscape work includes, but is not limited to the following:

1. Landscape grading.
2. Tree and shrub planting.
3. Aluminum Edging

B. Related Sections: Division 31, Section 312000, “Earthwork-Site” for rough grading and establishment of subgrade.

C. Subgrade Elevations: Excavation, filling and rough grading required to complete the Work will be included in this contract.

1.3 QUALITY ASSURANCE

A. Landscape work shall be performed by a single firm with at least 3 years of successful installation experience specializing in landscape work.

B. Adherence to applicable standards of the National Pollution Discharge Elimination System (NPDES) and fertilizer and pesticide use.

1.4 SOURCE QUALITY CONTROL

A. General: Ship landscape materials with certificates of inspection required by appropriate governing authorities. Comply with regulations applicable to landscape materials.

B. Do not make substitutions. If specified landscape material is not obtainable, submit verification of non-availability to Owner, together with proposal for use of equivalent material.

C. Analysis and Standards: Package standard products with manufacturer's certified analysis. For other materials, provide analysis by recognized laboratory made in

accordance with methods established by the Association of Official Agriculture Chemists, wherever applicable.

D. Trees and Shrub: Provide trees, shrubs, ground covers and plants of quantity, size, genus, species and variety shown and scheduled for landscape work and comply with recommendations and requirements of ANSI Z60.1 American Standard for Nursery Stock. Provide healthy, vigorous stock, grown in recognized nursery in accordance with good horticultural practice and free of disease, insects, eggs, larvae and defects such as knots, sun-scald, injuries, abrasions, or disfigurement.

E. Label at least 1 tree and 1 shrub of each variety with a securely attached waterproof tag bearing legible designation of botanical and common name.

F. Inspection: The Owner' Representative will inspect indicated trees and shrubs at site before installing, for compliance with requirements for genus, species, variety, size and quality. The Owner retains the right to further inspect trees and shrubs for size and condition of balls and root systems, insects, injuries and latent defects, and to reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from the project site. The Owners Designated Representative or Owner shall be the sole judge of acceptability.

1.5 SUBMITTALS

A. Certification: Submit certificates of inspection as required by governmental authorities. Submit other data substantiating that materials comply with specified requirements.

B. Planting Schedule: Submit proposed planting schedule, indicating dates for each type of landscape work during normal seasons for such work in area of site. Correlate with specified maintenance periods to provide maintenance from the date of substantial completion. Once accepted, revise dates only as approved in writing, after documentation of reason for a request for delay.

C. Maintenance Instructions: Submit typewritten instructions recommending procedures to be reviewed by owner for maintenance of landscape work for 2 full years. Submit prior to expiration of required maintenance period(s).

D. Submit samples of weed control filter fabric for approval.

1.6 DELIVERY, STORAGE AND HANDLING

A. Packaged Materials: Deliver packaged materials in containers showing weight, analysis and name of manufacturer. Protect materials from deterioration during delivery, and while stored at site.

B. Trees and Shrubs: Provide freshly dug trees and shrubs. Do not prune prior to delivery unless otherwise approved by Owners Designated Representative. Do not bend or bind-tie trees or shrubs in such manner as to damage bark, break branches or

destroy natural shape. Provide protective covering during delivery. Do not drop balled and burlapped stock during delivery.

C. Deliver trees, shrubs, ground covers and plants after preparations for planting have been completed and plant immediately. Deliver to the site only those plants that can be planted during the day of the delivery. No plant materials will be stored on-site overnight.

D. Do not remove container grown stock from containers until planting time.

1.7 JOB CONDITIONS

A. The Contractor is responsible for examining the existing site of the Work prior to the submission of bids in order to familiarize himself/herself with the character and condition of the site.

B. Proceed with and complete landscape work as rapidly as portions of site become available, working within seasonal limitations for each kind of landscape work required, as specified in Part 3.

C. Utilities: Determine location of overhead and underground utilities and perform work in a manner, which will avoid possible damage. Hand excavate, as required. Maintain grade stakes if set by others until removal is mutually agreed upon by all parties concerned (including Owner). Repair or replace any damaged items.

D. Excavation: When conditions detrimental to plant growth are encountered, such as rubble fill, adverse drainage conditions, or obstructions, notify Owners Designated Representative before planting.

E. Planting Time: Plant or install materials during normal planting seasons for each type of landscape work required as specified in Part 3. Correlate planting with specified maintenance periods to provide maintenance from the date of substantial completion.

F. All proper precautions so as not to disturb or damage subsurface improvements shall be observed. This shall not relieve the Contractor of the responsibility to locate electrical cables, storage tanks, sub-surface drainage, gas lines, etc., which might be encountered. If underground obstructions are encountered in the excavation of plant pits, alternate locations may be selected; verify with Owners Designated Representative new locations.

G. The Contractor shall at all times take reasonable and adequate precautions to protect the existing improvements during the course of the project. The Contractor at the Contractor’s expense shall correct any damage incurred.

H. Coordination with Lawns: If planting of trees and shrubs shall occur after lawn work, protect lawn areas and promptly repair damage to lawns resulting from planting operations.

1.8 SPECIAL PROJECT WARRANTY

A. Warranty trees, shrubs, ground covers, plants and bulbs for a period of 1 year after date of substantial completion, against defects including death and unsatisfactory growth, except for defects resulting from neglect by Owner, abuse or damage by others, or unusual phenomena or incidents which are beyond the Landscape Contractor's control.

B. Remove and replace trees, shrubs, or other plants found to be dead or in unhealthy condition during the warranty period. Make replacements during the growth season following the end of warranty period. Replace trees and shrubs, which are in doubtful condition at the end of warranty period; unless, in the opinion of Owners Designated Representative, it is advisable to extend warranty period for a full growing season.

C. Another inspection will be conducted at the end of the extended warranty period, if any, to determine acceptance or rejection. Only one for one replacement (per tree, shrub or plant) will be required at the end of warranty period, except for losses or replacements due to failure to comply with specified requirements.

PART 2 - PRODUCTS

2.1 PLANT MATERIALS

A. Quality: Provide trees, shrubs, and other plants of size, genus, species and variety shown and scheduled for landscape work and complying with recommendations and requirements of ANSI Z60.1 "American Standard for Nursery Stock."

B. Deciduous Trees: Provide trees of height and caliper scheduled or shown and with branching configuration recommended by ANSI Z60.1 for type and species required. Provide single stem trees except where special forms are shown or listed.

C. Provide balled and burlapped deciduous trees: Balls firm and unbroken of natural earth in which the plant has been growing, and of sufficient diameter and depth to adequately enclose all fibrous and feeding roots as outlined by ANSI Z60.1. Do not use manufactured, artificially produced or mudded-in balls or any plant materials in which the ball has been broken or cracked either before or during planting operations. Any ball over 30 inches shall be properly roped and bound with twine.

D. Container grown deciduous trees will be acceptable in lieu of balled and burlapped deciduous trees subject to specified limitations of ANSI Z60.1 for container stock.

E. Provide balled and burlapped deciduous shrubs.

F. Container grown deciduous shrubs will be acceptable in lieu of balled and burlapped deciduous shrubs subject to specified limitations for container grown stock.

G. Coniferous and Broadleafed Evergreens: Provide evergreens of sizes shown or listed. Dimensions indicate minimum spread for spreading and semi-spreading type

evergreens and height for other types, such as globe, dwarf, cone, pyramidal, broad up-right, and columnar. Provide normal quality evergreens with well-balanced form complying with requirements for other size relationships to the primary dimension shown.

H. Provide balled and burlapped evergreens.

I. Container grown evergreens will be acceptable subject to specified limitations for container grown stock.

J. Ornamental trees shall be well formed and have a crown typical of the species or variety.

K. Deciduous shrubs shall be well branched and have ample well balanced root systems capable of sustaining vigorous growth. They shall have a height-width ratio typical of sufficient well spaced side branches to give it proper weight and density.

L. Evergreen trees shall be of a form typical of their species or variety and not unnaturally sheared or color treated. They shall have received sufficient pruning to develop full bodies and substantial side branching.

L. Evergreen shrubs shall be well branched and have ample well balanced root systems capable of sustaining vigorous growth. They shall have a compact form and dense branching typical of their species or variety.

M. Ground Covers and Plants shall be established and well rooted in removable containers or integral peat pots and with not less than the minimum number an length of runners required by ANSI Z60.1 for the pot size indicated.

2.2 MISCELLANEOUS LANDSCAPE MATERIALS

B. Anti Desiccant: Emulsion type, film-forming agent designed to permit transpiration but retard excessive loss of moisture from plants. Deliver in manufacturer's fully identified containers and mix in accordance with manufacturer's instructions.

C. Wrapping: Tree-wrap tape not less than 4 inches wide, designed to prevent bore damage and winter freezing.

D. Stakes and Guys: Provide stakes and deadmen of sound new hardwood, treated softwood, or redwood, free of knotholes and other defects. Provide wire ties and guys of 2-strand, twisted, pliable galvanized iron wire not lighter than 12 ga. Provide not less than ½ inch diameter rubber or plastic hose, cut to required lengths and of uniform color, material and size to protect tree trunks from damage by wires. Provide at least 1 turnbuckle per tree located on the upwind guy.

E. Weed Control shall be 5 percent Dacthal granules, a weed control which kills weed seeds as they germinate, or equivalent.

F. Weed Control Filter Fabric shall be Typar, Mirafi, or DeWitt weed fabric, or approved equivalent. Unit weight to be a minimum of 1.9 oz./square yard, with a tensile strength of no less than 73 lbs.

G. Drip/Mowing Edge:

1. Edging to be aluminum 3/16" x 5 ½" inch mill finish in 16' foot sections.

2. Sections to be 6063 alloy, T-6 hardness with interlocking system and 5 stake punch-outs. Sections to lock together without offset or double thickness at the joints and secured with two 12" stakes at every joint.

3. Mill finish and painted black.

4. Stakes shall be 12" long, secured ½" below top of edging and locket into place. Stakes shall be placed in the inside of stone areas.

PART 3 - EXECUTION

3.1 GENERAL

A. Planting Season: The installation of plant materials must occur between April 15 and June 15 or August 15 and October 15. Extension of this planting season can be only with the approval of the Owners Designated Representative.

3.2 PREPARATION

A. Layout individual tree and shrub locations and areas for multiple plantings. Stake locations and outline areas and secure Owners Designated Representative's acceptance before start of planting work. Make minor adjustments as may be requested.

B. Preparation of Planting Soil:

1. Before mixing, clean topsoil of roots, plants, sods, stones, clay lumps, and other extraneous materials harmful or toxic to plant growth.
2. Mix specified soil amendments and fertilizers with topsoil at rates specified at the site. Delay mixing of fertilizer if planting will not follow placing of planting soil within a few days.
3. Schedule of Amended Backfill as describe in Planting Soil Specification 329113

3.3 PLANT PREPARATIONS

A. Stake tree locations and place shrubs for review and final orientation by Owner prior to installation.

1. Outlines of bed areas shall be clearly marked on the ground.

B. Plant pits shall be excavated with vertical sides and flat bottom per details.

C. Excavation for Trees and Shrubs:

1. Excavate pits, beds and trenches, with vertical sides and with bottom of excavation slightly raised at center to provide proper drainage. Loosen hard subsoil in bottom of excavation.
2. Allow for 9 inches setting layer of planting soil mixture.
3. For balled and burlapped trees and shrubs, make excavations at least half again as wide as the ball diameter and equal to the ball depth, plus scarify subsoil to a depth equal to 1/3 the ball depth.
4. For container grown stock, excavate as specified for balled and burlapped stock, adjusted to size of container width and depth.
5. Dispose of subsoil removed from planting excavations on site at stockpile location. Do not mix with planting soil or use as backfill.
6. Fill excavations for trees and shrubs with water and allow to percolate out before planting.

3.4 PLANTING

A. Planting Trees and Shrubs:

1. All plant materials shall be installed one week prior to the substantial completion date of the sitework.
2. Set balled and burlapped (B&B) stock on layer of compacted planting soil mixture, plumb and in center of pit or trench with top of ball at same elevation as adjacent finished landscape grades. Remove burlap from sides of balls; retain on bottoms. When set, place additional backfill around base and sides of ball, and work each layer to settle backfill and eliminate voids and air pockets. When excavation is approximately 2/3-full, water thoroughly before placing the remainder of backfill. Repeat watering until no more is absorbed. Water again after placing the final layer of backfill.

B. Slow Release Fertilizer Packets:

1. All woody plants shall be fertilized with slow-release fertilizer packets at the time of planting, unless otherwise directed by the Owner’s Representative. Fertilizer packets shall be placed within the planting contact with roots. Placement depth shall be 6" to 8". Packets shall not be cut, ripped or damaged.
2. If it becomes necessary to remove and replace dead or unhealthy plants, damaged or broken packets shall be replaced with new packets.
3. The application rates shall be as follows:

TYPES OF PLANTS	NO. OF PACKETS
Evergreen Trees	
Under 18" in height	1
18" to 3' in height	2

3' to 6' in height	3	
Over 6' in height	4	
Deciduous Trees		
Under 6' in height		2
6' to 12' in ht. or under 4” caliper		3
Over 4" caliper	4	
Shrubs		
Under 2' in height or spread	1	
2' to 3' in height or spread		2
Over 3' in height or spread	3	

C. Set container grown stock as specified for balled and burlapped stock, except cut cans on 2 sides with an approved can cutter and remove; remove bottoms of wooden boxes after partial backfilling so as not to damage root balls.

D. Dish top of backfill to allow for mulching.

E Mulch pits, trenches and planted areas. Provide 3 inches minimum thickness of mulch after settling and work into top of backfill and finish level with adjacent finish grades. Groupings of plants shall be mulched with weed fabric as one bed.

F. Apply anti-desiccant using power spray to provide an adequate film over trunks, branches, stems, twigs and foliage.

1. If deciduous trees or shrubs are moved in full-leaf, spray with anti-desiccant at nursery before moving and again 2 weeks after planting.

G. Prune, thin out and shape trees and shrubs in accordance with standard horticultural practice. Prune trees to retain required height and spread. Unless otherwise directed by Owners Designated Representative, do not cut tree leaders, and remove only injured or dead branches from flowering trees, if any. Prune shrubs to retain natural character.

H. Remove and replace excessively pruned or misformed stock resulting from improper pruning, as determined by Owners Designated Representative.

I. Wrap tree trunks of 2 inches caliper and larger. Start at ground and cover trunk to height of first branches and securely attach. Inspect tree trunks for injury, improper pruning and insect infestation and take corrective measures before wrapping.

J. The planting mix shall be smoothed and shaped to form a shallow basin slightly larger than the pit. All such areas shall then be mulched with a 3-inch layer of mulch. For bed planting, the entire area shall be raked smooth and mulched to a depth of 3 inches except lowered at shrub and tree trunks. Provide pronounced “V” edge at all plant and ground cover beds.

K. Circular area around individual trees to be mulched and free of vegetation. For trees 3" and greater in caliper, area to be 5 feet – 0 inches diameter. For trees less than 3 inches caliper, area to be 3 feet – 6 inches in diameter.

L. Guy and stake trees immediately after planting, as indicated. Remove guys and stakes at end of 1 year warranty period.

M. Watering: Thoroughly water all plants during and immediately after planting. This shall mean full and thorough saturation of all backfill in the pits and beds. Apply water only by open-end hose at a very low pressure to avoid air pockets and injury to the roots.

1. All plant materials shall be thoroughly watered twice during the first 24 hours after planting. All plant material shall be watered weekly thereafter, or more often, as required, to maintain health and to promote vigorous growth of plant material, during all growing seasons, which fall within the 12-month establishment period. Hoses used during watering operations shall not block the flow of vehicular or pedestrian traffic.

3.5 MAINTENANCE

A. Begin maintenance immediately after planting.

B. Maintain trees, shrubs and other plants until final acceptance but in no case less than the following period:

1. The entire guarantee period.

C. Maintain trees, shrubs and other plants by pruning, cultivating and weeding as required for healthy growth. Restore planting saucers. Tighten and repair stake and guy supports and reset trees and shrubs to proper grades or vertical positions as required. Restore or replace damaged wrappings. Spray as required to keep trees and shrubs free of insects and disease.

3.6 CLEANUP AND PROTECTION

A. During landscape work, keep pavements clean and work area in an orderly condition.

B. Protect landscape work and materials 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 by Owner at no additional cost to Owner.

C. Inspection: In progress inspections shall be made at regular intervals during execution of work on the project. A final inspection shall be made upon completion at the request of the Contractor.

3.7 PLANT GUARANTEE AND REPLACEMENT

A. Guarantee: Plants shall be guaranteed for one 1 full year from the sitework contract completion date.

B. Replacement: At the end of the guarantee period, an inspection will be made by the Owners Designated Representative upon written notice requesting such inspection submitted by the Contractor at least ten days before the anticipated date. Any plant required under this contract that is dead or not in satisfactory growth, as determined by the Owners Designated Representative, shall be removed from the project site; these and any plants missing, due to the Contractor's negligence, shall be replaced as soon as conditions permit, but during the normal planting season.

C. All replacements shall be plants of the same kind as specified in the plant schedule given on the project drawings. They shall be furnished and placed as specified under new planting; the cost shall be borne by the Contractor except for possible replacement resulting from removal, loss or damage due to occupancy of the project in any part, vandalism, or acts of neglect on the part of others, during the guarantee period after acceptance.

3.8 INSPECTION AND ACCEPTANCE

A. Replace plants which do not fulfill all the requirements of these Specifications or are in a declining or unimproved condition as determined by the Owner at the end of the warranty period, with plant material as originally specified but oversized to compensate for growth of adjacent plants. Replace rejected plants as quickly as possible, but during normal planting seasons.

B. Replacement Examination: Upon completion of replacement planting, arrange for Owners Designated Representative's inspection as specified for original plantings.

C. Replacement Warranty: Warranty replacement plants as above for 1 year from date of acceptance.

D. Second Replacements: Replace replacement plants that fail at the end of the replacement warranty period with oversized plants of the same species or with alternate species approved or recommended by the Architect.

3.9 FINAL ACCEPTANCE

A. Final acceptance will be granted in writing following completion of all inspections at the termination of all warranty periods.

B. Examination: Upon completion of the seeding work, submit written notice requesting examination. Submit request at least 7 calendar days prior to anticipated examination date.

C. Examination will include proper layout, material and installation, quality and maintenance, healthy growth and satisfactory turf conditions.

3.10 MATERIAL SCHEDULES

A. Amended Backfill/Planting soil

1. Trees & Shrubs:
Include one (1) part of Organic Manure to 7 parts approved topsoil. Add bonemeal at 5 lbs per cubic yard, and fertilizer as described. For ericaceous shrubs, add Miracid fertilizer or approved equivalent as per manufacturer's specification.

END OF SECTION 329300

SECTION 329313 – PLANTING SOILS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings 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. Supplying, placing and grading Planting Soils for plant beds and lawn areas.
2. Sampling and testing of existing on-site topsoil and imported soils.
3. Modifying, screening and amending existing on-site topsoil and imported soils to meet planting soil specifications.
4. Soil compaction testing, decompaction and soil restoration.
5. Fine Grading

B. Related Sections:
1. Section 311000 "Site Clearing" for protection of existing trees and plantings, topsoil stripping and stockpiling, and site clearing.
2. Section 312000 “Earth Moving-Site” for excavation, filling, rough grading, and backfill.
3. Section 329200 "Turf and Grasses" for turf (lawn), seeding, and sod.
4. Section 329300 "Plants" for tree, shrub and groundcover planting.

1.3 REFERENCES

A. ANSI: American National Standards Institute.

B. AOAC: Association of Official Agricultural Chemists.

C. ASTM: American Society for Testing Materials.

D. ASA: American Society of Agronomy.

E. SSSA: Soil Science Society of America.

F. AAPFCO: Association of American Plant Food Control Officials.

G. NAPT: North American Proficiency Testing Program.

1.4 DEFINITIONS

A. Backfill: The earth used to replace or the act of replacing earth in an excavation. This can be amended or unamended soil as indicated.

B. CEC: Cation exchange capacity.

C. Compost: The product resulting from the controlled biological decomposition of organic material that has been sanitized through the generation of heat and stabilized to the point that it is beneficial to plant growth.

D. Duff Layer: A surface layer of soil, typical of forested areas, that is composed of mostly decayed leaves, twigs, and detritus.

E. Finish Grade: Elevation of finished surface of planting soil.

F. Imported Soil: Soil that is transported to Project site for use.

G. Manufactured Soil: Soil produced by blending soils, sand, stabilized organic soil amendments, and other materials to produce planting soil.

H. Organic Matter: The total of organic materials in soil exclusive of undecayed plant and animal tissues, their partial decomposition products, and the soil biomass; also called "humus" or "soil organic matter."

I. Planting Soil: Native stockpiled or imported topsoil, manufactured topsoil, or surface soil modified and mixed with soil amendments to become topsoil for plant beds and turf areas

J. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

K. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.

L. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil"; but in disturbed areas such as urban environments, the surface soil can be subsoil.

M. 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 materials.

1.5 APPLICABLE STANDARDS

A. American Society for Testing Material (ASTM):
1. ASTM D421 Practice for Dry Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constraints.
2. ASTM D422 Standard Test Method for Particle-Size Analysis of Soils.
3. ASTM D2974 Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils.
4. ASTM D4972 Test Method for pH of Soils.
5. ASTM D5268 Standard Specification for Topsoil Used for Landscaping Purposes.
6. All standards shall include the latest additions and amendments as of the date of advertisement for bids.

1.6 REGULATORY REQUIREMENTS

A. Strictly comply with all applicable codes, regulations and requirements having jurisdiction.

B. All fertilizer applications shall be performed by a licensed applicator in strict conformance with all local, state and federal regulations. Notify the Owner’s Project Representative at least two (2) weeks prior to scheduled date of application.

1.7 SUBMITTALS

A. Product Data, for each type of product and amendment indicated including source.

B. Soil Analysis / Test Report for existing topsoil and proposed imported soils, meeting testing requirements of this specification section.

C. Material Certificates: For each type of imported soil, soil amendments and fertilizers before delivery to the site, according to the following:
   1. Manufacturer's qualified testing agency's certified analysis of standard products.
   2. Analysis of fertilizers, by a qualified testing agency, made according to AAPFCO methods for testing and labeling and according to AAPFCO's SUIP #25.
   3. Analysis of nonstandard materials, by a qualified testing agency, made according to SSSA methods, where applicable.

D. Samples: For each of the following:
   1. Existing On-Site Topsoil amended to meet specifications
   2. Imported Topsoil
      a. For each bulk-supplied material, 1-quart volume of each in sealed containers labeled with content, source, and date obtained. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of composition, color, and texture.

E. Qualification Data: For each testing agency.

F. Subgrade Testing: Field percolation test results as described in Part 3 Execution. Percolation tests shall be measured in inches per hour of drainage.

1.8 QUALITY ASSURANCE

A. Source Limitations for Planting Soil: Obtain all planting soil through one source.

B. Sources for Soil Components and Planting Soil: Submit information identifying sources for all soil components and the firm responsible for mixing of planting soil mixes.
   1. Soil mix supplier shall have a minimum of five years' experience at supplying custom planting soil mixes.
   2. Submit supplier name, address, telephone and fax numbers and contact name.
   3. Owner's Representative reserves the right to reject any soil supplier.

C. Submit certification that accepted supplier can provide sufficient quantities of materials and mixes for the entire project.

D. Soil-Testing Laboratory Qualifications: The Contractor shall engage an independent laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed. The soil-testing laboratory shall be subject to approval by the Owner's Representative.
   1. Testing Agencies: The following firms are acceptable testing agencies for the various components.
      a. UMASS Soil and Plant Tissue Laboratory, West Experiment Station, North Pleasant Street, University of Massachusetts, Amherst, MA 01003, (413) 545-2311.
      b. Cornell Nutrient Analysis Lab, c/o Soil Health Lab, G01 Bradfield Hall, 306 Tower Rd., Ithaca, NY 14853, 607-227-6055, soilhealth@cornell.edu
      c. Turf & Diagnostics.: 35 King Street, Trumansburg, New York 14886. tel: 607.387.5694, fax: 607.387.9499.
      d. Agro-One, 730 Warren Road, Ithaca, New York 14850, (800) 344-2697.

1.9 SOIL-SAMPLING REQUIREMENTS

A. General: Extract soil samples according to requirements in this article.

B. The Contractor shall provide a one cubic foot representative sample per each 1,000 cubic yard on-site stockpile of existing topsoil and proposed imported planting soil for testing. All stockpile sampling shall be per ASTM D 75 and Appendixes for securing samples from stockpiles.

1.10 SOIL TESTING REQUIREMENTS

A. Testing will be at the Contractor's expense. The Contractor shall engage a qualified testing agency to perform preconstruction soil analyses on existing on-site topsoil and proposed imported planting soils.

B. For each soil, perform testing on soil samples and furnish soil analysis and a written report containing soil-amendment and fertilizer recommendations by a qualified testing agency.

C. Contractor shall deliver all samples to testing laboratories and shall have the testing report sent directly to the Owner's Representative.

D. The soil analysis in the testing report shall state the USDA soil classification, percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; deleterious material; pH; and mineral and plant-nutrient content of topsoil.

E. Soil Testing:
   1. Soil Texture: Soil-particle, size-distribution analysis (sieve analysis) shall be performed and compared to the USDA Soil Classification System. Include sand, silt and clay, sand size distribution, sand particle shape, pH, uniformity coefficient by hydrometer method (ASTM D-422).
   2. To facilitate review and approval of sieve analysis, provide a computer-generated gradation curve from testing laboratory.
   3. Organic Matter: Percent organic per ASTM D2974.
   4. pH and buffer pH: Soil pH per ASTM D4972.
   5. Chemical analysis shall be undertaken for Nitrate Nitrogen, Ammonium Nitrogen, Phosphorus, Potassium, Calcium, Magnesium, extractable Aluminum, Lead, Zinc, Cadmium, Copper, Soluble Salts, and pH and buffer ph. A Conductivity Meter shall be used to measure Soluble Salts in 1:2 soil/water (v/v). Except where otherwise noted, nutrient tests shall be for available nutrients.

F. Recommendations: Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated to produce satisfactory planting soil suitable for healthy, viable plants and lawns. Include, at a minimum, recommendations for nitrogen, phosphorous, and potassium fertilization, and for micronutrients.
   1. Fertilizers and Soil Amendment Rates: State recommendations in weight per 1000 sq. ft. for 6-inch depth of soil.
   2. Soil Reaction: State the recommended liming rates for raising pH or sulfur for lowering pH according to the buffered acidity or buffered alkalinity in weight per 1000 sq. ft. for 6-inch depth of soil.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws if applicable.

B. Bulk Materials:
   1. Material should not be handled or hauled, placed or compacted when it is wet as after a heavy rainfall or is frozen. Soil should be handled only when the moisture content is less than at field capacity (saturated).
   2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
   3. Prohibit vehicular and pedestrian traffic on or around stockpiled planting soil.
   4. Soil that is to be stockpiled longer than two weeks, whether on or off site, shall not be placed in mounds greater than six feet high. If soil stockpiles greater than six feet high are present longer than two weeks then the contractor shall break down and disperse soil so that mounds do not exceed the six foot height restriction for longer than two weeks.
   5. Accompany each delivery of bulk materials with appropriate certificates.

1.12 FIELD CONDITIONS

A. The Contractor responsible for the execution of the Work of this Section shall review the subgrades and verify that the subgrades have been prepared as required by this article prior to proceeding with the spreading of the planting soils. Carefully review the requirements of this Section to understand the requirements of percolation testing, subgrade compaction, slope and absence of debris of the subgrade prior to spreading planting soils.

PART 2 - PRODUCTS

2.1 TOPSOIL

A. Topsoil: ASTM D 5268, pH range of 5.5 to 7.0, a minimum of 4 percent organic material content; free of stones one and one-quarter inches or larger in any dimension, clay lumps, brush, weeds, roots, and other extraneous materials harmful to plant growth.

B. Sources:
   1. Existing On Site Topsoil, stripped and stockpiled, tested and amended to meet the requirements of this section.
   2. Imported Topsoil: Imported, naturally formed soil from off-site sources that are naturally well-drained sites where topsoil occurs at least 4 inches deep. Soil shall not be from agricultural land, bogs, or marshes and shall not contain undesirable organisms; disease-causing plant pathogens; or weeds and invasive plants. The organic content and particle size distribution shall be the result of natural soil formation. Retained soil peds shall be the same color on the inside as is visible on the outside.
   3. Manufactured Topsoil: A commercial processing facility specializing in the manufacture of topsoil.

2.2 PLANTING SOIL

A. General:
1. Free of stones greater than one and one-quarter inches in any direction, lumps, plants and their roots, weeds, weed seeds, debris and other extraneous matter as determined by the Owner's Representative.
2. Soluble Salts (1:2), dS/m: Less than 0.6

B. Lawn Areas: Planting Soils for lawn areas shall be one of the following loamy sands and sandy loams; “loamy sand”, “loamy fine sand”, “loamy very fine sand”, or “coarse sandy loam”: determined by mechanical analysis (ASTM D 422) and based on the "USDA Classification System", and as defined in this Section. It shall be of uniform composition, without admixture of subsoil.
1. Planting soil for lawn areas shall have the following grain size distribution for material passing the #10 (2.0 mm) sieve:

Millimeter / Sieve	Percent Passing by Weight	
	Max.	Min.
2 / #10	-------	100
1 / #18	100	80
0.5 / #35	87	65
0.25 / #60	72	49
0.10 / #140	45	30
0.05 / #270	32	22
0.002	5	2

2. Maximum size shall be one and one quarter inches largest dimension. The maximum retained on the #10 sieve shall be 25% by weight of the total sample.
3. Uniformity Ratio: D80/D30 < 6.0
4. pH: 6.0 through 7.0
5. Organic Content: 4.0 - 6.0 percent
6. Saturated Hydraulic Conductivity: 2.0 inches to 4.0 inches per hour according to ASTM D5856-95 (2000) when compacted to 85% max. Standard Proctor, ASTM 698.

C. Plant Beds: Planting Soils for trees, shrubs, perennials and groundcover shall be one of the following sandy loams; “course sandy loam “, “sandy loam”, and “fine sandy loam”: determined by mechanical analysis (ASTM D 422) and based on the "USDA Classification System" and as defined in this Section. It shall be of uniform composition, without admixture of subsoil.
1. Planting soil for trees, shrubs, perennials and groundcover shall have the following grain size distribution for material passing the #10 (2.0 mm) sieve:

Millimeter / Sieve	Percent Passing by Weight	
	Max.	Min.
2 / #10	-------	100
1 / #18	100	80
0.5 / #35	87	67
0.25 / #60	78	48
0.10 / #140	68	30
0.05 / #270	55	22
0.002	7	2

2. Maximum size shall be one and one quarter inches largest dimension. The maximum retained on the #10 sieve shall be 25% by weight of the total sample.
3. Uniformity Ratio: D80/D30 < 6.0
4. pH: 5.0 through 6.5
5. Organic Content: 4.0 - 6.0 percent
6. Saturated Hydraulic Conductivity: 1.0 inches to 4.0 inches per hour according to ASTM D5856-95 (2000) when compacted to 85%. Standard Proctor, ASTM 698.

2.3 ORGANIC SOIL AMENDMENTS

A. Compost: Well-composted, stable, and weed-free organic matter not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings. The compost shall be a dark brown to black color and be capable of supporting plant growth with appropriate management practices in conjunction with addition of fertilizer and other amendments as applicable, with no visible free water or dust, with no unpleasant odor, and meeting the following criteria as reported by laboratory tests. Debris such as metal, glass, plastic, wood (other than residual chips), asphalt or masonry shall not be visible and shall not exceed one percent dry weight. Compost requires approval by the National Environmental Protetion Agency and NYS Department of Enviornmental Conservation for distribution. Product shall be certified by the US Composting Council Seal of Testing (STA). Compost shall meet the following criteria
   1. Organic Matter Content: 50 to 60 percent of dry weight. (ASTM F-1647, Method 1).
   2. The ratio of carbon to nitrogen shall be in the range of 10:1 to 25:1.
   3. One hundred percent of the material shall pass a 3/8-inch (or smaller) screen. (ASTM D422-63).
   4. pH: The pH shall be between 5.5 to 7.5 as determined from a 1:1 soil-distilled wate suspension using a glass electrode pH meter. (American Society of Agronomy Methods of Soil Analysis, Part 2, 1986).
   5. Salinity: Electrical conductivity of a one to two soil to water ratio extract shall not exceed 4.0 mmhos/cm (dS/m).
   6. Heavy metal contents shall conform to state and federal regulations.
   7. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source separated or compostable mixed solid waste.

B. Sphagnum Peat: Partially decomposed sphagnum peat moss, finely divided or granular texture, with a pH range of 3.4 to 4.8.

C. Muck Peat: Partially decomposed moss peat, native peat, or reed-sedge peat, finely divided or of granular texture, with a pH range of 6 to 7.5, and having a water-absorbing capacity of 1100 to 2000 percent.

D. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, debris, and material harmful to plant growth.

2.4 SOIL AMENDMENTS

A. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:
   1. Class: T, with a minimum of 99 percent passing through a No. 8 sieve and a minimum of 75 percent passing through a No. 60 sieve.

B. Sulfur: Granular, biodegradable, and containing a minimum of 90 percent elemental sulfur, with a minimum of 99 percent passing through a No. 6 sieve and a maximum of 10 percent passing through a No. 40 sieve.

C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.

D. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through a No. 50 sieve.

2.5 FERTILIZER

A. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of 4 percent nitrogen and 20 percent phosphoric acid.

B. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.

C. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
   1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency.

D. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
   1. Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency.

E. Commercial fertilizer shall be a product complying with laws of the State where the project is located and United States fertilizer laws.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Pre-Installation Examination Required: The Contractor shall examine previous work, related work, and conditions under which this work is to be performed and shall notify Owner’s Representative in writing of all deficiencies and conditions detrimental to the proper completion of this work. Beginning work means Contractor accepts substrates, previous work, and conditions.

B. Examination of Subgrade: The subgrade shall be inspected by the contractor prior to the start of soil placement for conformance with the Drawings for elevations of subgrade relative to finish grade. Subgrade shall be graded smooth and parallel to the finish grades. Contractor shall confirm that the subgrade is at the proper elevation, not over-compacted, and that no further earthwork is required to bring the subgrade to proper elevations.

C. Confirm that no adverse drainage conditions, or conditions detrimental to plant growth are present.

D. Confirm that surface all areas to be filled with Planting Soil are free of construction debris, refuse, compressible or biodegradable materials, stones greater than 2 inches

diameter, soil crusting films of silt or clay that reduces or stops drainage from the Planting Soil into the subsoil; and/or standing water.

E. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in areas to receive planting soil.

F. Do not proceed with planting soil placement until after unsatisfactory conditions have been corrected, and unsuitable materials have been removed from the site.

3.2 COORDINATION

A. Coordinate activities with other project contractors to prevent soil disturbance from traffic or other construction activities subsequent to placement of planting soils.

3.3 PREPARATION

A. Clean subgrade of all stones greater than 2 inches and all debris or rubbish and remove and dispose of off site.

B. Do not damage the work previously installed. Maintain all required angles of repose of materials adjacent to the planting soils. Do not over excavate compacted subgrades of adjacent pavement or structures during planting soil operations. Maintain a supporting 1:1 side slope of compacted subgrade material along the edges of all paving and structures where the bottom of the paving or structure is above the bottom elevation of the excavated planting area.

C. Clear the subgrade of all construction debris, trash, rubble and any foreign material. In the event that fuels, oils, concrete washout or other material harmful to plants have been spilled into the subgrade material, excavate the soil sufficiently to remove the harmful material. Such construction debris, trash, rubble and foreign material shall be removed from the site and disposed of in a legal manner. Fill any over excavation with approved fill and compact to the required subgrade compaction levels.

D. Protect adjacent walls, walks and utilities from damage or staining by the soil. Use 1/2 inch plywood and or plastic sheeting as directed to cover existing concrete, metal and masonry work and other items as directed during the progress of the work.

E. Subgrade Preparation:
1. Till / scarify subgrade to a minimum depth of 6 inches. Remove stones larger than 2 inches in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
2. Immediately install the Planting Soil. Protect the loosened area from traffic. DO NOT allow the loosened subgrade to become compacted.

3.4 PLACEMENT AND FINE GRADING

A. Spread unamended soil to depths required to meet finish grades after mixing with amendments and natural settlement. Do not spread if soil or subgrade is frozen, muddy, or excessively wet.

B. Remove all large stiff clods, lumps, brush, roots, stumps, litter and other foreign matter. Remove from unscreened soils all stones over 2 inch in diameter from the top 6 inches of the planting soils. Soils shall also be free of smaller stones in excessive quantities as determined by the Owner's Representative.

C. Apply soil amendments, (except compost) and fertilizer evenly on surface in accordance with soil test report recommendations and thoroughly blend them with unamended soil to produce planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.
   1. Mix lime and sulfur with dry soil before mixing fertilizer.
   2. Mix fertilizer with planting soil no more than seven days before planting.

D. Install planting soil in successive horizontal lifts no thicker than 6 inches in turf areas and 12 inches in plant bed areas to the desired compaction as described in this Section. The surface area of each lift hall shall be scarified by raking prior to placing the next lift.
   1. The depths and grades shown on the drawings are the final grades after settlement of the planting soils. Grade the finish surface of all planted areas so that the finished grades are slightly higher than the grades on the grading plan to anticipate any reduction of soil volume due to compaction, settling, erosion, decomposition, and other similar processes during the warranty period.
   2. In areas scheduled to receive sod, reduce elevation of planting soil to allow for soil thickness of sod to meet finish grade on plans.
   3. In plant bed areas, modify the grade so that the finish grade before adding mulch and after settlement is a maximum of one inch below any adjacent curbs or paved surfaces.

E. Compact planting soils to 82 - 85 percent of maximum dry density standard proctor according to ASTM D698.
   1. During the compaction process, all depressions caused by settlement or rolling shall be filled with additional planting soil and the surface shall be regraded and rolled until presenting a smooth and even finish corresponding to the required grades.
   2. In addition to the range cited above, compact each lift sufficiently to reduce settling but not enough to prevent the movement of water and feeder roots through the soil. The soil in each lift should feel firm to the foot in all areas and make only slight heel prints. At completion of the loam borrow installation, the soil should offer a firm, even resistance when a soil sampling tube is inserted from lift to lift.
   3. The Owner’s Representative may chose to perform percolation tests on installed planting soils in accordance with subgrade testing methods.
      a. In the event that percolation testing shows water drains through the soils at a rate less than one inch per hour, till the soil to depths required to break the over compaction and regrade to meet requirements of this specification at no additional cost to the Owner.

F. Sufficient grade stakes shall be set for checking the finished grades. Stakes must be set in the bottom of swales, at the top of slopes and at other critical grade locations. Deviation from indicated elevations that are greater than one-tenth of a foot shall not be permitted.

G. Connect contours and spot elevations with an even, smooth rounded slope. Finish grades shall be smooth and continuous with no abrupt changes at the top or bottom of slopes or at the interface with other surface materials.

H. Provide for positive drainage from all areas toward the existing inlets, drainage structures and or the edges of planting beds. Adjust grades as directed to reflect actual

constructed field conditions of paving, wall and inlet elevations. Notify the Owner's Representative if conditions make it impossible to achieve positive drainage.

I. Select equipment and phase work such that equipment to deliver or grade soil does not have to operate over previously installed Planting Soil to protect them from compaction.

J. Rake / scarify finished soil surface to a uniform, fine texture. Remove all large stiff clods, lumps, brush, roots, stumps, litter and other foreign matter, and stones over one inch in diameter.

K. Disturbed areas outside the limit of lawn work shall be graded smooth and spread with a minimum of 4 inches of planting soils and restored to original finished grade.

3.5 EROSION CONTROL

A. Immediately following the fine grading, erosion control practices including rolled erosion control products on slopes 3:1 or greater and at vegetated swales shall be installed in accordance with Section 329200, Turf and Grasses. The contractor shall be responsible for any temporary erosion control needed prior to establishment of vegetation, and repair and replacement of eroded areas.

3.6 PROTECTION

A. Protect areas of in-place soil from additional compaction, disturbance, erosion and contamination. Prohibit the following practices within these areas except as required to perform planting operations:
   1. Storage of construction materials, debris, or excavated material.
   2. Parking vehicles or equipment.
   3. Vehicle traffic.
   4. Foot traffic.
   5. Erection of sheds or structures.
   6. Impoundment of water.
   7. Excavation or other digging unless otherwise indicated.

B. If planting soil or subgrade is over compacted, disturbed, or contaminated by foreign or deleterious materials or liquids, remove the planting soil and contamination; restore the subgrade and replace contaminated planting soil with new planting soil in accordance with requirements of this Section. This includes compaction caused by other sub-contractors after the Planting Soil is installed and approved.

C. Repair and re-establish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or compaction due to subsequent construction operations or weather conditions. Scarify or remove and replace material to a depth as directed by the Owner's Representative; reshape and re-compact at optimum moisture content to the required density.

D. Where settling occurs, before final acceptance or during the warranty period, remove finish surfacing, backfill with additional approved material, compact to specified rates, and restore any disturbed areas to a condition consistent with Contract Documents.

3.7 CLEANING

A. Protect areas adjacent to planting-soil preparation and placement areas from contamination. Keep adjacent paving and construction clean and work area in an orderly condition.

B. Remove surplus soil and waste material including excess subsoil, unsuitable materials, trash, and debris and legally dispose of them off Owner's property unless otherwise indicated.

3.8 EXCESS MATERIALS

A. Contractor shall be responsible for maintaining all stockpiles of existing, on-site topsoil on the site until final placement of existing on-site topsoil and planting soils has been accepted by the Owner’s Representative. Contractor shall remove all excess, unused existing on-site topsoil from the site and dispose of it in a legal manner unless otherwise requested by the Owner.

END OF SECTION 329313

SECTION 331000 – WATER DISTRIBUTION PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
   1. Water-distribution piping and related components outside the building for combined water service and fire-service mains.

B. Related Sections:
   1. Drawings and General provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections.

1.2 DEFINITIONS

A. DIP: Ductile Iron Pipe.

1.3 SUBMITTALS

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

B. Field quality-control test reports.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Comply with requirements of the Veolia Water Department. Include tapping of water mains.
   2. Comply with standards of the Veolia Water Department for potable-water-service piping, including materials, installation, testing, and disinfection.
   3. Comply with standards the Veolia Water Department for fire-suppression water-service piping, including materials, hose threads, installation, and testing.

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

C. Comply with FMG's "Approval Guide" or UL's "Fire Protection Equipment Directory" for fire-service-main products.

D. NFPA Compliance: Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-service-main piping for fire suppression.

E. NSF Compliance:
   1. Comply with NSF 61 for materials for water-service piping and specialties for domestic water.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Preparation for Transport: Prepare valves, including fire hydrants, according to the following:
   1. Ensure that valves are dry and internally protected against rust and corrosion.
   2. Protect valves against damage to threaded ends and flange faces.
   3. Set valves in best position for handling. Set valves closed to prevent rattling.

B. During Storage: Use precautions for valves, including fire hydrants, according to the following:

1. Do not remove end protectors unless necessary for inspection; then reinstall for storage.
2. Protect from weather. Store indoors and maintain temperature higher than ambient dew-point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.

C. Handling: Use sling to handle valves and fire hydrants if size requires handling by crane or lift. Rig valves to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

D. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.

E. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.

F. Protect flanges, fittings, and specialties from moisture and dirt.

G. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

1.6 PROJECT CONDITIONS

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

1. Notify Construction Manager no fewer than two days in advance of proposed interruption of service.
2. Do not proceed with interruption of water-distribution service without Owner's written permission.

1.7 COORDINATION

A. Coordinate connection to water main with the Veolia Water Department and the Construction Manager.

PART 2 - PRODUCTS

2.1 DUCTILE-IRON PIPE AND FITTINGS

A. Pipe:

1. Centrifugally cast in accordance with ANSI/AWWA C151/A21.51.
2. Working Pressure: 150 psi
3. Pressure Class: 350 psi
4. Class 54 pipe
5. Joints: Push-on, ANSI/AWWA C111/A21.11
6. Laying Length: 18 or 20 feet.

B. Fittings:

1. Cast or Ductile Iron: ANSI/AWWA C110/21.10, or ANSI/AWWA C153/A21.53 ductile iron compact fittings.
2. Joints: Mechanical, ANSI/AWWA C111/A21.11
3. Working Pressure: 250 psi, if ANSI/AWWI C110/A21.10 fittings are used or 350 psi if ANSI/AWWA C153/A21.
4. All fittings shall include the appropriate accessories required for installation.

C. Lining and Coating:
1. All ductile iron pipe and fittings shall be furnished with a seal coated cement mortar lining conforming to ANSI/AWWA C104/A21.4, except that the lining thickness shall be twice the standard thickness and never less than 1/8 inch.
2. Buried pipe and fittings shall be furnished with a 1 mil thick standard petroleum asphaltic coating conforming to ANSI A21.51, and shall be wrapped with polyethylene film in accordance with ANSI/AWWA C105/A21.5.

2.2 JOINING MATERIALS
A. Refer to Division 22 Section "Common Work Results for Plumbing" for commonly used joining materials.

2.3 PIPING SPECIALTIES
A. Transition Fittings: Manufactured fitting or coupling same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

2.4 GATE VALVES
A. AWWA, Ductile-Iron Gate Valves:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
a. American AVK Co.; Valves & Fittings Div.
b. American Cast Iron Pipe Co.; American Flow Control Div.
c. American Cast Iron Pipe Co.; Waterous Co. Subsidiary.
d. Crane Co.; Crane Valve Group; Stockham Div.
e. East Jordan Iron Works, Inc.
f. McWane, Inc.; Clow Valve Co. Div. (Oskaloosa).
g. McWane, Inc.; Kennedy Valve Div.
h. McWane, Inc.; M & H Valve Company Div.
i. McWane, Inc.; Tyler Pipe Div.; Utilities Div.
j. Mueller Co.; Water Products Div.
k. NIBCO INC.
l. U.S. Pipe and Foundry Company.
2. Nonrising-Stem, High-Pressure, Resilient-Seated Gate Valves:
a. Description: Ductile-iron body and bonnet; with bronze or ductile-iron gate, resilient seats, bronze stem, and stem nut.
1) Standard: AWWA C509 or AWWA C515.
2) Minimum Pressure Rating: 250 psig (1725 kPa).
3) End Connections: Mechanical joint conforming to ANSI A21.11.
4) Interior Coating: Complying with AWWA C550.
5) Valves shall be Mueller brand, open left (counterclockwise). Contractor to verify compatibility of opening direction with Veolia Water Department standard.
6) Each valve shall be furnished complete with necessary nuts, bolts, studs, and gaskets.
B. Valve Boxes: Comply with AWWA M44 for cast-iron valve boxes. Include top section, adjustable extension of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over valve and with a barrel

approximately 5 inches in diameter.

1. Operating Wrenches: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut.

2.5 GATE VALVE ACCESSORIES AND SPECIALTIES

A. Tapping-Sleeve Assemblies Valves:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. American Cast Iron Pipe Co.; Waterous Co. Subsidiary.
b. East Jordan Iron Works, Inc.
c. Flowserve.
d. McWane, Inc.; Clow Valve Co. Div. (Oskaloosa).
e. McWane, Inc.; Kennedy Valve Div.
f. McWane, Inc.; M & H Valve Company Div.
g. Mueller Co.; Water Products Div.
h. U.S. Pipe and Foundry Company.

2. Description: Sleeve and valve compatible with drilling machine.

a. Standard: MSS SP-60.
b. Tapping Sleeve: Stainless-steel, two-piece bolted sleeve with flanged outlet for new branch connection. Include sleeve matching size and type of pipe material being tapped and with recessed flange for branch valve.
c. Valve: AWWA C515, ductile-iron, nonrising-stem, resilient-seated gate valve with one raised face flange mating tapping-sleeve flange. Valves shall open left (counterclockwise), with a standard 2-inch square operating nut with arrow cast on it showing the direction of opening.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Refer to Section 312000 "EARTHWORK-SITE" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

A. General: Use pipe, fittings, and joining methods for piping systems according to the following applications.
B. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used, unless otherwise indicated.
C. Do not use flanges or unions for underground piping.
D. Flanges, unions, grooved-end-pipe couplings, and special fittings may be used, instead of joints indicated, on aboveground piping and piping in vaults.
E. Underground Combined Water-Service and Fire-Service-Main Piping NPS 4 to NPS 12 shall be ductile iron, mechanical-joint pipe; ductile-iron, mechanical-joint

fittings; and ductile iron, mechanical joints.

3.3 VALVE APPLICATIONS

A. General Application: Use mechanical-joint-end valves for NPS 3 and larger underground installation and corporation and curb valves for smaller than NPS 3.

B. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Underground Valves, NPS 3 and Larger: AWWA, ductile-iron, nonrising-stem, high-pressure, resilient-seated gate valves with valve box.

3.4 PIPING SYSTEMS - COMMON REQUIREMENTS

A. See Division 22 Section "Common Work Results for Plumbing" for piping-system common requirements.

3.5 PIPING INSTALLATION

A. Water-Main Connection: Tap water main according to requirements of water utility company and of size and in location indicated.

B. Make connections larger than NPS 2 with tapping machine according to the following:

1. Install tapping sleeve and tapping valve according to MSS SP-60.
2. Install tapping sleeve on pipe to be tapped. Position flanged outlet for gate valve.
3. Use tapping machine compatible with valve and tapping sleeve; cut hole in main. Remove tapping machine and connect water-service piping.
4. Install gate valve onto tapping sleeve. Comply with MSS SP-60. Install valve with stem pointing up and with valve box.

C. Install ductile-iron, water-service piping according to AWWA C600 and AWWA M41.

D. Bury piping with depth of cover over top at least 60 inches, with top at least 12 inches below level of maximum frost penetration.

E. Extend water-service piping and connect to water-supply source and building-water-piping systems at outside face of building wall in locations and pipe sizes indicated.

1. Terminate water-service piping at building wall until building-water-piping systems are installed. Terminate piping with caps, plugs, or flanges as required for piping material. Make connections to building-water-piping systems when those systems are installed.

F. Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports.

G. See Division 22 Section "Domestic Water Piping" for potable-water piping inside the building.

3.6 JOINT CONSTRUCTION

A. See Division 22 Section "Common Work Results for Plumbing" for basic piping joint construction.

B. Make pipe joints according to the following:

1. Ductile-Iron Piping, Gasketed Joints for Water-Service Piping: AWWA C600 and AWWA M41.

3.7 ANCHORAGE INSTALLATION

A. Anchorage, General: Install water-distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include the following:
   1. Concrete thrust blocks.
   2. Locking mechanical joints.
   3. Set-screw mechanical retainer glands.
   4. Bolted flanged joints.
   5. Pipe clamps and tie rods.

B. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:
   1. Gasketed-Joint, Ductile-Iron, Water-Service Piping: According to AWWA C600.

C. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

3.8 VALVE INSTALLATION

A. AWWA Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.

3.9 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. See Division 22 Section "Common Work Results for Plumbing" for piping connections to valves and equipment.

C. Connect water-distribution piping to existing water main.

3.10 FIELD QUALITY CONTROL

A. Piping Tests: Conduct piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.

B. Hydrostatic Tests: Test at not less than one-and-one-half times working pressure for two hours. Increase pressure in 50-psig (350-kPa) increments and inspect each joint between increments. Hold at test pressure for 1 hour; decrease to 0 psig (0 kPa). Slowly increase again to test pressure and hold for 1 more hour. The maximum allowable leakage for a two-hour test per 1000 feet length of different sizes and nominal laying lengths of pipe shall be as shown in the following table:

Pipe Size (Inches)	Allowable Leakage at 150 PSI (Gallons/Two Hours/1000 Feet of Pipe)
4	0.66
6	1.00
8	1.32

Remake leaking joints with new materials and repeat test until leakage is within allowed limits.

C. Prepare reports of testing activities.

3.11 IDENTIFICATION

A. Install continuous underground detectable warning tape during backfilling of trench for underground water-distribution piping. Locate below finished grade, directly over piping. Underground warning tapes are specified in Section 312000 "EARTHWORK-SITE."

3.12 CLEANING

A. Clean and disinfect water-distribution piping as follows:
   1. Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.
      a. Fill system or part of system with water/chlorine solution containing at least 50 ppm of chlorine; isolate and allow to stand for 24 hours.
      b. After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.
      c. Take (2) water samples taken at least 24 hours apart in sterile bottles. Samples shall be tested for bacteriological quality and show the absence of coliform organisms. Repeat procedure if biological examination shows evidence of contamination.

B. Prepare reports of purging and disinfecting activities.

END OF SECTION 331000

SECTION 333000 – SANITARY SEWER SYSTEM

PART 1 - GENERAL

1.1 Section Includes:

A. Section includes furnishing all labor, materials, equipment and services required to complete and make fully functional, the work indicated on the Contract Drawings and as described in the Contract Documents. Work includes, but is not limited to the following:

1. Furnishing all work not required in other sections to complete and make operational the sewer system outside the building.
2. Sanitary sewer gravity piping.
3. Connections to the building sewer laterals after the cleanout.
4. Connecting new sanitary sewer piping to existing sanitary mains.

B. Excavation, bedding and backfill required for pipe installation is specified in Division 31 Specification Section 312000 “SITE EARTHWORK”.

1.2 SUBMITTALS

A. General: Submit each item to be used as part of the work for this section according to the Conditions of the Contract and Division 1 Specification Sections.

B. Shop drawings: Submit shop drawings and product data for sanitary sewer systems, showing piping materials, size, locations, and inverts. Include details of underground structures connections, and cleanouts.

C. Record Drawings: At project closeout, submit Record Drawings of installed sanitary sewerage piping and products, in accordance with requirements of General Conditions.

D. Inspection and test reports are specified in the Field Quality Control sub section.

1.3 QUALITY ASSURANCE

A. Manufacturer’s Qualifications: Firms regularly engaged in manufacture of sanitary sewerage and drainage system products of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than five (5) years.

B. Installer Qualifications: Firm with at least three (3) years of successful installation experience on projects with sanitary sewerage and drainage work similar to that required for Project.

C. Codes and Standards:

1. Plumbing Code Compliance: Comply with applicable portions of National Standard Plumbing Code pertaining to selection and installation of sanitary sewerage system materials and products.
2. New York State Regulation Compliance: Comply with the rules, regulations and standards of the New York State Department of Health (NYSDOH) and the New York State Department of Environmental Conservation (NYSDEC) pertaining to sanitary sewer systems.

1.4 PROJECT CONDITIONS

A. Refer to utility plans of Contract Drawings pertaining to existing above ground and underground utilities.

B. Field verify conditions at existing manholes or sanitary lines to remain which are scheduled to connect with proposed structures or pipes. Notify the Owners Designated Representative of any conditions varying from those indicated on the survey.

C. Interruption of Existing Sanitary Sewer Service: Do not interrupt sanitary sewer service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sanitary sewer service according to requirements indicated:

1. Notify Construction Manager no fewer than two days in advance of proposed interruption of sanitary sewer service.
2. Do not proceed with interruption of sanitary sewer service without Construction Manager's written permission.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic pipe or fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

1.6 SEQUENCING AND SCHEDULING

A. Coordinate sanitary sewerage system connections to related structures and building piping.

B. Coordinate with interior building drainage systems to avoid conflicts.

C. Coordinate with other utility work.

PART 2 - PRODUCTS

2.1 PVC PIPES AND FITTINGS

A. Polyvinyl Chloride (PVC) Sewer Pipe and Fittings: ASTM D 3034, SDR 26 gravity sewer pipe, non-perforated, for elastomeric gasket joints.

1. Gaskets: ASTM F 477, elastomeric seal.

2.2 SPECIAL PIPE COUPLINGS AND FITTINGS

A. Sleeve-Type Pipe Couplings: Rubber or elastomeric sleeve and band assembly fabricated to match outside diameters of pipes to be joined, for nonpressure joints.

1. Sleeves for Cast Iron Soil Pipe: ASTM C 564, rubber.
2. Sleeves for Plastic Pipe: ASTM F 477, elastomeric seal.
3. Sleeves for Dissimilar Pipes: Compatible with pipe materials being joined.
4. Bands: Stainless steel at least one at each pipe insert.

B. Gasket-Type Pipe Couplings: Rubber or elastomeric compression gasket, made to match outside diameter of smaller pipe and inside diameter or hub of adjoining larger pipe, for nonpressure joints.

1. Gaskets for Cast Iron Soil Pipe: ASTM C 564, rubber.
2. Gaskets for Plastic Pipe: ASTM F 477, elastomeric seal.
3. Gaskets for Dissimilar Pipes: Compatible with pipe materials being joined.

C. Saddle Type: Flexible tap saddle made to match outside diameter of adjoining pipes. Saddle to conform to ASTM D5926, with stainless steel bands.

2.3 CONCRETE

A. General: Cast-in-place concrete according to ACI 318, ACI 350R, and the following:

1. Cement: ASTM C 150, Type II.
2. Fine Aggregate: ASTM C 33, sand.
3. Coarse Aggregate: ASTM C 33 crushed gravel.
4. Water: Potable.

2.4 GREASE TRAP

A. Molded Polyethylene Seamless Grease Trap: Basis of design product GB-250 by Schier, or equal.
B. Riser Sections: Diameter and lengths to provide depth indicated on drawings. Basis of design is Fast Pitch by Schier, or equal.
C. Top Section: Flat slab top with risers to meet grade.
D. Resilient Connectors: ASTM C 923, of size required for piping, fitted into inlet and outlet openings: by Lockjoint, Kor-N-Seal or equal with stainless steel band clamp.
E. Frame and Cover: ASTM A 48, Class 35B, heavy-duty gray cast iron. Include indented top design with lettering stating “Grease Interceptor”, cast into cover.
   1. Size: 24” diameter

2.5 CLEANOUT TO GRADE

A. Cleanout as detailed on Construction Drawings. Cleanout shall be Polyvinyl Chloride (PVC) with a ferrous metal cleanout cap. Lettering on cover to read “SEWER”.
   1. Available manufacturers:
      a. Neenah Foundry Company, No. 1975-A, 2121 Brooks Ave., Neenah, WI 54956, (800) 558-5075.
      b. Syracuse Castings Company, No. 4155, 6177 South Bay Road, Cicero, NY 13039, (315) 699-2982.
      c. Or approved equal.

PART 3 - EXECUTION

3.1 GENERAL

A. Work of this part shall include furnishing all required materials, manpower, tools and equipment necessary to complete the installation of the Sanitary Sewer System as described herein and shown on the drawings and shall include all materials described in Part 2 unless approved otherwise in advance in writing.

3.2 EARTHWORK

A. Excavating, trenching and backfilling are specified in Division 31, Section 312000 “Earthwork-Site.”

3.3 IDENTIFICATION

A. Materials and their installation are specified in Division 31, Section 312000 “SITE EARTHWORK.” Furnish and install green warning tapes directly over piping at proper depth for location by detection equipment and at outside edges of underground structures.

1. Use warning tapes or detectable warning tape over ferrous piping.
2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.4 SANITARY SEWER PIPING APPLICATIONS

A. General: Include watertight joints.

B. Refer to Part 2 of this Section for detailed specifications for pipe and fitting products listed below. Use pipe, fittings, and joining methods according to the following applications.

1. Pipe Sizes: 4 inches and 6 inches: Polyvinyl chloride (PVC) sanitary sewer pipe and fittings; with gaskets and gasketed joints.

3.5 GREASE TRAP

A. Install components in accordance with manufacturer’s instructions and approved product data submittals.

3.6 SPECIAL PIPE COUPLING AND FITTING APPLICATIONS

A. Special Pipe Couplings: Use where indicated and where required to join piping and no other appropriate method is specified. Do not use instead of specified joining methods.

1. Use the following pipe couplings for nonpressure applications:
   a. Straight-pattern, sleeve type to join piping, of same size, with small difference in outside diameters.
   b. Increaser/reducer-pattern, sleeve type to join piping of different sizes.
   c. Gasket type to join piping of different sizes where annular space between smaller piping's outside diameter and larger piping's inside diameter permits installation.
   d. Internal-expansion type to join piping with same inside diameter.

3.7 INSTALLATION, GENERAL

A. General Locations and Arrangements: Drawings (plans and details) indicate the general location and arrangement of underground sanitary sewer systems piping. Location and arrangement of piping layout take into account many design considerations. Install piping as indicated, to extent practical.

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 according to 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 fittings for branch connections, except where direct tap into existing sanitary sewer is indicated.

D. Use proper size increasers, reducers, and couplings, where different sizes or materials of pipes and fittings are connected. Reduction of the size of piping in the direction of flow is prohibited.

E. Install gravity-flow-systems piping at constant slope between points and elevations indicated. Install straight piping runs at constant slope, not less than that specified, where slope is not indicated.

3.8 PIPE JOINT CONSTRUCTION AND INSTALLATION

A. General: Join and install pipe and fittings according to the following.
   1. Polyvinyl Chloride (PVC) Plastic Pipe and Fittings: As follows:
      a. Join solvent-cement-joint pipe and fittings with solvent cement according to ASTM D 2855 and ASTM F 402.
      b. Join pipe and gasketed fittings with elastomeric seals according to ASTM D3212.
   2. Join piping made of different materials or dimensions with couplings made for this application. Use couplings that are compatible with and fit both systems' materials and dimensions.

3.9 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318, ACI 350R, and as indicated.

3.10 FIELD QUALITY CONTROL

A. Clear interior of piping and structures of dirt and superfluous material as the 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 plug in end of incomplete piping at end of day and whenever work stops.
   3. Flush piping between manholes and other structures, if required by authorities having jurisdiction, to remove collected debris.

B. 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 the Project.
   1. Submit separate reports for each system inspection.
   2. Defects requiring correction include the following:
      a. Alignment: Less than full diameter of inside of pipe is visual between structures.
      b. Deflection: Flexible piping with deflection that prevents passage of a ball or cylinder of a size not less than 92.5 percent of piping diameter.
      c. Crushed, broken, cracked, or otherwise damaged piping.
      d. Infiltration: Water leakage into sanitary sewerage piping.
      e. Exfiltration: Water leakage from or around sanitary sewerage 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.

END OF SECTION 333000

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SECTION 334100 - STORM DRAINAGE SYSTEM

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. This Section includes furnishing all labor, materials, equipment and services required to complete and make fully functional, the work indicated on the Contract Drawings and as described in the Contract Documents. This Section includes but is not limited to the following:
   1. Storm drainage pipes
   2. Drop Inlets
   3. Catch Basins
   4. Yard drains
   5. Trench drain

B. Related Sections:
   1. Excavation, pipe bedding and backfill, filter fabric, and underground warning tape are specified in Division 31 Specification Section 312000 “Earthwork-Site”.

1.2 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract.

B. Shop Drawings:
   1. Manholes and catch basins: Include plans, elevations, sections, details, frames, and covers.

C. Record Drawings: At project closeout, submit Record Drawings of installed storm drainage piping and products in accordance with requirements of General Condition.

D. Inspection and test reports specified in the "Field Quality Control" Article specified herein.

1.3 QUALITY ASSURANCE

A. Manufacturer’s Qualifications: Firms regularly engaged in manufacture of drainage system products of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than five (5) years.

B. Installer Qualifications: Firm with at least three (3) years of successful installation experience on projects with drainage work similar to that required for Project.

C. Codes and Standards:
   1. Plumbing Code Compliance: Comply with applicable portions of National Standard Plumbing Code pertaining to selection and installation of storm drainage system materials and products.
   2. New York State Regulation Compliance: Comply with the rules, regulations and standards of the New York State Department of Health (NYSDOH) and New York State Department of Environmental Conservation (NYSDEC) pertaining to storm drainage systems.

1.4 DEFINITIONS

A. Storm Drainage Piping: System of storm sewer pipe, fittings, and appurtenances for gravity flow of storm drainage water, surface and subsurface generated.

1.5 PERFORMANCE REQUIREMENTS

A. Gravity-Flow, Nonpressure-Piping Pressure Ratings: Silt-tight joints per ASTM F477 for HDPE Pipe.

1.6 DELIVERY, STORAGE, AND HANDLING
A. Do not store plastic structures in direct sunlight.
B. Do not store plastic pipe or fittings in direct sunlight.
C. Protect pipe, pipe fittings, and seals from dirt and damage.
D. Handle precast concrete catch basins and any other structures according to manufacturer's rigging instructions.

1.7 PROJECT CONDITIONS
A. Refer to utility plans of Contract Drawings pertaining to existing above ground and underground utilities.
B. Contractor shall obtain and pay for all permitting, inspection and connection fees associated with this project.

1.8 SEQUENCING AND SCHEDULING
A. Coordinate with interior building drainage systems. Site storm drainage contractor shall be responsible for connection to the building drainage system.
B. Coordinate with other utility work.

PART 2 - PRODUCTS

2.1 PIPES AND FITTINGS
A. Corrugated, High Density Polyethylene (PE) Drainage solid or perforated, as noted on plans, double wall smooth interior pipe: AASHTO M 252 Type S, for 3 inch to 10 inch diameter, AASHTO M 294 Type S, for 12 inch to 48 inch diameter.
1. Couplings: ASTM D 3350 and AASHTO M294, high density polyethylene sleeve with ASTM D 1056 Type 2, Class A, Grade 2 gasket material that mates with pipe and fitting for silt-tight joints.

2.2 YARD DRAINS
A. Polyvinyl chloride (PVC) inlet drains, risers, and catch basins: ASTM F 794, F 979 and F 1336 mechanical property requirements for fabricated fittings, of dimensions, pipe connections, orientations, and depth indicated:
1. Structures: PVC pipe stock reformed utilizing a thermo-molding process with specified inlet & outlet pipe connection stubs and risers sized to fit specified frame and grate.
2. Diameter: 18” minimum (unless otherwise noted).
3. Joints: Fabricated fittings shall conform to ASTM D 3212 for watertight connections.
B. Frame and grates: Grates shall be capable of supporting H-10 loading for pedestrian areas. Metal used in the manufacture of the castings shall conform to ASTM A536 grade 70-50-05 for ductile iron, painted black, manufactured to fit specified PVC riser fitting. Grates shall be ADA and lockable. Basis of design “standard” style grate by Nyloplast.
1. Grates in lawn areas shall be circular, grates in all other areas shall be square.

2.3 UNDERGROUND DETENTION SYSTEM

A. Corrugated, High Density Polyethylene (PE) Drainage solid, double wall smooth interior pipe: AASHTO M 294 Type S.

1. Joint Performance: Bell and spigot joint shall meet the soil-tight requirements of ASTM F2306 and gaskets shall meet the requirements of ASTM F477. Plain end pipe and fitting connections shall be joined with coupling bands covering at least two full corrugations on each end of the pipe. Gasketed soil-tight coupling band connections shall incorporate a closed-cell synthetic expanded rubber gasket meeting the requirements of ASTM D1056 Grade 2A2.
2. Fittings shall conform to ASTM F2306 and meet joint performance requirements indicated above for fitting connections.

2.4 MANHOLE

A. Precast square, reinforced concrete structures with integral base and accessories complying with the following:
   1. Riser Sections: ASTM C 890, height and width as indicated on the Contract Documents.
   2. Keyed joints between riser sections: Rubber gaskets per ASTM C443 as recommended by the manufacturer.
   3. Concrete for Pre-cast units: Air content 6% by volume with an allowable tolerance of +/-1.5%. Minimum compressive strength of 4000 psi after 28 days.
   4. Pre-cast concrete structure load ratings: AASHTO HS-20 with 30% impact and 130 lb/cf equivalent soil pressure.
B. Frame and Cover: ASTM 48/A 48M, Class 35, gray iron designed to meet AASHTO M306 loading with “Storm” lettering.
   1. Size: Transitional frame with 42” square flange and 24-28” clear opening diameter.
   2. Frame Height: 4” minimum

2.5 CATCH BASINS

A. Precast Concrete Catch Basin and Precast Concrete Manholes: ASTM C 478 precast, reinforced concrete, of depth indicated, with shiplap joints.
   1. Diameter: 48 inches minimum.
   2. Base Section: 8-inch minimum thickness for floor slab and 5-inch for walls and base riser section and having a base section with integral floor.
   3. Riser Sections: 8-inch minimum wall thickness and lengths to provide depth indicated
   4. Top Section: Flat-slab-top traffic type as indicated.
   5. Shiplap Joint Sealant: Butyl rope joint sealant; ASTM C990-91 and AASHTO M-198B.
   6. Grade Rings: Include 2 or 3 pre-cast reinforced-concrete rings, of 8-inch total thickness each, that match inside diameter of top section opening.
   7. Steps: ASTM C 478-85a and C497-85 individual steps manufactured of copolymer polypropylene plastic. Omit steps for catch basins less than 24 inches deep.
   8. Pipe Connectors: ASTM C 923 cast or fitted into manhole walls, for each pipe connection
B. Frame and Grates: ASTM 48/A 48M, Class 35, gray iron designed to meet AASHTO

M306 loading. Include flat grate that meets ADA standards for openings.
1. Size: 24 by 24 inches minimum unless otherwise indicated.
2. Frame Height: 4” minimum in traffic areas, 6” in lawn areas
3. Minimum open area: 250 sq. in
4. Basis-of-design is product V5622-80 from East Jordan Iron Works, Inc., Denver, CO, or approved equal

2.6 TRENCH DRAIN

A. General Requirements for Polyester polymer concrete, Channel Drainage Systems:
1. Modular system of polyester polymer concrete channel sections, grates, and appurtenances.
2. Designed so grates fit into frames without rocking or rattling.
3. Number of units required to form lengths depicted on the plans.

B. Basis-of-Design Product: Subject to compliance with requirements, provide ACO Drain K100 as manufactured by ACO Polymer Products, Inc. or comparable product by one of the following:
1. MultiDrain Systems, Inc.
2. NDS, Inc.
3. Zurn Pluming Products Group
4. DuraTrench

C. Channel Sections
1. Interlocking-joint, modular units, with neutral slopes with end caps.
2. Rounded or inclined inside bottom surface with outlets in quantities, sizes, and locations indicated.
3. Internal Width: 4 inches.

D. Field-attached frames that fit channel sections and grates.
1. Material: Stainless steel

E. Pedestrian Duty Grate
1. Basis-of-Design: Subject to compliance with requirements, provide ACO Drain Type 492D slotted black plastic grate manufactured by ACO Polymer Products, Inc. or comparable product by one of the following:
a. MultiDrain Systems, Inc.
b. NDS Inc.
c. Zurn Plumbing Products Group
d. DuraTrench
2. Grate shall by Class C load rated.
3. Ends of grates shall be cut if necessary to meet specified tolerances.

F. Supports, anchors, and setting devices: Manufacturer’s standard unless otherwise indicated.

G. Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.

2.7 CONCRETE

A. General: Cast-in-place concrete according to ACI 318, ACI 350R, and the following:
1. Cement: ASTM C 150, Type II, Portland Cement.
2. Fine Aggregate: ASTM C 33, sand.
3. Coarse Aggregate: ASTM C33 crushed gravel.
4. Water: Potable.

B. Structures: Portland-cement design mix, 4000-psi minimum, with 0.35 maximum

Water-to-Cement (W/C) ratio.

1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
2. Reinforcement Bars: ASTM A 615, Grade 60 deformed steel.

2.7 HYDRODYNAMIC SEPARATOR

A. Precast Concrete Structures: ASTM C 478 precast, reinforced concrete, of depth indicated, with shiplap joints.

B. Product shall be approved by New York State Department of Environmental Conservation, NYSDEC, for use in redevelopment.

C. Basis of Design Product: Subject to compliance with requirements, provide an S-3 Barracuda by Advanced Drainage Systems, 1-800-821-6710. The separator shall have the following minimum treatment flow capacity:
   1. Treatment flow: 1.0 cfs

D. Frame and grate: ASTM 48/A 48M, Class 35, gray iron designed to meet AASHTO M306 loading. Include flat grate with drainage openings that meet ADA requirements, size 24” x 24”, min. frame height 4”, with a minimum open area: 250 sq. in

   1. Basis-of-design is product V5622-80 from East Jordan Iron Works, Inc., Denver, CO, or approved equal

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating, trenching and backfilling are specified in Division 2 Specification Section 312000 “Earthwork-Site.”

3.2 DRAINAGE PIPING APPLICATIONS

A. General: Include silt tight joints as indicated.

B. Refer to Part 2 of this Section for detailed specifications for pipe and fitting products listed below. Use pipe, fittings, and joining methods according to the following applications.
   1. Pipe Sizes 8 to 48 Inches: AASHTO M 294 Interim, corrugated polyethylene (PE) plastic pipe and fittings; corrugated, silt-tight couplings: silt-tight coupled joints.

3.3 INSTALLATION, GENERAL

A. General Locations and Arrangements: Drawings (plans and details) indicate the general location and arrangement of underground storm drainage systems piping. Location and arrangement of piping layout take into account many design considerations. Install piping as indicated, to extent practical.

B. Use proper size increasers, reducers, and couplings, where different sizes or materials of pipes and fittings are connected. Reduction of the size of piping in the direction of flow is prohibited, unless indicated otherwise on the Contract Drawings.

C. Install gravity-flow-systems piping at constant slope between points and elevations indicated. Install straight piping runs at constant slope, not less than 1 percent, where slope is not indicated.

D. Extend drainage piping and connect to building's storm drains and footing drains, of

sizes and in locations indicated. Terminate piping as indicated.

3.4 MANHOLE/CATCH BASIN INSTALLATION

A. Construct all concrete structures to sizes and shapes indicated.
B. Set frames, grates and covers to elevations indicated.
C. Install piping according to manufacturer's standard specifications.

3.5 YARD DRAIN INSTALLATION

A. Excavate to required dimensions and elevations.
B. Install basin plumb and level, at elevations and locations indicated.
C. Install in accordance with manufacturer's latest published installation instructions.

3.6 CHANNEL DRAINAGE SYSTEM INSTALLATION

A. Install with top surfaces of components, except piping, 1/8" below finished surface.
B. Assemble channel sections to form slope down toward drain outlets. Use sealants, adhesives, fasteners, and other materials recommended by system manufacturer.
C. Embed channel sections and drainage specialties in 4-inch minimum concrete around bottom and sides.
D. Fasten grates to channel sections if indicated.
E. Assemble channel sections with flanged or interlocking joints.

3.7 UNDERGROUND DETENTION SYSTEM

A. Underground detention system shall be installed according to manufacturer recommendations and in accordance with ASTM D2321

3.8 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318, ACI 350R, and as indicated.

3.9 CLOSING ABANDONED STORM DRAINAGE SYSTEMS

A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below.
   1. Close open ends of piping with at least 8-inch thick, brick masonry bulkheads.
   2. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.
   3. Backfill to grade according to Section 31 20 00 "Site Earthwork."

3.10 CONNECTIONS

A. Make branch connections to underground manholes by cutting into existing unit and creating an opening large enough to allow 3 inches of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure

wall to conform to shape of and be flush with inside wall unless otherwise indicated.

B. Use concrete that will attain a minimum 28-day compressive strength of 3000 psi.

C. Use epoxy-bonding compound as interface between new and existing concrete and piping material.

D. Protect existing piping, manholes, and structures to prevent concrete or debris from entering while make tap connections. Remove debris or other extraneous material that may accumulate.

3.11 FIELD QUALITY CONTROL

A. Clear interior of piping and structures of dirt and superfluous material as the 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 plug in end of incomplete piping at end of day and whenever work stops.
   3. Flush piping between catch basins and other structures, if required by authorities having jurisdiction, to remove collected debris.

B. 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 the Project.
   1. Submit separate reports for each system inspection.
   2. Defects requiring correction include the following:
      a. Alignment: Less than full diameter of inside of pipe is visual between structures.
      b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of a size not less than 92.5 percent of piping diameter.
      c. Crushed, broken, cracked, or otherwise damaged 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.

C. 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 authorities having jurisdiction.
   3. Schedule tests, and their inspections by authorities having jurisdiction, with at least 24 hours advance notice.
   4. Submit separate reports for each test.
   5. Where authorities having jurisdiction do not have published procedures, perform tests as follows:
      a. Storm Drainage: Perform lamping of HDPE pipe sections between drainage structures.

D. Contractor shall clean all existing and new storm drainage piping and structures prior to substantial completion. This is to include excavating accumulated sediments and debris in all catch basins, area drains, etc.

END OF SECTION 334100

SECTION 334600 - SUBDRAINAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Perforated-wall pipe and fittings.
2. Geotextile filter fabrics.

B. Related Sections Include the Following:

1. Division 07 Sections "Self-Adhering Sheet Waterproofing" for molded-sheet drainage panels installed with subdrainage.

1.2 SUBMITTALS

A. Product Data:

1. Geotextile filter fabrics.

PART 2 - PRODUCTS

2.1 PERFORATED-WALL PIPES AND FITTINGS

A. Perforated PVC Sewer Pipe and Fittings: meeting the requirements of AASHTO M278, Class PS46 PVC pipeing system for subsurface drainage of transportation facilities. Provide ASTM D 2729, Schedule 40, rigid PVC pipe in 4 inch diameter, with bell-and-spigot ends, for loose joints.

2.2 SOIL MATERIALS

A. Soil materials are specified in Section 312000 "Earthmoving."

2.3 GEOTEXTILE FILTER FABRICS

A. Description: Fabric of PP or polyester fibers or combination of both, with flow rate range from 110 to 330 gpm/sq. ft. (4480 to 13 440 L/min. per sq. m) when tested according to ASTM D 4491.

B. Structure Type: Nonwoven, needle-punched continuous filament.

1. Survivability: AASHTO M 288 Class 2.
2. Styles: Flat and sock.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces and areas for suitable conditions where subdrainage systems are to be installed.

B. Verify that drainage panels installed as part of foundation wall waterproofing is properly positioned to drain into subdrainage system.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Section 312000 "Earthmoving."

3.3 FOUNDATION DRAINAGE INSTALLATION

A. Place impervious fill material on subgrade adjacent to bottom of footing after concrete footing forms have been removed. Place and compact impervious fill to dimensions indicated, but not less than 6 inches (150 mm) deep and 12 inches (300 mm) wide.

B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.

C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 4 inches (100 mm).

D. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with adhesive or tape.

E. Install drainage piping as indicated in Part 3 "Piping Installation" Article for foundation subdrainage.

F. Add drainage course to width of at least 6 inches (150 mm) on side away from wall and to top of pipe to perform tests.

G. After satisfactory testing, cover drainage piping to width of at least 6 inches (150 mm) on side away from footing and above top of pipe to within 12 inches (300 mm) of finish grade.

H. Install drainage course and wrap top of drainage course with flat-style geotextile filter fabric.

I. Place layer of flat-style geotextile filter fabric over top of drainage course, overlapping edges at least 4 inches (100 mm).

J. Install drainage panels on foundation walls as follows:

1. Coordinate placement with other drainage materials.

2. Lay perforated drainage pipe at base of footing. Install as indicated in Part 3 "Piping Installation" Article.
3. Separate 4 inches (100 mm) of fabric at beginning of roll and cut away 4 inches (100 mm) of core. Wrap fabric around end of remaining core.
4. Attach panels to wall beginning at subdrainage pipe. Place and secure molded-sheet drainage panels, with geotextile facing away from wall.

K. Place backfill material over compacted drainage course. Place material in loose-depth layers not exceeding 6 inches (150 mm). Thoroughly compact each layer. Final backfill to finish elevations and slope away from building.

3.4 PIPING INSTALLATION

A. Install piping beginning at low points of system, true to grades and alignment indicated, with unbroken continuity of invert. Bed piping with full bearing in filtering material. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions and other requirements indicated.

1. Foundation Subdrainage: Install piping level and with a minimum cover of 36 inches (915 mm) unless otherwise indicated.
2. Lay perforated pipe with perforations down.
3. Excavate recesses in trench bottom for bell ends of pipe. Lay pipe with bells facing upslope and with spigot end entered fully into adjacent bell.

B. Use increasers, reducers, and couplings made for different sizes or materials of pipes and fittings being connected. Reduction of pipe size in direction of flow is prohibited.

C. Install thermoplastic piping according to ASTM D 2321.

3.5 PIPE JOINT CONSTRUCTION

A. Join perforated PVC sewer pipe and fittings according to ASTM D 3212 with loose bell-and-spigot, push-on joints.

B. Special Pipe Couplings: Join piping made of different materials and dimensions with special couplings made for this application. Use couplings that are compatible with and fit materials and dimensions of both pipes.

3.6 BACKWATER VALVE INSTALLATION

A. Comply with requirements for backwater valves specified in Section 334100 "Storm Utility Drainage Piping."

B. Install horizontal backwater valves in header piping downstream from perforated subdrainage piping.

C. Install horizontal backwater valves in piping where indicated.

3.7 CLEANOUT INSTALLATION

A. Comply with requirements for cleanouts specified in Section 334100 "Storm Utility Drainage Piping."

B. Cleanouts for Foundation Subdrainage:

1. Install cleanouts from piping to grade. Locate cleanouts at beginning of piping run and at changes in direction. Install fittings so cleanouts open in direction of flow in piping.
2. In vehicular-traffic areas, use NPS 4 (DN 100) cast-iron soil pipe and fittings for piping branch fittings and riser extensions to cleanout. Set cleanout frames and covers in a cast-in-place concrete anchor, 18 by 18 by 12 inches (450 by 450 by 300 mm) deep. Set top of cleanout flush with grade.
3. In nonvehicular-traffic areas, use NPS 4 (DN 100) PVC pipe and fittings for piping branch fittings and riser extensions to cleanout. Set cleanout frames and covers in a cast-in-place concrete anchor, 12 by 12 by 4 inches (300 by 300 by 100 mm) deep. Set top of cleanout 1 inch (25 mm) above grade.
4. Comply with requirements for concrete specified in Section 033000 "Cast-in-Place Concrete."

3.8 CONNECTIONS

A. Comply with requirements for piping specified in Section 334100 "Storm Utility Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect low elevations of subdrainage system to solid-wall-piping storm drainage system.

3.9 IDENTIFICATION

A. Arrange for installation of green warning tapes directly over piping. Comply with requirements for underground warning tapes specified in specified in Section 312000 "Earthmoving."

1. Install detectable warning tape over nonferrous piping and over edges of underground structures.

3.10 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. After installing drainage course to top of piping, test drain piping with water to ensure free flow before backfilling.
2. Remove obstructions, replace damaged components, and repeat test until results are satisfactory.

B. Drain piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.11 CLEANING

A. Clear interior of installed piping and structures of dirt and other superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed. Place plugs in ends of uncompleted pipe at end of each day or when work stops.

END OF SECTION 334600