SECTION 22 04 00

GENERAL REQUIREMENTS FOR PLUMBING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes: Every item of labor, materials, equipment and appurtenances for installing Plumbing Systems included in Division 22 of the Specifications.

B. Related Sections:

1. Section 01 91 13 – General Commissioning Requirements
2. Section 03 30 00 – Cast–in Place Concrete
3. Section 22 05 13 – Common Motor Requirements for Plumbing Equipment
4. Section 22 05 23 – General-Duty Valves for Plumbing Piping
5. Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment
6. Section 22 05 33 – Heat Tracing for Plumbing Piping
7. Section 22 05 53 – Painting and Identification for Plumbing Piping and Equipment
8. Section 22 07 00 – Plumbing Insulation
9. Section 22 11 16 – Domestic Water Piping
10. Section 22 11 19 – Domestic Water Piping Specialties
11. Section 22 11 23 – Domestic Water Pumps
12. Section 22 13 16 – Sanitary Waste and Vent Piping
13. Section 22 13 19 – Sanitary Waste Piping Specialties
14. Section 22 14 13 – Facility Storm Drainage Piping
15. Section 22 14 23 – Storm Drainage Piping Specialties

16. Section 22 14 29 – Sump Pumps

17. Section 22 16 13 – Facility Natural – Gas Piping

18. Section 22 33 00 – Electric, Domestic – Water Heaters

19. Section 22 34 00 – Fuel–Fired, Domestic – Water Heaters

20. Section 22 40 00 – Plumbing Fixtures

21. Section 22 47 00 – Drinking Fountains and Water Coolers

22. Section 23 09 00 – Instrumentation and Control for HVAC

23. Section 23 50 00 – Central Heating Equipment

24. Division 26 – Electrical

25. Division 31 – Earthwork

26. Division 33 - Utilities

1.03 DRAWINGS

A. The Plumbing Drawings are diagrammatic in nature and show the general arrangement of all piping, equipment and appurtenances and shall be followed as closely as actual building construction and the work of other trades will permit. Because of the small scale of the Plumbing Drawings, it is not feasible to indicate all offsets, fittings and accessories that may be required. The Contractor shall investigate the construction conditions affecting the work and provide fittings and accessories as required to meet actual conditions.

B. Where discrepancies in scope of work as to which Trade provides specific items, such as starters, disconnects, flow switches, electrical control components, etc. exist, such conflicts shall be reported to the Engineer. If such action is not taken, the Contractor, as applicable, shall furnish such items as part of his work, for complete and operable systems and equipment, as determined by the Engineer.

1.04 REGULATIONS AND STANDARDS

A. The completed installation and all materials and equipment shall conform to local ordinances and codes, other regulations and standards listed herein or in related sections. These are intended as a minimum and shall be exceeded if required by the specifications or the Drawings. In the event of conflict between the codes, standards, or regulations, and information contained in the Contract Documents, the applicable code, standards, or regulation shall take precedence.

1.05 LIMITS OF CONTRACT:

A. Sanitary Sewer, Storm Sewer and Water Service piping shall be extended under this section of the specifications to a point 5'-0" beyond the building line, unless otherwise indicated on the drawings, where the pipes shall be capped or plugged with location identified and left ready for connection and extension included under Division 33 Utilities.

1.06 INSPECTION CERTIFICATES

A. The Contractor shall furnish three copies of certificates of final acceptance to the Engineer from all inspection authorities having jurisdiction.

1.07 SUBSTANTIAL COMPLETION INSPECTION

A. The Engineer will visit the site for the purpose of conducting a substantial completion inspection once the following items have been met by the Contractor:

1. All Plumbing systems shall be complete, operational and under automatic control.

2. Plumbing systems cleaning, balancing, and testing shall be complete and the final report shall be approved by the Engineer.

B. All discrepancies noted in the substantial completion report shall be corrected prior to the final inspection. The Contractor shall provide a detailed item-by-item description of all corrections made for each item on the substantial completion discrepancy list prior to scheduling final inspection by the Engineer. Additional visits required after the final inspection, for the reason that previously documented discrepancies had not been corrected at the time of the final inspection, will be made at the Contractor’s expense.

1.08 ASBESTOS

A. Asbestos Free Materials: The intention of these Drawings and specifications is that there are no asbestos-containing materials installed on this project. To the best of the Architects and Engineers knowledge, none of the material or equipment specified herein or shown on the Drawings contains asbestos. The Contractor shall make every effort to prevent any asbestos materials from being installed in or used on the construction of the project. At the completion of the project, the Contractor shall certify by letter that to the best of his knowledge, no asbestos-containing materials were used for or in the construction of this project.

B. Existing Materials:

1. Contractor shall review the Owners asbestos management plan to ensure suspected asbestos containing materials are under surveillance.

2. Discovery: If during the construction of this project, work involving friable asbestos is suspected, or encountered, all work in this area shall be discontinued and the Owner or the

Owner's representative, shall be notified immediately and the Owner with his own forces or by separate contract shall be responsible for complete investigation, removal, and disposition of the friable asbestos hazard in accordance with applicable laws and regulations. If the Contractor claims that delay or additional cost is involved because of such action by the Owner, he shall make such claim as provided elsewhere in the Contract Documents.

3. Removal: All work involving the removal of friable asbestos will be done under a separate contract.

1.09 MATERIALS AND WORKMANSHIP

A. Equipment and material used in the project shall be new and undamaged. The Plumbing installation shall fit into the space allotted and shall allow adequate and acceptable clearances for entry, servicing and maintenance. Similar types of equipment shall be the products of the same manufacturer unless specified otherwise. Work shall be performed by mechanics or tradesmen skilled in the trade involved.

B. All piping and equipment shall be installed in a neat and organized manner, parallel to other work and the nearest building elements, unless specifically shown otherwise on the Drawings.

C. Equipment and materials shall be suitable for use in the environment in which they are installed. Equipment exposed to outside conditions shall be adequately protected from the weather, manufactured from materials suitable for outdoor use, and designed specifically for use in outdoor environments.

1.10 SUBMITTALS

A. Submit shop drawings, product data and samples in accordance with Division 01 for all items as specified in related sections of these specifications. One (1) PDF format of the submittal shall be submitted. One (1) PDF format of the submittal will be returned to the Contractor. All submittal data shall be correctly identified to show project name, and the exact model, style or size of item being submitted. Improperly identified submittals will not be reviewed by the Engineer. Each item submitted for review shall bear the Subcontractor's stamp which states that they have reviewed the submission, that it is complete, and that in their opinion it meets the contract requirements. Contractor's stamp shall identify the specification section, paragraph and page number for which the submittal is being made. Shop drawings will be reviewed only for general compliance with the Contract Documents. Review will not include correctness of details, proper configuration, utility connections, dimensions, sizes, quantities, and the like. Any submission which has not been reviewed and stamped by the Plumbing Subcontractor will not be reviewed be the Engineer. No reviews prior to award of Contract will be considered or accepted. Re-submissions of shop drawings, product data and samples shall include the entire original submittal. **Partial submittals will not be reviewed by the Engineer.**

B. Submissions will be stamped by the Engineer in one of the following ways:

“No Exceptions Taken"	No exceptions are taken and subject to compliance\ with the Contract Documents.
"Make Corrections Noted"	Minor corrections are noted and a re-submittal is not required subject to compliance with the corrections and the Contract Documents.
"Correct and Resubmit "	The submitted material, method or system meets the intent of the specifications, yet has insufficient data to determine compliance with the Contract Documents. Re-submittal is required.
"Rejected"	The submitted material, method or system does not meet the intent of the specifications, or has insufficient data to determine compliance with the Contract Documents.

C. Submission Procedures:

1. If a submission is satisfactory to the Engineer, the Engineer will annotate the submission, "No Exceptions Taken" or "Make Corrections Noted" and transmit one (1) PDF format to the Contractor. If a resubmission is required, the Engineer will annotate the submission “Correct and Resubmit” or "Rejected" and transmit one (1) format to the Contractor for appropriate action.

2. The Contractor shall revise and resubmit submissions as required by the Engineer until submissions are acceptable to the Engineer.

3. Approval of a working and/or shop drawings by the Engineer will constitute acceptance of the subject matter for which the drawing was submitted and not for any other structure, material, equipment or appurtenances indicated as shown.

4. The Engineer's review of the Contractor's submissions shall in no way relieve the Contractor of any of his responsibilities under the Contract. An approval of a submission shall be interpreted to mean that the Engineer has no specific objections to the submitted material, subject to conformance with the Contract Documents.

5. Where as-built drawings, record drawings and specifications are available and when provided to the Contractor for use in performing the work, the Contractor shall verify the content of such drawings and specifications, the suitability of their use in performing the work and their accuracy for the purposes in which the Contractor intends to use any record or historical documents which may be obtained. In no case shall the Contractor assume that such documents reflect a true and accurate record of the construction. Acceptance of any such materials, records, and/or drawings shall in no way result in additional cost to the Owner should an error and/or omission in these documents result in additional costs to the Contractor.

6. On the first pages of all submittals, the Contractor shall provide a table showing all individual specification section paragraphs and drawings that apply to the equipment/component and a statement for each paragraph and drawing that the requirements have been met. The table shall be similar in format to the following, but shall include all relevant specification paragraphs and drawings:

Section 22 07 00 (example)	
1.2 A	Comply
1.2 B	Comply
1.3 A	Comply
1.3 B	Comply
1.3 C	Comply
1.4 A	Comply
1.4 A.1	Comply
1.4 A.2	Comply
Drawing M0.01	Comply

D. Equivalents: Manufacturers, trade names, and model numbers indicated herein and on Drawings shall be interpreted as establishing a standard of quality and shall not be construed as limiting competition. Unless definitely stated otherwise and upon complying with Division 1, the Contractor may use any article which, in his judgment is equal to that specified and is accepted by the Engineer. Manufacturers listed first in these specifications and on Drawings were used as a basis of design. It will be the responsibility of the Contractor to verify all connections, physical sizes, capacities, etc. of all other manufacturer's items, both named or proposed. If the equipment necessitates changes in rough-in, piping, wiring or other building systems from that indicated on the Drawings, the Contractor shall be responsible for all additional costs included and notify other trades. Where such changes are required, detail drawings indicating all required changes shall be submitted for review at the same time the manufacturers drawings are submitted for approval.

E. Shop drawings, diagrams, product data and such other data necessary to fully describe and substantiate compliance with these specifications shall be submitted for all equipment and materials where specifically required by specification and all items identified with an [S] behind the product title. Submittals not required by the Contract Documents will not be reviewed.

F. Shop Drawing manual(s) shall be submitted in accordance with Division 01 and shall include a complete product index, a copy of all approved shop drawings, and the name, address and telephone number of supplier or nearest representative. The manual(s) shall be presented to the Engineer for review and transmittal to the Owner before final payment is recommended.

G. Operation and Maintenance manual(s) shall be submitted in accordance with Division 01, this Section and shall include a complete product index in each volume, installation and maintenance data, parts lists, a copy of all approved shop drawings and the name, address and telephone number of supplier or nearest representative. All Plumbing devices, equipment and systems marked [O/M] in these specifications shall be included and all other such plumbing items that will require servicing before the duration of its useful life has been reached. Manual(s) shall be presented to the Engineer for review and transmittal to the Owner before final payment is recommended.

1.11 WARRANTY

A. The Contractor shall provide a warranty for a period of one year for all work provided under the Contract to include, but not necessarily limited to, all systems, equipment, materials, and workmanship. This shall not be construed to limit any extended warranty periods of longer than one year for specific items or systems specified elsewhere in the Contract Documents.

B. The warranty period shall commence on the date of acceptance by the Owner and shall cover all parts and labor as required to fulfill the warranty at no cost to the Owner.

C. Comply with requirements for additional warranties specified in Division 01.

D. Information on all warranties shall be included in the O&M Manuals specified herein to be provided to the Owner.

E. In phased construction, warranties shall not begin until substantial completion of the FINAL phase. Contractor shall maintain all new equipment and systems until that time. Owner will maintain all existing equipment and systems. Where new systems are connected to existing, the Contractor and Owner shall determine coordination of maintenance responsibilities at the preconstruction meeting.

1.12 EXISTING UNDERGROUND UTILITIES

A. The location of underground utilities shown on the Drawings shall be considered approximate, and any locations may not be indicated or known. Care shall be exercised by the Contractor during construction to locate and protect the known and unknown utilities, and to prevent disrupting the affected utility. The Contractor shall be responsible for repairing damage to any utility caused by his work.

B. Where any existing utilities are damaged, they shall be repaired as directed by the Engineer, with materials approved by the local utility company or the Owner, at no additional cost to the Owner.

1.13 INTERRUPTION OF UTILITY SERVICES

A. It is necessary that close liaison be maintained with the Administrative Authorities in all matters affecting interruptions of any utility services serving the facility and existing buildings.

Prior to interrupting any utility service, the Administrative Authorities shall be consulted and interruptions for connections made at a time (or times) suitable to the Administrative Authorities. Work shall be laid out and planned to limit the interruption times to a minimum.

1.14 COORDINATION OF WORK

A. General: The Contract Documents indicate the extent and general arrangement of the Plumbing systems. The Contractor shall be responsible for the coordination and proper relation of the Plumbing work to the building structure and to the work of other trades. No additional compensation or extension of completion time will be granted for extra work caused by the lack of coordination.

B. Cooperation: The Contractor shall provide dimensions and locations of all openings, shafts and similar items to the proper trades and install work as required so as not to interfere with, or delay, the building construction.

C. Locations of lines and equipment shall be determined from actual field measurements. The outlines of the building shown on the Plumbing Drawings are intended only as a guide to indicate relative locations of the Plumbing work. Refer to Architectural and Structural Drawings for building construction details. The Contractor shall determine the exact routing and location of his systems prior to fabrication or installation of any system component. Accurate measurements and coordination shall be completed to verify dimensions and characteristics for the installation of each system.

D. Unless necessitated by equipment access or otherwise indicated in the Contract Documents, all equipment, piping and conduit concealed above ceilings and in finished or utility spaces shall be routed as high as possible.

E. Offsets, transitions and changes of direction in all systems shall be made as required to maintain proper headroom and pitch of sloping lines whether or not indicated on the drawings. The Contractor shall provide manual air vents and drains as required for his work to affect these offsets, transitions and changes in direction, as applicable.

F. Cutting and Patching: Comply with requirements for cutting and patching specified in Division 01.

G. Roughing-In: Verify the locations of machines, door swings, block coursing, alignment of tile end and other similar features before roughing-in for Plumbing equipment components and/or controls.

H. Damage to Other Work: Each Contractor is responsible for damage to other work caused by his work or workmen. Repairing of damaged work shall be done by the Contractor who installed the work, and as directed by the Architect-Engineer; the cost of which shall be paid for by the Contractor responsible for the damage.

1.15 EQUIPMENT INSTALLATION

A. General: Equipment shall be installed in accordance with manufacturer's instructions to conform with the details and application indicated. Where manufacturer's recommendations or installation instructions require options or accessories not specified, they shall be included and installed by the Contractor.

B. Supports: Provide necessary supports for all equipment and appurtenances as required; this includes but is not limited to frames or supports for items such as storage tanks, water heaters, air compressors, plumbing fixtures, pumps, valves, and other similar items requiring supports. Floor mounted equipment in Equipment Rooms shall be set on 4-inch high concrete foundation pads unless shown otherwise. All pads shall be poured such that the top of the pad is level. Foundation drawings, bolt setting information and foundation bolts shall be furnished by the subcontractors furnishing the equipment for all equipment required to have concrete foundations. Concrete for foundations shall be provided by Plumbing Subcontractor unless indicated otherwise. Except where indicated all equipment shall be anchored to concrete pads.

C. Service Area: All equipment and appurtenances shall be located to permit adequate service clearance in accordance with manufacturer's recommendations and as otherwise required. Service clearance shall include but not be limited to service and removal of plumbing system, water heaters, pumps, motors, controls and other of equipment. All piping and other equipment shall be located outside of the service area or shall be flanged for easy removal to facilitate equipment service. All equipment shall be located with sufficient distance from building features, structural components, and the equipment of other trades. Service clearance in front of electrical panels shall be minimum as required by National Electric Code (NEC) where applicable.

D. Temporary Requirements: Openings in equipment shall be kept plugged at all times until connection is made to the system. The ends of all pipes and equipment openings shall be kept plugged or capped properly with approved devices. Approved devices are items such as specially molded plastic caps, pipe plugs, test plugs and sheet metal caps.

1.16 SLEEVES AND INSERTS

A. General: Sleeves and inserts shall be provided and correctly located in the structure, as require for the work.

B. Inserts shall be steel and proper size for loads encountered.

C. Sleeves shall be provided for all pipes passing through concrete or masonry walls, partitions, concrete beams or slabs installed during construction of the wall, partition, beam or slab. Sleeves through existing concrete walls and slabs may be omitted if wall or slab can be core drilled and properly sealed in a manner acceptable to the Engineer. Sleeves placed horizontally in walls or in any position in beams shall be standard weight ASTM A53 steel pipe of length equal to thickness of wall or beam. Those placed vertically in non-waterproof floors shall be 20 gauge galvanized sheet steel of length equal to thickness of slab, flared and nailed to the form, or fastened to reinforcing fabric and filled with sand during pouring to prevent deformation. Sleeves occurring in floors of rooms where hose bibs or floor drains occur, and in pipe spaces, shall be standard weight steel pipe projecting 2" above the finished floor except in

Equipment Rooms they shall project four (4) inches above floor. Sleeves in floors with waterproof membrane shall be provided with flanges or flashing rings and shall be clamped or flashed into membrane. All sleeves (and core drilled openings) shall be of sufficient diameter to clear bare or covered pipes by 1/4" all around except sleeves on lines subject to movement by expansion which shall clear the bare pipe or insulation on insulated pipe at least one inch all around. Pipes through exterior walls below grade and above footings shall be installed in sleeves having a minimum size of two larger pipe diameters and sealed watertight with flexible synthetic rubber seals. Sleeve shall have anchor and water stop plate. The entire assembly shall be tightened and adjusted and made watertight. Sleeves for pipes and conduit, penetrating fire (and smoke) rated partitions, walls and floors shall be sealed in accordance with the terms of U.L. Listed Through-Penetration Firestop Systems XHEZ as published in the U.L. Fire Resistance Directory. Penetrations shall exactly conform to details of the Firestop System indicated for the type of partition, wall and floor construction encountered. All penetrations through nonfireresistance rated floor assemblies and through the ceiling membrane of nonfireresistance rated roof assemblies shall be fireblocked with tightly packed mineral-wool insulation secured in place. All penetrations through equipment room walls and other areas of noise or heat generation shall be tightly sealed with mineral fiber rope. All penetrations through draftstop partitions shall be sealed to maintain the integrity of the partition. All firestopping and draftstopping of sleeves for Plumbing work shall be provided under Division 22.

1.17 ESCUTCHEONS

A. Where pipes pass through floors, walls or ceilings in finished rooms, they shall be fitted with chromium plated escutcheons of suitable pattern to effectively cover the rough opening. Where sleeves project above floors, special deep type escutcheons shall be provided.

1.18 ACCESS DOORS

A. Provide for all concealed valves, controls, dampers, junction boxes, equipment, or any item requiring access. Doors shall be of sufficient size and so located that the concealed items may be serviced or completely removed and replaced. Doors required for Plumbing work shall be furnished as a part of this Division to the General Contractor for installation. The Plumbing Sub-Contractor shall provide locations of all access doors such that service may be safely performed from a ladder, lift, or platform without the need for support from the ceiling system. Doors in acoustic tile ceilings shall be furnished in multiples of tile sizes. Doors are not required in exposed grid type ceilings where tiles are removable. Doors shall be metal access doors with cam lock, style to match ceiling or wall construction. Doors occurring in rated construction shall be fire rated U.L. labeled access doors correlated to preserve the integrity of the rated construction. Doors leading to concealed spaces shall be provided with means to open from the inside. Doors shall be prime finish steel except those in toilets, shower rooms, locker rooms, kitchens and other similar areas shall be stainless steel with brushed finish.

1.19 ELECTRICAL WIRING AND EQUIPMENT

A. Motors shall be provided in place as an integral part of the driven equipment, ready for electrical connections. Motors shall be in accordance with NEMA Standards and of design suitable for the starting and running characteristics of the driven equipment. Minimum efficiencies of motors shall be "nominal" efficiency as indicated in ASHRAE Standard 90.1-1989 as amended by 90.1c-1993 (ie: 1 HP, 82.5%; 5 HP, 87.5%; 10 HP, 89.5%; 20 HP, 91%; 50 HP, 93%) and shall meet or exceed those contained in NEMA MG1-1993, Table 10-12.

B. Motor starters and motor protective switches shall be provided under Division 26 except where specified to be furnished specifically with the driven equipment. Accessories such as auxiliary contacts, hand-off-automatic switches, start-stop switches, pilot lights, control power transformers and other similar items shall be provided in or on the controllers as required by the control sequence indicated. Starting equipment, unless factory mounted on the equipment, shall be installed under Division 26.

D. Wiring, low voltage (100 volts or less) control wiring shall be provided as a part of Section 23 09 00 Instrumentation and Control for HVAC. Wiring material and installation shall be in strict accordance with Division 26 and manufacturer's recommendations to comply with the sequence of control indicated. Verify that wiring of all motors and controls required by equipment furnished is accomplished for the correct sequence of operation.

E. Wiring, line voltage (101 volts or higher) power or control wiring shall be furnished and installed under Division 26.

F. Disconnects shall be provided for each item of equipment under Division 26 unless specified otherwise in other sections.

G. Miscellaneous manual or automatic control and protective or signal devices required for the sequence of operation indicated for mechanical equipment shall be provided under the section of the specifications where the item of equipment is specified unless indicated otherwise.

1.20 PROTECTION FROM MOVING PARTS

A. Belts, pulleys, chains, gears, shafts, couplings and other rotating or moving parts located so that any person may come in close proximity thereto shall be fully enclosed or properly guarded.

1.21 RECORD OF UNDERGROUND LINES

A. On completion of the project, the Contractor shall prepare and submit to the Engineer a drawing in PDF format showing the location of any underground lines installed in locations different from those on the Architect-Engineer's Drawings. The location of cleanouts, and the distance from the building to outside sewers, mains, and manholes shall be dimensioned.

1.22 CHARTS AND DIAGRAMS

A. General: Material as listed below shall be provided by the Contractor and shall be mounted in separate hardwood frames where directed in the field or folded and stored in a plastic document

folder and located in the control cabinets. All charts, diagrams and schemes shall be photographic positives prepared from original tracings. A copy of charts and diagrams shall be included with O/M manuals.

B. Automatic Temperature Control Diagrams identified as to name, sequence of operation, location and number of systems. Components of a control system shall be identified as to location, function, temperature setting and manufacturer's part number.

C. Electric Sequence Control Diagrams of entire Mechanical system.

D. Charts for identification of valves.

1.23 INSTRUCTION OF OWNER'S REPRESENTATIVE

A. Contractors shall instruct the representative of the Owner in the proper operation and maintenance of all elements of the Plumbing systems. Competent representatives of the Contractor shall spend such time as necessary to fully prepare the Owner to operate and maintain the Plumbing systems.

1.24 COMMISSIONING OF PLUMBING SYSTEMS:

A. Refer to Section 01 91 13, General Commissioning Requirements, for systems to be commissioned and responsibilities for commissioning.

B. All pre-functional testing and startups for each component of a system shall be successfully completed by the Subcontractor responsible for the purchase of the equipment or system and shall be conducted prior to formal functional performance testing (FPT) of equipment or subsystems of the given system.

1.25 CONSTRUCTION STATUS REPORT

A. Each item of discrepancies noted on Construction Status Report prepared by the Engineer shall be answered in detail in writing by the Contractor before payment can be recommended.

1.26 GRAPHICS DATABASE

A. This project's Computer Aided Design & Drafting (CADD) drawing files may be obtained directly from the Engineer for use in preparing computer graphics specific to this project. Refer to Appendix A at the end of this Section for Letter of Indemnification.

1.27 ALTERNATES:

A. Refer to Specifications Section - Bidding Requirements for description of Bid Alternates.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 PHASING OF WORK

A. Coordinate phasing requirements with Division 01.

3.2 DEMOLITION

A. Contractor shall visit site before bidding to determine extent of demolition.

B. Removal of Piping and Equipment: Remove all piping connections and equipment, plugging outlets, etc., such that are not required for present equipment and fixtures, or are not reused or needed for reconnecting new equipment and fixtures. Remove all equipment, fixtures, etc., indicated to be removed, or not reused or needed after the renovations are complete.

C. Where piping or other similar items passing through rated assemblies are removed; the assemblies shall be patched in accordance with UL so as to maintain the integrity of the assembly.

D. The Owner will select and retain such existing plumbing fixtures, equipment and materials which are indicated to be removed and not reused, as he desires. All other existing plumbing fixtures, equipment and materials indicated to be removed and not reused shall become the property of the Contractor, who shall promptly remove them from the premises. All existing equipment and fixtures indicated to be relocated shall be disconnected, removed, relocated and reconnected. All equipment and fixtures shall be protected from damage during demolition.

E. Miscellaneous: In all altered portions of the buildings, the Contractor shall remove or alter as necessary all existing Plumbing work that is not coordinated to operate with the new construction. Demolition shall not begin until the work schedule is approved by the owner. The work shall be scheduled to prevent any disruption to the normal operations of the building.

3.3 CONNECTIONS TO EQUIPMENT FURNISHED BY OTHERS:

A. The Plumbing Contractor shall make proper connections to all equipment furnished by others where indicated on the drawings. Contractor shall make connections to fixtures and equipment and install water cutoffs or stops, and gas cocks at each piece of equipment. Comply with requirements for pipe and fittings specified under appropriate Division 22 sections herein.

B. The exact location of and roughing-in requirements of each piece of equipment shall be determined by the Contractor before roughing-in is done.

C. Check Valves: Provide check valves in hot and cold-water connections to fixtures where faucets or valves generally remain open during extended operation.

3.4 CONNECTIONS TO CULINARY EQUIPMENT:

A. General: Unless specified herein or marked otherwise on drawings, all equipment in the Culinary area will be furnished by the owner and set in place by the General Contractor. This Contractor shall be responsible for making all plumbing connections to all of this equipment and shall include in his bid, all plumbing work in the Culinary area. This Contractor shall furnish all items of material and appurtenances necessary for making all plumbing connections to this equipment.

B. Cutoff or Stops: Provide on all hot and cold-water connections. Connecting pieces of water piping shall be copper with the exception of such parts that come as an integral part of the equipment. Exposed piping shall have chrome finish.

C. Backflow Preventers: All kitchen equipment requiring water connections, such as but not limited to, garbage disposers and ice makers, shall have backflow prevention devices in accordance with the Virginia Statewide Plumbing Code and the Virginia Department of Health Regulations. All reduced pressure zone backflow preventer vents shall be extended and properly discharged into a floor drain.

D. Vacuum Breakers, Shock Absorbers & Check Valves: Install as required in water connections to dishwasher.

   1. Install A.G.A. rated pressure and temperature relief valve (ANSI Z21.22), thermometer, pressure reducing valve, etc. in connections to dishwasher and as indicated on the drawings. Provide shock absorbers in all connections at quick-closing valves.

E. Connecting Piping: Standard weight, Galvanized-steel pipe with galvanized cast iron drainage fittings and traps or DWV copper tubing with copper fittings shall be used for waste drain piping connections from all sinks. Make extensions to all sill drains, refrigerator drains, drips, etc., as required, and extend to open waste drains. Paint exposed pipe and fittings to have chrome finish.

F. Shut-off Cock: Install bronze shut-off cock with lever handle in gas connection to each piece of equipment.

G. Check Valves: Provide check valves in hot and cold-water connections to fixtures such as pre-rinse sinks where valves generally remain open during extended operation.

END OF SECTION

APPENDIX A
LETTER OF INDEMNIFICATION

Project Name: Salem High School – Phase 1 Renovations

Project Location: Salem, VA

The Contractor may obtain from Ascent Engineering Group a CD-ROM or electronic mail version of the projects Revit / CADD database. All seals, details, schematics, tables, controls, etc. will be deleted. All drawings will be provided in Autocad™ 2014 format.

Ascent Engineering Group reserves all rights to the original drawing files.

The Recipient agrees, to the fullest extent permitted by the law, to hold harmless and indemnify Ascent Engineering Group, as defined in the Bid Documents, from and against all claims, liabilities, losses, damages, and costs, including but not limited to attorney's fees, arising out of or in any way connected with the use, modification, misinterpretation, misuse, or reuse by the Recipient or others of the machine readable information and data provided by Ascent Engineering Group under this Agreement. The foregoing indemnification applies, without limitation, to any use of the project documentation on other projects, for additions to this project, or for completion of this project by others, excepting only such use as may be authorized, in writing, by Ascent Engineering Group.

The electronic drawing files are not part of the Contract Documents for the Project. The Recipient assumes all risks associated with the use of the transmitted files. Ascent Engineering Group will not be responsible for any differences in the information included in the transmitted files and the information shown on the Contract Documents. Modifications to the Contract Documents made before or during construction may or may not be included in the transmitted electronic drawing files.

The Recipient further agrees that the drawing files will only be used in graphics preparation for the above-referenced project.

Company Name of Recipient: _____

Recipient's Designated Representative: _____

Title: _____

Signature: _____

Address: _____

Return to: Ascent Engineering Group
5228 Valleypointe Parkway, Suite 4
Roanoke, VA 24019
AEG # 18410

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SECTION 22 05 13

COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

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

B. Related Sections:

1. Section 22 04 00 – General Requirements for Plumbing
2. Section 22 11 23 – Domestic Water Pumps
3. Section 22 14 29 – Sump Pumps
4. Section 22 33 00 – Electric, Domestic – Water Heaters
5. Section 22 34 00 – Fuel–Fired, Domestic – Water Heaters
6. Section 22 47 00 – Drinking Fountains and Water Coolers
7. Division 26 – Electrical

1.03 COORDINATION

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

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

PART 2 - PRODUCTS

2.01 GENERAL MOTOR REQUIREMENTS

A. Comply with requirements in this Section except when stricter requirements are specified in plumbing equipment schedules or Sections.

B. Comply with NEMA MG 1 unless otherwise indicated.

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

2.02 MOTOR CHARACTERISTICS

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

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.03 SINGLE-PHASE MOTORS

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

1. Permanent-split capacitor.

2. Split phase.

3. Capacitor start, inductor run.

4. Capacitor start, capacitor run.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

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

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

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION – NOT USED

END OF SECTION

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SECTION 22 05 23

GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Brass ball valves.
2. Bronze ball valves.
3. Iron ball valves.
4. Bronze lift check valves.
5. Bronze swing check valves.
6. Iron swing check valves.
7. Iron gate valves.
8. Bronze globe valves.

B. Related Sections:

1. Section 01 91 13 – General Commissioning Requirements
2. Section 03 30 00 – Cast– in Place Concrete
3. Section 22 04 00 – General Requirements for Plumbing
4. Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment
5. Section 22 05 53 – Painting and Identification for Plumbing Piping and Equipment
6. Section 22 07 00 – Plumbing Insulation
7. Section 22 11 16 – Domestic Water Piping

8. Section 22 11 19 – Domestic Water Piping Specialties
9. Section 22 11 23 – Domestic Water Pumps
10. Section 22 13 16 – Sanitary Waste and Vent Piping
11. Section 22 13 19 – Sanitary Waste Piping Specialties
12. Section 22 14 13 – Facility Storm Drainage Piping
13. Section 22 14 23 – Storm Drainage Piping Specialties
14. Section 22 14 29 – Sump Pumps
15. Section 22 16 13 – Facility Natural – Gas Piping
16. Section 22 33 00 – Electric, Domestic – Water Heaters
17. Section 22 34 00 – Fuel-Fired, Domestic – Water Heaters
18. Section 22 40 00 – Plumbing Fixtures
19. Section 22 47 00 – Drinking Fountains and Water Coolers
20. Division 26 – Electrical

1.03 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

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

D. NRS: Nonrising stem.

E. OS&Y: Outside screw and yoke.

F. RS: Rising stem.

G. SWP: Steam working pressure.

1.04 SUBMITTALS

A. Product Data: For each type of valve indicated [S]. Comply with requirements for submittals in Division 01 and Section 22 04 00 “General Requirements for Plumbing”.

1.05 QUALITY ASSURANCE

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

B. ASME Compliance:

1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.

2. ASME B31.1 for power piping valves.

3. ASME B31.9 for building services piping valves.

C. NSF Compliance for valve materials that will be in contact with potable water:

1. NSF 61 "Drinking Water System Components - Health Effects".

2. NSF 372 "Drinking Water System Components - Lead Content".

1.06 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.

2. Protect threads, flange faces, grooves, and weld ends.

3. Set gate, and globe valves closed to prevent rattling.

4. Set ball and plug valves open to minimize exposure of functional surfaces.

5. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.

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

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

PART 2 - PRODUCTS

2.01 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.

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

1. Gate Valves: With rising stem.

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

F. Valve-End Connections:

1. Flanged: With flanges according to ASME B16.1 for iron valves.

2. Pressure-Seal: With pressure-seal-joint according to ASME B16.51.

3. Solder Joint: With sockets according to ASME B16.18.

4. Threaded: With threads according to ASME B1.20.1.

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

2.02 BRASS BALL VALVES[S]

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

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

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

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

c. DynaQuip Controls.

d. Flow-Tek, Inc.; a subsidiary of Bray International, Inc.

e. Hammond Valve.

f. Jamesbury; a subsidiary of Metso Automation.

g. Jomar International, LTD.

h. Kitz Corporation.

i. Legend Valve.

j. Marwin Valve; a division of Richards Industries.

k. Milwaukee Valve Company.

l. NIBCO INC.

m. Red-White Valve Corporation.

n. RuB Inc.

2. Description:

a. Standard: MSS SP-110.

b. SWP Rating: 150 psig.

c. CWP Rating: 600 psig.

d. Body Design: Two piece.

e. Body Material: Forged brass.

f. Ends: Threaded.

g. Seats: PTFE or TFE.

h. Stem: Brass.

i. Ball: Chrome-plated brass.

j. Port: Full.

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

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

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

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

c. Flow-Tek, Inc.; a subsidiary of Bray International, Inc.

d. Hammond Valve.

e. Jamesbury; a subsidiary of Metso Automation.

f. Kitz Corporation.

g. Marwin Valve; a division of Richards Industries.

h. Milwaukee Valve Company.

i. RuB Inc.

2. Description:

a. Standard: MSS SP-110.

b. SWP Rating: 150 psig.

c. CWP Rating: 600 psig.

d. Body Design: Two piece.

e. Body Material: Forged brass.

f. Ends: Threaded.

g. Seats: PTFE or TFE.

h. Stem: Stainless steel.

i. Ball: Stainless steel, vented.

j. Port: Full.

2.03 BRONZE BALL VALVES [S]

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

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

a. American Valve, Inc.

b. Conbraco Industries, Inc.; Apollo Valves.

c. Crane Co.; Crane Valve Group; Crane Valves.

d. Hammond Valve.

e. Lance Valves; a division of Advanced Thermal Systems, Inc.

f. Legend Valve.

g. Milwaukee Valve Company.

h. NIBCO INC.

i. Red-White Valve Corporation.

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

2. Description:

a. Standard: MSS SP-110.

b. SWP Rating: 150 psig.

c. CWP Rating: 600 psig.

d. Body Design: Two piece.

e. Body Material: Bronze.

f. Ends: Threaded.

g. Seats: PTFE or TFE.

h. Stem: Bronze.

i. Ball: Chrome-plated brass.

j. Port: Full.

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

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

a. Conbraco Industries, Inc.; Apollo Valves.

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

c. Hammond Valve.

d. Lance Valves; a division of Advanced Thermal Systems, Inc.

e. Milwaukee Valve Company.

f. NIBCO INC.

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

2. Description:

a. Standard: MSS SP-110.

b. SWP Rating: 150 psig.

c. CWP Rating: 600 psig.

d. Body Design: Two piece.

e. Body Material: Bronze.

f. Ends: Threaded.

g. Seats: PTFE or TFE.

h. Stem: Stainless steel.

i. Ball: Stainless steel, vented.

j. Port: Full.

k. Port: Regular.

2.04 IRON BALL VALVES [S]

A. Class 125, Iron 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. American Valve, Inc.

b. Conbraco Industries, Inc.; Apollo Valves.

c. Kitz Corporation.

d. Sure Flow Equipment Inc.

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

2. Description:

   a. Standard: MSS SP-72.

   b. CWP Rating: 200 psig.

   c. Body Design: Split body.

   d. Body Material: ASTM A 126, gray iron.

   e. Ends: Flanged.

   f. Seats: PTFE or TFE.

   g. Stem: Stainless steel.

   h. Ball: Stainless steel.

   i. Port: Full.

2.05 BRONZE LIFT CHECK VALVES [S]

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 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.

2.06 BRONZE SWING CHECK VALVES [S]

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. American Valve, Inc.

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

   c. Crane Co.; Crane Valve Group; Jenkins Valves.

   d. Crane Co.; Crane Valve Group; Stockham Division.

   e. Hammond Valve.

   f. Kitz Corporation.

   g. Milwaukee Valve Company.

   h. NIBCO INC.

   i. Powell Valves.

   j. Red-White Valve Corporation.

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

   l. Zy-Tech Global Industries, 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. Ends: Threaded.

   f. Disc: Bronze.

2.07 IRON SWING CHECK VALVES [S]

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

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. Kitz Corporation.

    f. Legend Valve.

    g. Milwaukee Valve Company.

    h. NIBCO INC.

    i. Powell Valves.

    j. Red-White Valve Corporation.

    k. Sure Flow Equipment Inc.

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

    m. Zy-Tech Global Industries, Inc.

2. Description:

    a. Standard: MSS SP-71, Type I.

    b. CWP Rating: 200 psig.

    c. Body Design: Clear or full waterway.

    d. Body Material: ASTM A 126, gray iron with bolted bonnet.

    e. Ends: Flanged.

    f. Trim: Bronze.

    g. Gasket: Asbestos free.

2.08 IRON GATE VALVES [S]

A. Class 125, NRS, 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. Flo Fab Inc.

    e. Hammond Valve.

    f. Kitz Corporation.

    g. Legend Valve.

    h. Milwaukee Valve Company.

    i. NIBCO INC.

    j. Powell Valves.

    k. Red-White Valve Corporation.

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

    m. Zy-Tech Global Industries, Inc.

2. Description:

    a. Standard: MSS SP-70, Type I.

    b. CWP Rating: 200 psig.

    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.

2.09 BRONZE GLOBE VALVES [S]

A. Class 125, Bronze Globe 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; Stockham Division.

    c. Hammond Valve.

    d. Kitz Corporation.

    e. Milwaukee Valve Company.

    f. NIBCO INC.

    g. Powell Valves.

    h. Red-White Valve Corporation.

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

    j. Zy-Tech Global Industries, 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.

    e. Stem and Disc: Bronze.

    f. Packing: Asbestos free.

    g. Handwheel: Malleable iron.

PART 3 - EXECUTION

3.01 EXAMINATION

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

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

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

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

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

3.02 VALVE INSTALLATION

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

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

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

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

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

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

2. Lift Check Valves: With stem upright and plumb.

3.03 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.

3.04 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

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

1. Shutoff Service: Ball or gate valves.

2. Throttling Service: Globe or ball valves.

3. Pump-Discharge Check Valves:

a. NPS 2 and Smaller: Bronze lift check valves with bronze disc.

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 3 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.

2. For Copper Tubing, NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.

3. For Steel Piping, NPS 3 and Smaller: Threaded ends.

4. For Steel Piping, NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.

3.05 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 3 and Smaller:

1. Bronze and Brass Valves: May be provided with solder-joint or pressure-seal-joint ends instead of threaded ends.

2. Ball Valves: Two-piece, full-port, brass or bronze with brass, bronze or stainless-steel trim.

3. Bronze Swing Check Valves: Class 125, bronze disc.

4. Bronze Globe Valves: Class 125, bronze disc.

B. Pipe NPS 4 and Larger:

1. Iron Valves: Flanged ends.

2. Iron Ball Valves: Class 125.

3. Iron Swing Check Valves: Class 125, metal seats.

4. Iron Gate Valves: Class 125, NRS.

3.06 STORM-DRAINAGE VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze and Brass Valves: Threaded ends.

2. Ball Valves: Two-piece, full-port, brass or bronze with brass, bronze or stainless-steel trim.

3. Bronze Lift Check Valves: Class 125, bronze disc.

END OF SECTION

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SECTION 22 05 29

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

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. Pipe positioning systems.
8. Equipment supports.

B. Related Sections:

1. Section 01 91 13 – General Commissioning Requirements
2. Section 05 50 00 – Metal Fabrications
3. Section 22 04 00 – General Requirements for Plumbing
4. Section 22 05 23 – General – Duty Valves for Plumbing Piping
5. Section 22 05 53 – Painting and Identification for Plumbing Piping and Equipment
6. Section 22 07 00 – Plumbing Insulation
7. Section 22 11 16 – Domestic Water Piping

8. Section 22 11 19 – Domestic Water Piping Specialties
9. Section 22 11 23 – Domestic Water Pumps
10. Section 22 13 16 – Sanitary Waste and Vent Piping
11. Section 22 13 19 – Sanitary Waste Piping Specialties
12. Section 22 14 13 – Facility Storm Drainage Piping
13. Section 22 14 23 – Storm Drainage Piping Specialties
14. Section 22 16 13 – Facility Natural – Gas Piping
15. Section 22 40 00 – Plumbing Fixtures
16. Section 22 47 00 – Drinking Fountains and Water Coolers

1.03 DEFINITIONS

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

1.04 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 SEI/ASCE 7 “Minimum Design Loads for Buildings and Other Structures.

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

2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.05 SUBMITTALS

A. Product Data: For each type of product indicated [S]. Comply with requirements in Division 01 and Section 22 04 00 “General Requirements for Plumbing”.

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

1. Trapeze pipe hangers.

2. Metal framing systems.

3. Pipe stands.

4. Equipment supports.

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

1. Detail fabrication and assembly of trapeze hangers.

2. Design Calculations: Calculate requirements for designing trapeze hangers.

D. Welding certificates.

1.06 QUALITY ASSURANCE

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

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

PART 2 - PRODUCTS

2.01 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.

2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.

3. Nonmetallic Coatings: Plastic coating, jacket, or liner.

4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Stainless-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.

2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

C. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.

2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel, stainless steel or cadmium plated steel.

2.02 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.

2.03 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. Allied Tube & Conduit.

b. Cooper B-Line, Inc.

c. Flex-Strut Inc.

d. GS Metals Corp.

e. Thomas & Betts Corporation.

f. Unistrut Corporation; Tyco International, Ltd.

g. Wesanco, Inc.

2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.

3. Standard: MFMA-4.

4. Channels: Continuous slotted steel channel with inturned lips.

5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.

6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

7. Paint Coating: Alkyd.

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; a subsidiary of Mueller Water Products Inc.

b. Empire Industries, Inc.

c. ERICO International Corporation.

d. Haydon Corporation; H-Strut Division.

e. NIBCO INC.

f. PHD Manufacturing, Inc.

g. PHS Industries, 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.

7. Coating: Paint.

2.04 THERMAL-HANGER SHIELD INSERTS

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

1. Carpenter & Paterson, Inc.

2. Clement Support Services.

3. ERICO International Corporation.

4. National Pipe Hanger Corporation.

5. PHS Industries, Inc.

6. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.

7. Piping Technology & Products, Inc.

8. Rilco Manufacturing Co., Inc.

9. Value Engineered Products, Inc.

B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa)] minimum compressive strength and vapor barrier.

C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig minimum compressive strength.

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

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

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

2.05 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 or 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.

2.06 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: Plastic or Stainless steel.

3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.

4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

E. High-Type, Multiple-Pipe Stand:

1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.

2. Bases: One or more; plastic.

3. Vertical Members: Two or more protective-coated-steel channels.

4. Horizontal Member: Protective-coated-steel channel.

5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

F. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.07 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.

2.08 EQUIPMENT SUPPORTS

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

2.09 MISCELLANEOUS MATERIALS

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

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

1. Properties: Nonstaining, noncorrosive, and nongaseous.

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

PART 3 - EXECUTION

3.01 HANGER AND SUPPORT INSTALLATION

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

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

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.

2. Field fabricate from ASTM A 36, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

E. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.

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

F. 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. Comply with Division 07 Section "Roof Accessories" for curbs.

G. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture. Comply with Division 22 plumbing fixture Sections for requirements for pipe positioning systems for plumbing fixtures.

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

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

J. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

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

L. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

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

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

O. Insulated Piping:

1. Attach clamps and spacers to piping.

    a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.

    b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.

    c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

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

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

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

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

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

    a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.

b. NPS 4: 12 inches long and 0.06 inch thick.

c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.

d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.

5. Insulated Pipes NPS 2 1/2 inches and Larger: Include reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.

6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.02 EQUIPMENT SUPPORTS

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

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

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

3.03 METAL FABRICATIONS

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

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

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

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.

4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.04 ADJUSTING

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

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

3.05 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

   1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. 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.

3.06 HANGER AND SUPPORT SCHEDULE

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

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

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

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

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

F. Use 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. 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.

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

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.

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

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

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.

2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.

3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.

4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.

5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

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

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

2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.

3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.

4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.

5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.

6. C-Clamps (MSS Type 23): For structural shapes.

7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.

8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.

9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.

10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.

11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.

12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb.

    b. Medium (MSS Type 32): 1500 lb.

    c. Heavy (MSS Type 33): 3000 lb.

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.

14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

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

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.

2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.

3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

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

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.

2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.

3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.

4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.

5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.

6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.

7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.

8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

a. Horizontal (MSS Type 54): Mounted horizontally.

b. Vertical (MSS Type 55): Mounted vertically.

c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

P. Comply with MSS SP-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.

S. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION

SECTION 22 05 33

HEAT TRACING FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes heat tracing for Plumbing piping with the following electric heating cables:

1. Self-regulating, parallel resistance.

B. Related Sections:

1. Section 01 91 13 – General Commissioning Requirements

2. Section 22 04 00 – General Requirements for Plumbing

3. Section 22 05 23 – General – Duty Valves for Plumbing Piping

4. Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment

5. Section 22 05 53 – Painting and Identification for Plumbing Piping and Equipment

6. Section 22 07 00 – Plumbing Insulation

7. Section 22 11 16 – Domestic Water Piping

8. Section 22 11 16 – Domestic Water Piping Specialties

9. Division 26 – Electrical

1.02 SUBMITTALS

A. Product Data: For each type of product.

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

2. Schedule heating capacity, length of cable, spacing, and electrical power requirement for each electric heating cable required.

B. Shop Drawings: For electric heating cable.

1. Include plans, elevations, sections, and attachment details.

2. Include diagrams for power, signal, and control wiring.

C. Field quality-control reports.

D. Operation and Maintenance Data: For electric heating cables to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.01 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

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

1. BriskHeat.

2. Chromalox.

3. Delta-Therm Corporation.

4. Easy Heat; a division of EGS Electrical Group LLC.

5. Pyrotenax; a brand of Tyco Thermal Controls LLC.

6. Raychem; a brand of Tyco Thermal Controls LLC.

7. Thermon Americas Inc.

8. Trasor Corp.

B. Comply with IEEE 515.1.

C. Heating Element: Pair of parallel No. 16 AWG or larger, nickel-coated, stranded copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length. Terminate with waterproof, factory-assembled, nonheating leads with connectors at one end, and seal the opposite end watertight. Cable shall be capable of crossing over itself once without overheating.

D. Electrical Insulating Jacket: Flame-retardant polyolefin.

E. Cable Cover: Tinned-copper braid and polyolefin outer jacket.

F. Maximum Operating Temperature (Power On): 150 deg F.

G. Maximum Exposure Temperature (Power Off): 185 deg F.

H. 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.

I. Capacities and Characteristics:

1. Maximum Heat Output: 5 W/ft..

2. Piping Diameter: 3/4 NPS.

3. Number of Parallel Cables: 1.

4. Electrical Characteristics:

a. Volts: 120.

b. Phase: 1.

c. Hertz: 60.

2.02 CONTROLS

A. Remote bulb unit with adjustable temperature range from 30 to 50 deg F.

B. Snap action; open-on-rise, single-pole switch with minimum current rating adequate for connected cable.

C. Remote bulb on capillary, resistance temperature device, or thermistor for directly sensing pipe-wall temperature.

D. Corrosion-resistant, waterproof control enclosure.

2.03 ACCESSORIES

A. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer, or as recommended in writing by manufacturer.

B. Warning Labels: Refer to Division 22 Section, "Identification for Plumbing Piping and Equipment."

C. Warning Tape: Continuously printed "Electrical Tracing"; vinyl, at least 3 mils thick, and with pressure-sensitive, permanent, waterproof, self-adhesive back.

1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches: 3/4 inch minimum.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.

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

3.02 APPLICATIONS

A. Install electric heat tracing for the applications:

1. Freeze Protection for piping systems exposed to outdoor conditions.

3.03 INSTALLATION

A. Install electric heating cable across expansion joints according to manufacturer's written instructions; use slack cable to allow movement without damage to cable.

B. Install electric heating cables after piping has been tested and before insulation is installed.

C. Install electric heating cables according to IEEE 515.1.

D. Install insulation over piping with electric cables according to Division 22 Section, "Plumbing Piping Insulation."

E. Install warning tape on piping insulation where piping is equipped with electric heating cables.

F. Set field-adjustable switches and circuit-breaker trip ranges.

3.04 CONNECTIONS

A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.05 FIELD QUALITY CONTROL

A. Testing Agency: Owner will 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 tests after cable installation but before application of coverings such as insulation, wall or ceiling construction, or concrete.

2. Test cables for electrical continuity and insulation integrity before energizing.

3. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.

D. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounted cables.

E. Cables will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.06 PROTECTION

A. Protect installed heating cables, including nonheating leads, from damage during construction.

B. Remove and replace damaged heat-tracing cables.

END OF SECTION

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SECTION 22 05 53

PAINTING AND IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Prepare and paint Division 22 equipment, accessories, piping and miscellaneous materials located in Equipment Rooms, Boiler Rooms and other utility areas housing Plumbing equipment and materials.

2. Identification of piping in exposed and accessible locations.

3. Marking and designation of equipment.

B. Not Included in Section:

1. Painting of piping or equipment exposed in finished areas other than those listed under “Section Includes” above.

C. Related Sections:

1. Section 01 91 13 – General Commissioning Requirements

2. Section 22 04 00 – General Requirements for Plumbing

3. Section 22 05 23 – General – Duty Valves for Plumbing Piping

4. Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment

5. Section 22 07 00 – Plumbing Insulation

6. Section 22 11 16 – Domestic Water Piping

7. Section 22 11 19 – Domestic Water Piping Specialties

8. Section 22 13 16 – Sanitary Waste and Vent Piping

9. Section 22 14 13 – Facility Storm Drainage Piping

10. Section 22 16 13 – Facility Natural – Gas Piping

11. Section 22 33 00 – Electric, Domestic – Water Heaters

12. Section 22 34 00 – Fuel-Fired, Domestic – Water Heaters

13. Section 22 40 00 – Plumbing Fixtures

14. Section 22 47 00 – Drinking Fountains and Water Coolers

15. Division 26 – Electrical

1.03 SUBMITTALS:

A. For each type of Product indicated [S]. Comply with requirements in Division 01 and Section 22 04 00 "General Requirements for Plumbing.

1.04 REFERENCED STANDARDS:

A. General: The following standards or codes (latest edition) form a part of this specification to the extent indicated by the reference thereto.

B. American National Standards Institute (ANSI):

ANSI A13.1	Scheme for Identification of Piping Systems

C. American Society for Testing and Materials (ASTM):

ASTM E 84	Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM C 411	Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation

D. National Fire Protection Association (NFPA):

Standard 255	Method of Test of Surface Burning Characteristics of Building Materials

E. Underwriters Laboratories, Inc. (UL)

Standard 723	Tests for Surface Burning Characteristics of Building Materials

F. California Department of Health Services

Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

A. Except as otherwise specified, materials shall be the products of the following manufacturers:

1. Sherwin-Williams

2. Pratt and Lambert

3. Pittsburg Paints (PPG)

4. Benjamin Moore

5. Porter Paints

6. Seton Identification Products

2.02 MATERIALS:

A. Deliver all paints and materials to the project site in their unopened original containers with all labels intact and legible at the time of use.

B. For adhesives and sealants applied within the building waterproofing envelope, comply with low emitting requirements in Division 01 section ”Indoor Air Quality Requirements.”

C. All coatings exposed to supply and return airstreams and where applied to exposed surfaces in a return air plenum, shall have a composite flame spread rating not exceeding 25, and a smoke developed rating not exceeding 50 as tested under procedure ASTM E-84-75, NFPA 255 and UL 723. Coatings shall not flame, glow, smolder or smoke when tested in accordance with ASTM C411, latest edition.

D. Sherwin-Williams Industrial Maintenance Coatings System 4000 products are listed below to establish color and a standard of quality.

1. All Hangers and Supports: One coat Pro-Industrial Zero VOC Acrylic Gloss Black.

2. All major items of equipment and equipment supports including pumps, tanks and all other similar items shall be painted as follows:

a. Uninsulated hot surfaces on equipment, operating at or above 150°F, shall be painted with two coats of No. B59S8 Heat Resistant Aluminum.

b. Other unfinished equipment surfaces of aluminum, iron and steel shall be primed with one coat of Pro-Cryl Primer (1000g/L). Galvanized surfaces shall be chemically prepared and primed with one coat of Galvite B50W3 Primer. Field insulated surfaces shall be primed with No. B28W200 Wall Primer. Where equipment is furnished with

factory finish coat, only touch up to match finish is required at any damaged areas. Finish all equipment with two coats of Pro–Industrial Zero VOC Acrylic Gloss, No. SW4063 Robotic Blue. Exterior of belt guards and other protective guards shall be finished with two coats of Pro–Industrial Zero VOC Acrylic Gloss, No. SW4084 safety yellow color. Interior of and all items covered by belt guards and other protective guards shall be finished with two coats of No. SW4083 safety orange color.

c. Nameplates and Testing Agency Labels on equipment or machinery shall not be painted.

3. Piping: Exposed in equipment rooms and where connections are made to equipment located in storage rooms and other utility type areas.

a. Priming:

(1) Insulation Canvas or Paper Jacket: One coat Pro-Cryl Primer (1000g/L).

(2) Insulation Aluminum Jacket: One coat Pro-Cryl Primer (1000g/L).

(3) Bare Iron or Steel or Copper: One coat Pro-Cryl Primer (1000g/L).

(4) Galvanized Steel: Pipes shall be chemically prepared and primed with one coat of Pro-Cryl B66-310 Primer.

(5) Asphalt Coated Pipe: One coat No. B28W200 Wall Primer.

b. Finish: All pipe lines and the supports or hangers therefore, shall be finished with Pro–Industrial Zero VOC Acrylic Gloss gray No. SW4028 Gypsum applied in sufficient number of coats to effectively cover the prime coat. Painting of pipe hangers is specified hereinbefore.

c. Exposed gas piping shall be primed and painted with two (2) coats of Series 54 Alkyd Gloss Enamel, No. SW4084 Safety Yellow Color.

d. Materials shall be as recommended by the manufacturer for the surface to be finished.

e. Unless otherwise specified, primer shall be by the same manufacturer as the finish coat.

f. Materials shall not be thinned or cut except as recommended by the coating manufacturer. Thinners shall be by the same manufacturer as the primer and finish coat.

E. Valve tags shall be neat circular brass with designations stamped thereon, attached with solid brass jack chain to each valve stem or handle.

F. Each item of equipment such as pumps, water heaters, tempering valves and equipment control devices such as motor starters, disconnect switches, etc. shall be properly marked with laminated engraved plastic nameplates fastened with sheet metal screws, bolts, rivets or permanent adhesive. Pressure sensitive tape is not acceptable.

G. All piping, insulated and un-insulated, shall be identified with Seton Ultra-Mark or equal wrap around piping system markers and arrow flow directional marker. Markers shall be pre-coiled, semi-rigid plastic or polyester with sealed color graphics. Markers shall be minimum 12 inches long with 1-¼ inch high letters, formed to cover entire circumference of the pipe. Markers shall be attached to piping using plastic tie wraps. Pipe identification shall use the same designations or abbreviations used on the drawings. Marker colors shall be in accordance with ANSI.

H. For field applications within the weatherproofing system, all paints, adhesives and sealants shall comply with the requirements of the California Health Services Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers.

PART 3 - EXECUTION

3.01 WORKMANSHIP:

A. The work shall be accomplished by qualified mechanics skilled in the painting trade. Painting of equipment, piping, ductwork and other materials shall not commence until all testing is complete and systems are ready for operation. Materials shall be applied according to manufacturer's directions. All containers shall be securely closed when not in use. Flammable materials shall not be stored on premises. Flammable waste shall be disposed of daily in devices approved for such purposes. Materials shall be evenly spread, and smoothly flowed on without runs or sags. Each coat shall be thoroughly dry before application of succeeding coats.

3.02 PROTECTION OF WORK:

A. The painters shall protect all adjacent surfaces with drop covers during the process of painting. Upon completion, paint spots, if any, shall be removed from all surfaces.

3.03 PREPARATION OF SURFACE:

A. Surfaces to be painted shall be completely dry before applying paint. Metal surfaces shall be cleaned with mineral spirits before applying materials. Rust and scale shall be removed by wire brushing or sanding. Galvanized surfaces shall be chemically pretreated with crystalline (zinc phosphate) phosphate in strict accordance with the manufacturer's recommendations. Surfaces shall not be painted when the temperature is, or is likely to be, near the freezing point, or when they are exposed to hot sun.

3.04 IDENTIFICATION OF PIPES AND EQUIPMENT:

A. Equipment: After all other painting is completed; each major item of equipment shall be properly identified with nameplates. Identification symbols and designations shall be the same as shown on the Contract Documents. Where equipment is installed above lay-in ceilings the

plastic nameplate shall be adhered to the face of the T-bar support so that it can be identified from within the space.

B. Apply piping system markers after completion of required insulation and finishes on piping systems. Markers shall be applied in the following locations and where identified by the Engineer:

1. At each valve and at connection to equipment.

2. At every tee and branch connection.

3. At each riser including branch risers from mains.

4. At each side of a pipe passage through floors, walls and partitions.

5. Every 15 feet on straight runs of piping mains and branches.

6. Within 6 feet of elbows (each side).

7. At access doors or similar points that permit view of concealed piping.

8. Markers shall be provided on all piping above lay-in ceilings.

9. Provide arrow markers showing direction of flow incorporated into, or adjacent to, each piping system marker.

10. Apply all piping system markers where view is unobstructed, and legends can be read and easily identified.

11. Apply all tags and piping system markers in accordance with the supplier's instructions.

END OF SECTION

SECTION 22 07 00

PLUMBING INSULATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Insulation Materials:

a. Calcium silicate.

b. Flexible elastomeric.

c. Mineral fiber.

d. Polyolefin.

2. Insulating cements.

3. Adhesives.

4. Sealants.

5. Factory-applied jackets.

6. Tapes.

7. Securements.

8. Corner angles.

B. Related Sections:

1. Section 01 91 13 – General Commissioning Requirements

2. Section 22 04 00 – General Requirements for Plumbing

3. Section 22 05 23 – General – Duty Valves for Plumbing Piping

4. Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment
5. Section 22 05 33 – Heat Tracing for Plumbing Piping
6. Section 22 05 53 – Painting and Identification for Plumbing Piping and Equipment
7. Section 22 11 16 – Domestic Water Piping
8. Section 22 11 19 – Domestic Water Piping Specialties
9. Section 22 11 23 – Domestic Water Pumps
10. Section 22 13 16 – Sanitary Waste and Vent Piping
11. Section 22 13 19 – Sanitary Waste Piping Specialties
12. Section 22 14 13 – Facility Storm Drainage Piping
13. Section 22 14 23 – Storm Drainage Piping Specialties
14. Section 22 33 00 – Electric, Domestic – Water Heaters
15. Section 22 34 00 – Fuel–Fired, Domestic – Water Heaters
16. Section 22 40 00 – Plumbing Fixtures
17. Section 22 47 00 – Drinking Fountains and Water Coolers
18. Division 26 – Electrical

1.03 DEFINITIONS

A. Runout: Last section of pipe from branch or main to fixtures or equipment.

1.04 SUBMITTALS

A. Product Data: For each type of product indicated [S]. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any). Comply with requirements in Division 01 and Section 22 04 00 “General Requirements for Plumbing”.

B. Shop Drawings:

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.

2. Detail attachment and covering of heat tracing inside insulation.

3. Detail insulation application at pipe expansion joints for each type of insulation.

4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.

5. Detail removable insulation at piping specialties, equipment connections, and access panels.

6. Detail application at linkages of control devices.

7. Detail field application for each equipment type.

C. Qualification Data: For qualified Installer.

D. 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.

E. Field quality-control reports.

1.05 QUALITY ASSURANCE

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

B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.

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

2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.06 DELIVERY, STORAGE, AND HANDLING

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

1.07 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Section 22 05 29 “Hangers and Supports for Plumbing Piping and Equipment."

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

C. Coordinate installation and testing of heat tracing.

1.08 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.01 INSULATION MATERIALS [S]

A. Comply with requirements in Part 3 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. Calcium Silicate:

1. 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. Industrial Insulation Group (The); Thermo-12 Gold.

2. Preformed Pipe Sections: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.

3. Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.

4. Prefabricated Fitting Covers: Comply with ASTM C 450 and ASTM C 585 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

G. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

1. 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. Aeroflex USA Inc.; Aerocel.

b. Armacell LLC; AP Armaflex.

c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.

H. Mineral-Fiber, Preformed Pipe Insulation:

1. 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. Fibrex Insulations Inc.; Coreplus 1200.

b. Johns Manville; Micro-Lok.

c. Knauf Insulation; 1000(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 "Factory-Applied Jackets" Article.

I. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials.

1. 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. Armacell LLC; Tubolit.

b. Nomaco Inc.; IMCOLOCK, IMCOSHEET, NOMALOCK, and NOMAPLY.

c. RBX Corporation; Therma-cell.

2.02 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.

2.03 SEALANTS

A. Joint Sealants: Provide sealants either manufactured or recommended by the insulation material manufacturer.

2.04 FACTORY-APPLIED JACKETS [S]

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.

2.05 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. 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. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.

b. Compac Corp.; 104 and 105.

c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.

d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.

2. Width: 3 inches.

3. Thickness: 11.5 mils.

4. Adhesion: 90 ounces force/inch in width.

5. Elongation: 2 percent.

6. Tensile Strength: 40 lbf/inch in width.

7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

2.06 SECUREMENTS

A. Bands:

1. 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. Childers Products; Bands.

b. PABCO Metals Corporation; Bands.

c. RPR Products, Inc.; Bands.

2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch or 3/4 inch wide with wing or closed seal.

3. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

2.07 CORNER ANGLES

A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.

1. Verify that systems and equipment to be insulated have been tested and are free of defects.

2. Verify that surfaces to be insulated are clean and dry.

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

3.02 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.03 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment and piping including fittings, valves, and specialties.

B. 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.

C. Install insulation with longitudinal seams at top and bottom of horizontal runs.

D. Install multiple layers of insulation with longitudinal and end seams staggered.

E. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

    1. Install insulation continuously through hangers and around anchor attachments.

    2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.

    3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

    4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:

    1. Draw jacket tight and smooth.

    2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.

3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

    a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.

5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches 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. Testing agency labels and stamps.

2. Nameplates and data plates.

3.04 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.

2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.

4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant.

C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Division 07 Section "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

E. 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 07 Section "Penetration Firestopping."

3.05 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.

2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.

3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.

4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever

is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.

6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.

7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.

9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.

2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.

3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.

4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with

insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.06 CALCIUM SILICATE INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation materials.

2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.

3. Apply a skim coat of mineral-fiber, hydraulic-setting cement to insulation surface. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth or tape. Overlap edges at least 1 inch. Apply finish coat of lagging adhesive over glass cloth or tape. Thin finish coat to achieve smooth, uniform finish.

3.07 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.

2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.

4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.

2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

3. Install insulation to flanges as specified for flange insulation application.

4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.08 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.

2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.

3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.

4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.

2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.

4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.

2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.

2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.

3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

4. Install insulation to flanges as specified for flange insulation application.

3.09 POLYOLEFIN INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Seal split-tube longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.

2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyolefin sheet insulation of same thickness as pipe insulation.

4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of polyolefin pipe insulation.

2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install cut sections of polyolefin pipe and sheet insulation to valve body.

2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

3. Install insulation to flanges as specified for flange insulation application.

4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.10 FINISHES

A. Equipment and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 22 05 53 “Painting and Identification for Plumbing Piping and Equipment”.

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 field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.

2. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of fittings, two locations strainers, three locations of 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 materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.13 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold Water:

1. Insulation shall be the following:

a. Calcium Silicate: 1 inch thick at pipe hangers. Calcium silicate shall be installed in preformed sections 12 inches long enclosing pipe around entire circumference.

2. NPS 2-1/2 and larger: Insulation shall be the following:

a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

b. Flexible Elastomeric: 1 inch thick in walls and pipe chases after Building “Dry-In”.

c. Polyolefin: 1 inch thick under floor slab and in walls and chases prior to Building “Dry-In”.

3. NPS 2 and smaller: Insulation shall be the following:

a. Mineral–Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.

b. Flexible Elastomeric: 1/2 inch thick in walls and chases after Building “Dry-In”.

c. Polyolefin: 1/2 inch thick in walls and chases prior to Building “Dry In”.

B. Domestic Hot and Recirculated Hot Water:

1. Insulation shall be the following:

a. Calcium Silicate: 1-1/2 inch thick at pipe hangers. Calcium silicate shall be installed in preformed sections 12 inches long enclosing pipe around entire circumference.

2. NPS 2-1/2 and Larger: Insulation shall be the following:

a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1- 1/2 inches thick.

b. Flexible Elastomeric: 1-1/2 inches thick, in walls and chases after Building “Dry-In”.

c. Polyolefin: 1- 1/2 inches thick in walls and chases prior to Building “Dry-In”.

3. NPS 2”and smaller: Insulation shall be the following:

a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

b. Flexible Elastomeric: 1 inch thick in walls and chases after Building “Dry-In”.

c. Polyolefin: 1 inch thick in walls and chases prior to Building “Dry-In”.

C. Stormwater and Overflow:

1. All Pipe Sizes: Insulation shall be the following:

a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

b. Interior rain conductors and secondary rain conductors including fittings, from the bottom of the roof drains to 3’-6” below the last fitting where the lowest horizontal offset turns down into the vertical.

c. Down 4’-0” below the roof drain on vertical rain conductors without horizontal offsets.

D. Roof Drain and Overflow Drain Bodies:

1. All Pipe Sizes: Insulation shall be the following:

a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

E. Aboveground Floor Drains, Traps, and Sanitary Drain Piping Receiving Condensate and Equipment Drain Water below 60 Deg F:

1. All Pipe Sizes: Insulation shall be the following:

a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch thick.

3.14 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Domestic Water Piping:

1. Insulation shall be the following:

a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.

b. Polyolefin: 2 inches thick.

END OF SECTION

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SECTION 22 11 16

DOMESTIC WATER PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Under-building slab and above ground domestic water pipes, tubes, fittings, and specialties inside the building.

2. Specialty valves.

3. Flexible connectors.

B. Related Sections:

1. Section 01 91 13 – General Commissioning Requirements

2. Section 03 30 00 – Cast – in Place Concrete

3. Section 22 04 00 – General Requirements for Plumbing

4. Section 22 05 23 – General – Duty Valves for Plumbing Piping

5. Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment

6. Section 22 05 53 – Painting and Identification for Plumbing Piping and Equipment

7. Section 22 07 00 – Plumbing Insulation

8. Section 22 11 19 – Domestic Water Piping Specialties

9. Section 22 11 23 – Domestic Water Pumps

10. Section 22 33 00 – Electric, Domestic – Water Heaters

11. Section 22 34 00 – Fuel–Fired, Domestic – Water Heaters

12. Section 22 40 00 – Plumbing Fixtures

13. Section 22 47 00 – Drinking Fountains and Water Coolers

14. Section 23 09 00 – Instrumentation and Control for HVAC

15. Division 26 – Electrical

16. Division 31 – Earthwork

17. Division 33 – Utilities

1.03 SUBMITTALS

A. Product Data: For each type of product indicated [S]. Comply with requirements in Division 1 and Section 22 04 00 “General Requirements for Plumbing”.

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 coordinated with each other, using input from Installers of the items involved:

1. Fire-suppression-water piping.

2. Domestic water piping.

3. HVAC hydronic piping.

4. Electric Switchgear, Panelboards

D. Field quality-control reports.

1.04 QUALITY ASSURANCE

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

B. NSF Compliance for materials that will be in contact with potable water:

1. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."

2. Comply with NSF 372, "Drinking Water System Components- Lead Content."

1.05 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 Owner no fewer than two days in advance of proposed interruption of water service.

PART 2 - PRODUCTS

2.01 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.

2.02 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: Above ground, 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.

5. Copper Pressure-Seal-Joint Fittings:

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

1) Elkhart Products Corporation; Industrial Division.

2) NIBCO INC.

3) Viega; Plumbing and Heating Systems.

b. NPS 2 and Smaller: Wrought-copper fitting with EPDM-rubber O-ring seal in each end.

c. NPS 2-1/2 to NPS 4: Cast-bronze or wrought-copper fitting with EPDM-rubber O-ring seal in each end.

B. Soft Copper Tube: Under building slab, ASTM B 88, Type K water tube, annealed temper.

1. Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

2. Copper Pressure-Seal-Joint 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) Elkhart Products Corporation; Industrial Division.

2) NIBCO INC.

3) Viega; Plumbing and Heating Systems.

b. NPS 2 and Smaller: Wrought-copper fitting with EPDM-rubber O-ring seal in each end.

c. NPS 3 and NPS 4: Cast-bronze or wrought-copper fitting with EPDM-rubber O-ring seal in each end.

2.03 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.

D. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.04 SPECIALTY VALVES [S]

A. Comply with requirements in Section 22 05 23"General-Duty Valves for Plumbing Piping" for general-duty metal valves.

B. Comply with requirements in Section 22 11 19 "Domestic Water Piping Specialties" for balancing valves, drain valves, backflow preventers, and vacuum breakers.

2.05 TRANSITION FITTINGS

A. General Requirements:

1. Same size as pipes to be joined.

2. Pressure rating at least equal to pipes to be joined.

3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

C. Sleeve-Type Transition Coupling: AWWA C219.

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

a. Cascade Waterworks Manufacturing.

b. Dresser, Inc.; Dresser Piping Specialties.

c. Ford Meter Box Company, Inc. (The).

d. JCM Industries.

e. Romac Industries, Inc.

f. Smith-Blair, Inc; a Sensus company.

g. Viking Johnson; c/o Mueller Co.

2.06 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, 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. Hart Industries International, Inc.

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

f. 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, 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, 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, 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. 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. Perfection Corporation; a subsidiary of American Meter Company.

    b. Precision Plumbing Products, Inc.

    c. Victaulic Company.

2. Description:

    a. Electroplated steel nipple complying with ASTM F 1545.

    b. Pressure Rating: 300 psig at 225 deg F.

    c. End Connections: Male threaded or grooved.

    d. Lining: Inert and noncorrosive, propylene.

2.07 FLEXIBLE CONNECTORS

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

1. Flex-Hose Co., Inc.

2. Flexicraft Industries.

3. Flex Pression, Ltd.

4. Flex-Weld, Inc.
5. Hyspan Precision Products, Inc.
6. Mercer Rubber Co.
7. Metraflex, Inc.
8. Proco Products, Inc.
9. Tozen Corporation.
10. Unaflex, Inc.
11. Universal Metal Hose; a Hyspan company

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.

PART 3 - EXECUTION

3.01 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

C. Install shutoff valve immediately upstream of each dielectric fitting.

D. Install domestic water piping level with 0.25 percent slope downward toward drain and plumb.

E. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

F. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

G. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

H. Install piping adjacent to equipment and specialties to allow service and maintenance.

I. Install piping to permit valve servicing.

J. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure rating used in applications below unless otherwise indicated.

K. Install piping free of sags and bends.

L. Install fittings for changes in direction and branch connections.

M. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

N. Install pressure gages on suction and discharge piping from each plumbing pump. Comply with requirements in Section "22 11 19 “Domestic Water Piping Specialties” for pressure gages.

O. Install thermometers at inlet of hot water circulating pump and outlet piping from each water heater. Comply with requirements in Section 22 11 19 "Domestic Water Piping Specialties" for thermometers.

P. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 22 04 00 "General Requirements for Plumbing."

Q. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 22 04 00 "General Requirements for Plumbing."

3.02 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

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

C. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

E. Pressure-Sealed Joints: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.

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

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

3.03 VALVE INSTALLATION

A. General-Duty Valves: Comply with requirements in Section 22 05 23 "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 valves for piping NPS 2 and smaller. Use ball or gate valves for piping NPS 2-1/2 and larger.

C. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping. Drain valves are specified in Section 22 11 19 "Domestic Water Piping Specialties."

1. Hose-End Drain Valves: At low points in water mains, risers, and branches.

D. Install balancing valve in each hot-water circulation return branch and discharge side of each pump and circulator. Comply with requirements in Section 22 11 19 "Domestic Water Piping Specialties" for balancing valves.

3.04 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping:

1. NPS 1-1/2 and Smaller: Fitting-type coupling.

2. NPS 2 and Larger: Sleeve-type coupling.

3.05 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 unions.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.

3.06 FLEXIBLE CONNECTOR INSTALLATION

A. Install bronze-hose flexible connectors in copper domestic water tubing.

3.07 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support products and installation.

1. Vertical Piping: MSS Type 8 or 42, clamps.

2. Individual, Straight, Horizontal Piping Runs:

a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.

b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.

c. Longer Than 100 Feet If Indicated: MSS Type 49, spring cushion rolls.

3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.

4. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support vertical piping and tubing at base and at each floor.

C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.

D. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.

2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.

3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.

4. NPS 2-1/2: 108 inches with 1/2-inch rod.

5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.

E. Install supports for vertical copper tubing every 10 feet.

F. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.08 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment and machines to allow service and maintenance.

C. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:

1. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.

2. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Comply with requirements in Division 22 plumbing fixture Sections for connection sizes.

3. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.09 IDENTIFICATION

A. Identify system components. Comply with requirements Section 22 05 53 "Painting and Identification for Plumbing Piping and Equipment" for identification materials and installation.

3.10 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 must be made. Perform tests specified below in presence of authorities having jurisdiction:

a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.

b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

3. Reinspection: If authorities having jurisdiction find that piping will not pass 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 diagram of 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 pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.

5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.

6. Prepare reports for tests and 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.

3.11 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.

2. Open shutoff valves to fully open position.

3. Open throttling valves to proper setting.

4. Remove plugs used during testing of piping and for temporary sealing of piping during installation.

5. Remove and clean strainer screens. Close drain valves and replace drain plugs.

6. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.

7. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.12 CLEANING

A. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.

2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:

a. Flush piping system with clean, potable water until dirty water does not appear at outlets.

b. Fill and isolate system according to either of the following:

1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.

2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.

c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.

d. Submit water samples in sterile bottles to testing agency for testing. Repeat procedures if biological examination shows contamination.

B. Clean non-potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.

2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:

a. Flush piping system with clean, potable water until dirty water does not appear at outlets.

b. Submit water samples in sterile bottles to testing agency for testing. Repeat procedures if biological examination shows contamination.

C. Prepare and submit reports of purging and disinfecting activities.

D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.13 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Under-building-slab, domestic water piping shall be the following:

1. Soft copper tube, ASTM B 88, Type K; wrought-copper solder-joint fittings; and pressure-sealed joints.

D. Aboveground, domestic water piping shall be the following:

1. Hard copper tube, ASTM B 88, Type L; cast- or wrought-copper solder-joint fittings; and soldered joints.

2. Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.

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: Ball valves for piping NPS 3 and smaller. Gate valves for piping NPS 4 and larger.

2. Throttling Duty: Globe or ball valves.

3. Hot-Water Circulation Piping, Balancing Duty: Thermostatic, self-actuated balancing valve.

4. Drain Duty: Hose-end drain valves.

B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

END OF SECTION

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SECTION 22 11 19

DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section includes:

1. Backflow Prevention Devices
2. Balancing Valves.
3. Temperature-Actuated Water Mixing Valves.
4. Strainers.
5. Outlet Boxes.
6. Hose Bibbs.
7. Wall Hydrants.
8. Drain Valves.
9. Water Hammer Arresters.
10. Air Vents.
11. Trap-Seal Primer Valves.
12. Trap-Seal Primer Systems.
13. Thermometers
14. Pressure Gages

B. Related Sections:

1. Section 01 91 13 – General Commissioning Requirements

2. Section 22 04 00 – General Requirements for Plumbing
3. Section 22 05 23 – General – Duty Valves for Plumbing Piping
4. Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment
5. Section 22 05 53 – Painting and Identification for Plumbing Piping and Equipment
6. Section 22 07 00 – Plumbing Insulation
7. Section 22 11 16 – Domestic Water Piping
8. Section 22 11 23 – Domestic Water Pumps
9. Section 22 33 00 – Electric, Domestic – Water Heaters
10. Section 22 30 00 – Fuel– Fired, Domestic – Water Heaters
11. Section 22 40 00 – Plumbing Fixtures
12. Section 22 45 00 – Emergency Plumbing Fixtures
13. Section 22 47 00 – Drinking Fountains and Water Coolers
14. Division 26 – Electrical

1.03 PERFORMANCE REQUIREMENTS

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

1.04 SUBMITTALS

A. Product Data: For each type of product indicated [S]. Comply with requirements in Division 01 and Section 22 04 00 “General Requirements for Plumbing”.

B. Field quality-control test reports.

C. Operation and Maintenance Data: For domestic water piping specialties indicated [O/M], include in emergency, operation, and maintenance manuals. Comply with requirements in Division 01 and Section 22 04 00 “General Requirements for Plumbing”.

1.05 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 for materials that will come in contact with potable water:

1. NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components.

2. NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."

3. NSF 372, "Drinking Water System Components - Lead Content."

PART 2 - PRODUCTS

2.01 BACKFLOW PREVENTION DEVICES [S] [O/M]

A. Backflow Prevention Devices: All equipment subject to backflow or back siphonage such as, but not limited to Wall Hydrants, Hose Bibbs, Clothes Washer, Dishwasher, Ice Machines, Coffee Machines, Soap Dispensers, etc., shall be equipped with Backflow Prevention Devices to satisfy the requirements of the International Plumbing Code, all local codes and ordinances.

B. Pressure Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements.

2. Standard:

a. Spill-Resistant: ASSE 1001.

b. Anti-Siphon, Spill-Resistant: ASSE 1056.

3. Operation: Continuous-pressure applications.

4. Pressure Loss: 10 psig maximum, through middle 1/3 of flow.

5. Size: Same as connecting piping.

6. Body: Bronze.

7. End Connections: Threaded.

8. Accessories:

a. Valves: Ball type, on inlet and outlet.

C. Intermediate Atmospheric-Vent Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements.

2. Standard: ASSE 1012.

3. Operation: Continuous-pressure applications.
4. Size: Same as connecting piping.
5. Body: Bronze.
6. End Connections: Union, solder joint.
7. Finish: Rough bronze.

D. Reduced-Pressure-Principle Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements.
2. Standard: ASSE 1013.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 10 psig maximum, through middle 1/3 of flow range.
5. Size: Same as connecting piping.
6. Body: Bronze.
7. End Connections: Threaded.
8. Accessories:
    a. Valves: Ball type with threaded ends on inlet and outlet
    b. Air-Gap Fitting: ASME A112.1.2, matching backflow preventer connection.
    c. Strainer: On inlet.

E. Dual-Check-Valve Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements.
2. Standard: ASSE 1024.
3. Operation: Continuous-pressure applications.
4. Size: NPS 1/2
5. Body: Bronze, with union inlet and outlets.
6. Finish: Chrome plated in exposed locations.

2.02 WATER PRESSURE-REDUCING VALVES [S] [O/M]

A. Water Regulators:

1. Manufacturers: Subject to compliance with requirements.
2. Standard: ASSE 1003.
3. Pressure Rating: Initial working pressure of 150 psig.
4. Body: Bronze.
5. Size: Same as connected piping.
6. End Connections: Union, threaded.

2.03 BALANCING VALVES [S] [O/M]

A. Copper-Alloy Calibrated Balancing Valves:

1. Manufacturers: Subject to compliance with requirements.
2. Type: Directional, self-acting thermostatic recirculation assembly.
3. Body: Stainless steel or bronze with all lead-free components.
4. Size: Same as connected piping, but not larger than NPS 2.
5. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

2.04 TEMPERATURE-ACTUATED WATER MIXING VALVES [S] [O/M]

A. Water Tempering Valves:

1. Manufacturers: Subject to compliance with requirements.
2. Standard: ASSE 1070, thermostatically controlled water tempering valve.
3. Pressure Rating: 125 psig minimum, unless otherwise indicated.
4. Body: Bronze body with corrosion-resistant interior components.
5. Temperature Control: Adjustable.
6. Inlets and Outlet: Copper Union Threaded or Union Sweat.
7. Finish: Rough or chrome-plated bronze.

8. Tempered-Water Setting: 109 deg F.

9. Tempered-Water Design Flow Rate: 4 GPM at 5 psig pressure loss.

2.05 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig minimum, unless otherwise indicated.

2. Body: Bronze for NPS 3 and smaller; cast iron for NPS 4 and larger.

3. End Connections: Threaded for NPS 3 and smaller; flanged for NPS 4 and larger.

4. Screen: Stainless steel with round perforations, unless otherwise indicated.

5. Perforation Size:

a. Strainers NPS 3 and Smaller: 0.020 inch.

b. Strainers NPS 4 and Larger: 0.045 inch.

6. Drain: Pipe plug.

2.06 OUTLET BOXES [S]

A. Laundry Outlet LO-1: Refer to Detail on Drawings

1. Manufacturers: Subject to compliance with requirements.

2. Mounting: Recessed.

3. Material and Finish: Galvanized steel box and faceplate.

4. Faucet: Combination valve fitting, complying with ASME A112.18.1. Include garden-hose thread complying with ASME B1.20.7 on outlet.

5. Drain: NPS 2 Standpipe and P-trap for direct waste connection to drainage piping.

B. Icemaker Outlet Box IMB:

1. Manufacturers: Subject to compliance with requirements.

2. Mounting: Recessed.

3. Material and Finish: Galvanized steel box and faceplate.

4. Shutoff: NPS 1/2 compression angle valve with NPS 1/4 outlet.

2.07 HOSE BIBBS [S]

A. Hose Bibbs:

1. Manufacturers: Subject to compliance with requirements.

a. Hose Bibbs in Finished Areas Inside Building: Chrome plated, 1/2" inlet, with wall flange, furnished with loose key handle and vacuum breaker.

b. Hose Bibbs in Equipment Rooms and Unfinished Areas Inside Building: Rough chrome plated, 3/4" inlet, furnished with cross or lever handle and vacuum breaker.

2. Standard: ASME A112.18.1 for sediment faucets.

3. Body Material: Bronze.

4. Seat: Bronze, replaceable.

5. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.

6. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.

7. Pressure Rating: 125 psig.

8. Vacuum Breaker: Integral or field-installation, non-removable, drainable, hose-connection vacuum breaker complying with ASSE 1011.

9. Include operating key with each operating-key hose bibb.

10. Include integral wall flange with each chrome-plated hose bibb.

2.08 WALL HYDRANTS [S]

A. Non-freeze Wall Hydrants:

1. Manufacturers: Subject to compliance with requirements.

2. Standard: ASME A112.21.3M for exposed outlet, self-draining wall hydrants.

3. Pressure Rating: 125 psig.

4. Operation: Loose key.

5. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.

6. Inlet: NPS 3/4.

7. Outlet: Exposed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.

8. Nozzle and Wall-Plate Finish: Polished nickel bronze.

9. Operating Keys(s): Two with each wall hydrant.

2.09 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.

10. Vacuum Breaker: Integral, non-removable, drainable, hose-connection vacuum breaker complying with ASSE 1011.

2.10 WATER HAMMER ARRESTERS (SHOCK ABSORBERS) [S]

A. Water Hammer Arresters:

1. 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. AMTROL, Inc.

b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.

c. Tyler Pipe; Wade Div.

d. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASSE 1010 or PDI-WH 201.

3. Type: Metal bellows or Copper tube with piston.

4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

2.11 AIR VENTS [S]

A. Bolted-Construction Automatic Air Vents:

1. Body: Bronze.

2. Pressure Rating: 125-psig minimum pressure rating at 140 deg F.

3. Float: Replaceable, corrosion-resistant metal.

4. Mechanism and Seat: Stainless steel.

5. Size: NPS 1/2 minimum inlet.

6. Inlet and Vent Outlet End Connections: Threaded.

2.12 TRAP-SEAL PRIMER VALVES [S]

A. Supply-Type, Trap-Seal Primer Valves:

1. Manufacturers: Subject to compliance with requirements.

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: Rough bronze for.

8. Accessories: Distribution Unit where trap primers serves multiple drains.

2.13 TRAP-SEAL PRIMER SYSTEMS [S] [O/M]

A. Trap-Seal Primer Systems:

1. Manufacturers: Subject to compliance with requirements.

2. Standard: ASSE 1044,

3. Piping: NPS 3/4, ASTM B 88, Type L; copper, water tubing.

4. Cabinet: Surface-mounting steel box with stainless-steel cover.

5. Electric Controls: 24-hour timer, solenoid valve, and manual switch for 120-V ac power.

6. Vacuum Breaker: ASSE 1001.

7. Number Outlets: Refer to floor plans.

8. Size Outlets: NPS 1/2.

2.14 FILLED-SYSTEM THERMOMETERS [S]

A. Direct-Mounted, Metal-Case, Vapor-Actuated Thermometers:

1. 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. Ashcroft Inc.

b. Marsh Bellofram.

c. Miljoco Corporation.

d. Palmer Wahl Instrumentation Group.

e. REOTEMP Instrument Corporation.

f. Trerice, H. O. Co.

g. Weiss Instruments, Inc.

2. Standard: ASME B40.200.

3. Case: Sealed type, cast aluminum or drawn steel; 4-1/2-inch nominal diameter.

4. Element: Bourdon tube or other type of pressure element.

5. Movement: Mechanical with link to pressure element and connection to pointer.

6. Dial: Non-reflective aluminum with permanently etched scale markings 0 deg F to 200 deg f.

7. Pointer: Dark-colored metal.

8. Window: Glass.

9. Ring: Metal.

10. Connector Type(s): Union joint, adjustable, 180 degrees in vertical plane with ASME B1.1 screw threads.

11. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.

    a. Design for Thermowell Installation: Bare stem.

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

B. Thermowells:

1. Standard: ASME B40.200.

2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.

3. Material for Use with Copper Tubing: CNR or CUNI.

4. Type: Stepped shank unless straight or tapered shank is indicated.

5. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.

6. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.

7. Bore: Diameter required to match thermometer bulb or stem.

8. Insertion Length: Length required to match thermometer bulb or stem.

9. Lagging Extension: Include on thermowells for insulated piping and tubing.

10. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

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

PART 3 - EXECUTION

3.01 INSTALLATION

A. Comply with requirements in other Division 22 Sections for piping joining materials, joint construction, and basic installation requirements.

B. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction and the International Plumbing Code.

1. Locate backflow preventers in same room as connected equipment or system.

2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.

3. Do not install bypass piping around backflow preventers.

C. Install water regulators with inlet and outlet shutoff valves and bypass with memory-stop balancing valve. Install pressure gages on inlet and outlet.

D. Install thermostatic balancing valves with inlet and outlet shutoff valves in locations where they can easily be serviced. Install check valve on outlet.

E. Install temperature-actuated water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.

F. Install Y-pattern strainers for water on supply side of each domestic water pump.

G. Install outlet boxes recessed in wall with face plate flush with finished wall.

H. Install water hammer arresters in water piping according to PDI-WH 201.

I. Install air vents at high points of water piping.

J. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.

K. Install trap-seal primer systems with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust system for proper flow.

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

M. Install thermowells with extension on insulated piping.

N. Fill thermowells with heat-transfer medium.

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

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

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

R. Install thermometers in the following locations:

1. Outlet of each water heater.

2. Inlet of each hot water circulating pump.

3.02 CONNECTIONS

A. Comply with requirements, for piping installation, in Sections 22 11 16 “Domestic Water Piping”. Drawings indicate general arrangement of piping and specialties.

B. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

C. Connect wiring according to Section 26 05 23 "Low-Voltage Electrical Power Conductors and Cables."

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

3.03 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following: Comply with requirements in Section 22 05 53 “Painting and Identification for Plumbing Piping and Equipment.

1. Intermediate atmospheric-vent backflow preventers.

2. Outlet boxes.

3. Supply-type, trap-seal primer valves.

4. Trap-seal primer systems.

3.04 ADJUSTING

A. Set field-adjustable temperature set points of temperature-actuated water mixing valves.

B. Adjust faces of thermometers and pressure gages to proper angle for best visibility.

END OF SECTION

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SECTION 22 11 23

DOMESTIC WATER PUMPS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. In-line, high efficiency large wet rotor hot water circulating pumps with ECM motor.

B. Related Sections:

1. Section 01 91 13 – General Commissioning Requirements
2. Section 22 04 00 – General Requirements for Plumbing
3. Section 22 05 23 – General – Duty Valves for Plumbing Piping
4. Section 22 05 29 – Hanger and Supports for Plumbing Piping and Equipment
5. Section 22 05 53 – Painting & Identification for Plumbing Piping and Equipment
6. Section 22 07 00 – Plumbing Insulation
7. Section 22 11 16 – Domestic Water Piping
8. Section 22 11 19 – Domestic Water Piping Specialties
9. Section 22 34 00 – Fuel Fired, Domestic – Water Heaters
10. Division 24 – Building Automation System
11. Division 26 – Electrical

1.03 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. DDC: Direct Digital Control

1.04 SUBMITTALS

A. Product Data: For each type of product indicated [S]. Include materials of construction, rated capacities, certified performance curves with operating points plotted on curves, operating characteristics, electrical characteristics, and furnished specialties and accessories. Comply with requirements in Division 01 and Section 22 04 00 “General Requirements for Plumbing”.

B. Operation and Maintenance Data: For domestic water pumps indicated [O/M], to include in operation and maintenance manuals. Comply with requirements in Division 01 and Section 22 04 00 “General Requirements for Plumbing.

1.05 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.

PART 2 - PRODUCTS

2.01 IN-LINE, HIGH EFFICIENCY LARGE WET ROTOR HOT WATER CIRCULATING PUMPS WITH ECM MOTOR[S] [O/M]

A. Manufacturer: Subject to compliance with requirements.

B. Description: Factory-assembled and -tested, in-line, high efficiency, wet rotor centrifugal pumps.

C. Pump Construction:

1. Pump and Motor Assembly: Hermetically sealed, oil lubricated with hardened steel shaft with flexible spring coupler, designed for installation with pump and motor shaft horizontal.

2. Casing: Lead-Free Bronze, with companion-flange connections.

3. Impeller: Stainless Steel

4. Rotor: Permanent Magnet

5. Motor: Electronically commutated with permanent magnet.

D. Capacities and Characteristics:

1. Capacity: 5 gpm.

2. Total Dynamic Head: 12 feet.

3. Minimum Working Pressure: 125 psig.

4. Maximum Continuous Operating Temperature: 225 deg F.

5. Inlet and Outlet Size: NPS 3/4.

6. Pump Speed: 1725 rpm.

7. Pump Control: Set-point temperature control. The pump shall maintain a constant temperature in the system using a built-in temperature sensor.

8. Motor Horsepower: 1/12.

9. Electrical Characteristics:

    a. Volts: 120.

    b. Phases: Single.

    c. Hertz: 60.

    d. Full-Load Amperes: 1.3.

2.02 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors.

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections in Division 26.

2.03 CONTROLS

A. Direct Digital Control: Comply with requirements in Division 24 “Building Automation System”.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine roughing-in of domestic-water-piping system to verify actual locations of connections before pump installation.

3.02 PUMP INSTALLATION

A. Comply with HI 1.4.

B. Install horizontally mounted, in-line, centrifugal pumps with shaft(s) horizontal.

C. Install continuous-thread hanger rods and of size required to support pump weight.

1. Comply with requirements for hangers and supports in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."

3.03 CONNECTIONS

A. Comply with requirements for piping in Section 22 11 16 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to pumps to allow service and maintenance.

C. Connect domestic water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles.

1. Comply with requirements for flexible connectors in Section 22 11 16 "Domestic Water Piping"

2. Install shutoff valve on suction side of each pump, and check, shutoff, and throttling valves on discharge side of each pump. Install valves same size as connected piping. Comply with requirements for valves specified in Section 22 05 23 "General-Duty Valves for Plumbing Piping" and comply with requirements for strainers in Section 22 11 19 "Domestic Water Piping Specialties."

3. Install thermometer at inlet of each circulating pump. Comply with requirements for thermometers in Section 22 11 19 “Domestic Water Piping Specialties”.

D. Comply with Division 26 requirements for electrical connections, and wiring methods.

E. Connect DDC Controls to pumps that they control.

3.04 IDENTIFICATION

A. Comply with requirements for identification in Section 22 05 53 "Painting and Identification for Plumbing Piping and Equipment" for identification of pumps.

3.05 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup check according to manufacturer's written instructions.

2. Check piping connections for tightness.

3. Clean strainers on suction piping.

4. Set DDC Controls**,** 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 pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.

   c. Verify that pump is rotating in the correct direction.

6. Prime pump by opening suction valves and closing drains and prepare pump for operation.

7. Start motor.

8. Open discharge valve slowly.

9. Adjust temperature settings on thermostats.

10. Adjust timer settings.

3.06 ADJUSTING

A. Adjust domestic water pumps to function smoothly and lubricate as recommended by manufacturer.

B. Adjust initial temperature set points.

C. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

END OF SECTION

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SECTION 22 13 16

SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Pipe, tube, and fittings.

2. Specialty pipe fittings.

B. Related Sections:

1. Section 01 91 13 – General Commissioning Requirements

2. Section 03 30 00 – Cast-In Place Concrete

3. Section 22 04 00 – General Requirements for Plumbing

4. Section 22 05 23 – General – Duty Valves for Plumbing Piping

5. Section 22 05 29 – Hanger and Supports for Plumbing Piping and Equipment

6. Section 22 05 53 – Painting and Identification for Plumbing Piping and Equipment

7. Section 22 07 00 – Plumbing Insulation

8. Section 22 13 19 – Sanitary Waste Piping Specialties

9. Section 22 40 00 – Plumbing Fixtures

10. Section 22 47 00 – Drinking Fountains and Water Coolers

11. Division 31 - Earthwork

1.03 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:

1. Soil, Waste, and Vent Piping: 10-foot head of water.

1.04 SUBMITTALS

A. Product Data: For each type of product indicated [S]. Comply with requirements in Division 01 and Section 22 04 00 “General Requirements for Plumbing”.

B. Field quality-control reports.

1.05 QUALITY ASSURANCE

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

B. Comply with NSF/ANSI 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.

1.06 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 Owner no fewer than two days in advance of proposed interruption of sanitary waste service.

PART 2 - PRODUCTS

2.01 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.

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

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following: AB&I Foundry, Charlotte Pipe & Foundry or Tyler Pipe. Cast iron pipe and fittings shall be manufactured in the USA bear the Collective Trademark of the Cast Iron Soil Pipe Institute.

B. Pipe and Fittings: ASTM A 74, Service class.

C. Gaskets: ASTM C 564, rubber.

D. Caulking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.03 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following: AB&I Foundry, Charlotte Pipe & Foundry or Tyler Pipe. Cast Iron Pipe and fittings shall be manufactured in the USA and bear the Collective Trademark of the Cast Iron Soil Pipe Institute

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

C. Sovent Stack Fittings: ASME B16.45 or ASSE 1043, hubless, cast-iron aerator and deaerator drainage fittings.

D. CISPI, Hubless-Piping Couplings:

1. 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. ANACO Coupling.

   b. Ideal Corporation.

   c. Mission Rubber Company; a division of MCP Industries, Inc.

   d. Tyler Pipe.

2. Standards: 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.

E. Heavy-Duty, Hubless-Piping Couplings:

1. 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. ANACO Corporation.

   b. Ideal Corporation.

   c. Mission Rubber Company; a division of MCP Industries, Inc.

   d. Tyler Pipe.

2. Standards: ASTM C 1540.

3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.04 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

B. Cellular-Core PVC Pipe: **Cellular core pipe shall not be permitted**.

C. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

D. Adhesive Primer: ASTM F 656.

1. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. Solvent Cement: ASTM D 2564.

1. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.05 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.

2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

3. Unshielded, Non-pressure Transition Couplings:

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

1) Dallas Specialty & Mfg. Co.

2) Fernco Inc.

3) Mission Rubber Company; a division of MCP Industries, Inc.

4) Plastic Oddities; a division of Diverse Corporate Technologies, Inc.

b. Standard: ASTM C 1173.

c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.

d. Sleeve Materials:

1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.

2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.

3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

4. Pressure Transition Couplings:

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

1) Cascade Waterworks Mfg. Co.

2) Dresser, Inc.

3) EBAA Iron, Inc.

4) JCM Industries, Inc.

5) Romac Industries, Inc.

6) Smith-Blair, Inc.; a Sensus company.

7) The Ford Meter Box Company, Inc.

8) Viking Johnson.

b. Standard: AWWA C219.

c. Description: Metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.

d. Center-Sleeve Material: Manufacturer's standard.

e. Gasket Material: Natural or synthetic rubber.

f. Metal Component Finish: Corrosion-resistant coating or material.

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, 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) Hart Industries International, Inc.

4) Jomar International Ltd.

5) Matco-Norca, Inc.

6) McDonald, A. Y. Mfg. Co.

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

8) 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 Flanges:

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

1) Capitol Manufacturing Company.

2) Central Plastics Company.

3) Matco-Norca, Inc.

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

5) Wilkins; a Zurn company.

b. Description:

1) Standard: ASSE 1079.

2) Factory-fabricated, bolted, companion-flange assembly.

3) Pressure Rating: 125 psig minimum at 180 deg F.

4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

PART 3 - EXECUTION

3.01 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Section 31 20 00 - Earth Moving.

3.02 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping 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 soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

J. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

K. Install soil and waste drainage and vent piping at the following minimum slopes unless otherwise indicated:

1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 2 and smaller; 1 percent downward in direction of flow for piping NPS 3 and larger.

2. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

L. 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."

M. Install underground PVC piping according to ASTM D 2321.

N. 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. Comply with requirements for cleanouts in Section 22 04 00 “General Requirements for Plumbing”.

2. Install drains in sanitary drainage gravity-flow piping. Comply with requirements for drains in Section 22 13 19 "Sanitary Waste Piping Specialties."

O. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

P. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves in Section 22 04 00 “General Requirements for Plumbing”.

Q. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons in Section 22 04 00 “General Requirements for Plumbing”.

3.03 JOINT CONSTRUCTION

A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum calked joints.

C. Joints for hubless, cast-iron soil pipes and fittings shall conform to CISPI 310 , latest revision and be certified by NSF for compliance to CISPI 310.

D. 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.

E. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.

2. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

3.04 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: Unshielded, nonpressure transition couplings.

B. Dielectric Fittings:

1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

3.05 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger and support devices and installation in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.

2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.

3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.

4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.

5. Vertical Piping: MSS Type 8 or Type 42, clamps.

6. Install individual, straight, horizontal piping runs:

a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.

b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.

c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.

7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.

8. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support horizontal piping and tubing within 12 inches of each fitting and coupling.

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.

E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.

2. NPS 3: 60 inches with 1/2-inch rod.

3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.

4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.

5. NPS 10 and NPS 12: 60 inches with 7/8-inch rod.

6. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

F. Install supports for vertical cast-iron soil piping every 15 feet.

G. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.06 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect drainage and vent piping to the following:

1. Plumbing Fixtures: Connect drainage 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 the plumbing code.

3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.

4. Install cleanouts in stacks near floor and floor cleanouts with cover flush with floor.

5. Comply with requirements for cleanouts and drains specified in Section 22 13 19 "Sanitary Waste Piping Specialties."

6. Equipment: Connect drainage piping as indicated. Provide union for each connection, flanges may be used instead of unions for connections NPS 2-1/2 and larger.

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

E. Make connections according to the following unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, at final connection to each piece of equipment.

2. Install flanges, in piping NPS 2-1/2 and larger, at final connection to each piece of equipment.

3.07 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification in Section 22 05 53 "Painting and Identification for Plumbing Piping and Equipment."

3.08 FIELD QUALITY CONTROL

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

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.

2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary drainage and vent piping according to plumbing code:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.

3. Drainage and Vent Water Test: A water test shall be applied to the drainage system either in its entirety or in sections. If applied to the entire system, all openings in the piping shall be tightly closed, except the highest opening, and the system shall be filled with water to the point of overflow. If the system is tested in sections, each opening shall be tightly plugged except the highest openings of the section under test, and each section shall be filled with water, but no section shall be tested with less that 10-foot head of water. In testing successive sections, at least the upper 10 feet of the next preceding section shall be tested so that no joint or pipe in the building , except the uppermost 10 feet of the system, shall have been submitted to a test of less than 10-foot head of water. This pressure shall be held for at least 15 minutes. The system shall then be tight at all points.

4. Drainage and Vent Air Test: An air test shall be made by forcing air into the system until there is a uniform gauge pressure of 5 psi or sufficient to a balance a 10 inch column of mercury. This pressure shall be held for a test period of at least 15 minutes. Any adjustments to the test pressure required because of changes in ambient temperature or the seating of gaskets shall be made prior to the beginning of the test period. **Plastic piping shall not be tested with air unless manufacturer literature states air testing is acceptable.**

5. Drainage and Vent Final Test: The final test of the completed drainage and vent system shall be visual and in sufficient detail to determine compliance with the provisions of the plumbing code. Where a smoke test is utilized, it shall be made by filling all traps with water and then introducing into the entire system a pungent, thick smoke produced by one or more smoke machines. When the smoke appears at stack openings on the roof, the stack openings shall be closed and pressure equivalent to a 1-inch water column shall be held for a test period of not less than 15 minutes.

6. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

7. Prepare reports for tests and required corrective action.

3.09 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.10 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground, soil, waste, and vent piping shall be either of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.

2. Hubless, cast-iron soil pipe and fittings CISPI or heavy-duty hubless-piping couplings; and coupled joints.

3. Dissimilar Pipe-Material Couplings: Unshielded, non-pressure transition couplings.

C. Underground, soil, waste, and vent piping shall be the following:

1. In Kitchens, Boiler Rooms and other areas where equipment discharge temperature is above 140 degrees F. or noted “CI” on the drawings: Service class, cast-iron soil piping; gaskets; and gasketed joints.

2. Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

3. Dissimilar Pipe-Material Couplings: Unshielded, non-pressure transition couplings.

END OF SECTION

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SECTION 22 13 19

SANITARY WASTE PIPING SPECIALITIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section includes:

1. Cleanouts.
2. Floor drains.
3. Through-penetration firestop assemblies.
4. Miscellaneous sanitary drainage piping specialties.
5. Solid Interceptors.

B. Related Sections:

1. Section 01 91 13 – General Commissioning Requirements
2. Section 03 30 00 – Cast-In Place Concrete
3. Section 22 04 00 – General Requirements for Plumbing
4. Section 22 05 29 – Hanger and Supports for Plumbing Piping and Equipment
5. Section 22 05 53 – Painting and Identification for Plumbing Piping and Equipment
6. Section 22 07 00 – Plumbing Insulation
7. Section 22 11 16 – Domestic Water Piping
8. Section 22 11 19 – Domestic Water Piping Specialties
9. Section 22 13 16 – Sanitary Waste and Vent Piping
10. Section 22 14 13 – Facility Storm Drainage Piping

11. Section 22 14 23 – Storm Drainage Piping Specialties

12. Section 22 40 00 – Plumbing Fixtures

13. Section 22 47 00 – Drinking Fountains and Water Coolers

14. Division 26 – Electrical

15. Division 31 – Earthwork

16. Division 33 - Utilities

1.03 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. FRP: Fiberglass-reinforced plastic.

C. HDPE: High-density polyethylene plastic.

D. PE: Polyethylene plastic.

E. PP: Polypropylene plastic.

F. PVC: Polyvinyl chloride plastic.

1.04 SUBMITTALS

A. Product Data: For each type of product indicated [S]. Comply with requirements in Division 01 and Section 22 04 00 “General Requirements for Plumbing”:

B. Field quality-control test reports.

C. Operation and Maintenance Data: For drainage piping specialties indicated [O/M], to include in emergency, operation, and maintenance manuals. Comply with requirements in Division 01 and Section 22 04 00 “General Requirements for Plumbing”.

1.05 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of 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.

1.06 COORDINATION

A. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.01 CLEANOUTS [S]

A. Floor Cleanouts:

1. Manufacturers: Subject to compliance with requirements.
2. Standard: ASME A112.36.2M.
3. Size:
    a. NPS 4 and smaller: Cleanout same as connected drainage piping.
    b. NPS 6: NPS 4 cleanout.
    c. NPS 8: NPS 6 cleanout.
    d. NPS 10 and larger: NPS 8 cleanout.
4. Type: Adjustable housing.
5. Body Material: Cast iron.
6. Clamping Device: Not required.
7. Flashing Flange: As required.
8. Outlet Connection: Inside caulk.
9. Closure: Brass plug with tapered threads.
10. Adjustable Housing Material: Cast iron with threads.
11. Frame and Cover Material and Finish:
    a. Finished Areas: Nickel bronze.
    b. Unfinished Areas: Cast iron.

12. Frame and Cover Shape: Round.

13. Top-Loading Classification:

    a. Finished Areas: Light Duty

    b. Unfinished Areas: Heavy Duty.

14. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

B. Base of Exposed Vertical Stacks Near Floor:

1. Manufacturers: Subject to compliance with requirements.

2. Standard: ASME A112.36.2M and ASTM A74, ASTM A888, 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 cleanout size.

C. Wall Cleanouts:

1. Description: Sanitary tee fitting with cleanout ferrule and plug. Face of cleanout opening shall be located within 1-1/2" of the finished wall surface.

2. Standard: ASME A112.36.2M, for cleanouts. Include wall access.

3. Body Size: Same as connected drainage piping.

4. Body Material: Hub-and-spigot or Hubless cast-iron as required to match connected piping.

5. Closure: Countersunk, drilled-and-threaded, brass plug.

6. Ferrule and Closure Plug Size:

    a. NPS 4 and Smaller: Cleanout same as connected drainage piping.

    b. NPS 6: NPS 4 cleanout.

    c. NPS 8: NPS 6 cleanout.

    d. NPS 10 and larger: NPS 8 cleanout.

7. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.

D. Exterior Cleanouts:

1. Manufacturers: Subject to compliance with requirements.

2. Standard: ASME A112.36.2M.

3. Size:

a. NPS 4 and Smaller: Cleanout same as connected drainage piping.

b. NPS 6: NPS 4 cleanout.

c. NPS 8: NPS 6 cleanout.

d. NPS 10 and larger: NPS 8 cleanout.

4. Type: Adjustable Housing

5. Body Material: Cast Iron.

6. Closure Plug Size: Brass with taper threads

7. Frame and Cover: Round Cast Iron

8. Top loading Classification: Heavy Duty.

9. Outlet: No-Hub or spigot.

2.02 FLOOR DRAINS [S]

A. General Requirements: Drains are listed to generally describe type and features and shall be modified and furnished as required herein, suitable for construction conditions.

1. Drains shall have one-piece bodies or the Contractor shall effectively seal drain bodies to prevent leakage from two-piece body drains.

2. Strainers shall be ¼" thick, or equivalent, nickel bronze in finished spaces.

3. Strainers shall be cast iron in equipment rooms, shops, unfinished storage rooms and janitor closets.

4. Strainer sizes shall be 5" for 2" drains, 7" for 3" drains, and 8" for 4" drains unless otherwise noted.

5. Provide flashing clamps for all floors with water-proofing membranes.

6. Drains located in Composition Decks, “Dex-O-Tex”, or similar compositions floor surfaces shall be furnished with special 4” wide flanges for bonding the flooring surface to the strainer. The height of the top of strainer above the flange shall be determined and provided after coordinating with the flooring Contractor for thickness requirements.

7. Weepholes shall be eliminated in all drains where composition deck, “Dex-O-Tex”, or waterproof floors are provided without waterproofing membrane.

8. Drain body shall be tapped for trap primer for drains in kitchens and mechanical spaces unless noted otherwise.

9. Drains located in areas other than kitchens and mechanical spaces shall be provided with a formed, elastomeric trap-seal device.

B. Cast-Iron Floor Drains:

1. Manufacturers: Subject to compliance with requirements.

2. Standard: ASME A112.6.3.

3. Body Material: Gray iron.

4. Outlet: Bottom, caulk or soil pipe gasket.

5. Backwater Valve: Not required.

6. Coating on Surfaces:

a. Drains Receiving Condensate: Acid-resistant epoxy on interior and exposed exterior surfaces.

b. Kitchen Floor Sinks: Acid-resistant epoxy on interior surfaces.

c. Other Areas: Not required.

7. Sediment Bucket: As specified.

8. Top or Strainer Material and Shape:

a. Finished Areas: Round, 1/4” thick, or equivalent, nickel bronze.

b. Kitchen Floor Sinks: Square, 3/4 Grate, nickel bronze.

c. Unfinished Areas: Round, cast iron tractor grate.

9. Trap Material: Cast iron or PVC.

10. Trap Pattern: Standard P-trap.

2.03 ROOF FLASHING ASSEMBLIES

A. Comply with requirements for roof flashing.

2.04 THROUGH-PENETRATION FIRESTOP ASSEMBLIES [S]

A. Through-Penetration Firestop Assemblies:

1. Manufacturers: Subject to compliance with requirements.

2. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.

3. Size: Same as connected soil, waste, or vent stack.

4. 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.

5. Stack Fitting: ASTM A 48/A 48M, gray-iron, hubless-pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.

6. Special Coating: Corrosion resistant on interior of fittings.

2.05 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES [S]

A. 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.

B. Floor-Drain, Trap-Seal Protection Device:

1. Description: Formed, chemical resistant, elastomeric trap-seal.

2. Standard: ASSE 1072 barrier type floor drain trap seal protection devices.

3. Size: Same as floor drain outlet.

C. Air-Gap Fittings:

1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.

2. Body: Bronze or cast iron.

3. Inlet: Opening in top of body.

4. Outlet: Larger than inlet.

5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

2.06 INTERCEPTORS [S]

A. Solids Interceptors:

1. Manufacturers: Subject to compliance with requirements.

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. Exterior Coating: Not required.

6. Body Dimensions: 8” x 11” H.

7. Inlet and Outlet Size: NPS 2.

8. End Connections: Threaded.

9. Mounting: Above floor.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Comply with requirements in other Division 22 Sections for piping joining materials, joint construction, and basic installation requirements.

B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Locate at each change in direction of piping greater than 45 degrees.

2. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.

3. Locate at base of each vertical soil and waste stack.

C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor. Cleanouts on 6” and smaller pipes shall be provided a minimum clearance of 18”

for rodding. Cleanouts on 8” and larger pipes shall be provided a minimum clearance of 36” for rodding.

D. Set exterior cleanouts flush with finished grade and provide 18” square by 6” deep concrete apron around cleanout.

E. For cleanouts located in concealed piping, locate cleanout opening within 1-1/2” of the finished wall surface. Install wall access covers flush with finished wall.

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 elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:

a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.

b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.

c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.

3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.

4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

G. Install through-penetration firestop assemblies in plastic stacks at floor penetrations.

H. Install floor drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.

1. Exception: Fitting may be omitted if trap has trap-seal primer connection.

2. Size: Same as floor drain inlet.

I. Install floor drain, trap-seal protection device on inlet to floor drains that are not provided with trap-seal primers.

1. Size: Same as floor drain inlet.

J. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

K. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

L. Install wood-blocking reinforcement for wall-mounting-type specialties.

M. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.02 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Ground equipment according to Section 22 05 26 "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.03 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.04 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION

SECTION 22 14 13

FACILITY STORM DRAINAGE PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Pipe, tube, and fittings.

2. Specialty pipe fittings.

B. Related Sections:

1. Section 01 91 13 – General Commissioning Requirements

2. Section 03 30 00 – Cast-In Place Concrete

3. Section 22 04 00 – General Requirements for Plumbing

4. Section 22 05 23 – General – Duty Valves for Plumbing Piping

5. Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment

6. Section 22 05 53 – Painting and Identification for Plumbing Piping and Equipment

7. Section 22 07 00 – Plumbing Insulation

8. Section 22 14 23 – Storm Drainage Piping Specialties

9. Section 22 14 29 – Sump Pumps

10. Division 26 – Electrical

11. Division 31 – Earthwork

12. Division 33 – Utilities

1.03 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.

1.04 SUBMITTALS

A. Product Data: For each type of product indicated [S]. Comply with requirements Division 01 and Section 22 04 00 “General Requirements for Plumbing”.

1.05 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of 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.

1.06 PROJECT CONDITIONS

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

1. Notify Owner no fewer than two days in advance of proposed interruption of storm-drainage service.

PART 2 - PRODUCTS

2.01 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.

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

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following: AB&I Foundry, Charlotte Pipe and Foundry, Tyler Pipe. Cast iron pipe and fittings shall be manufactured in the USA bear the Collective Trademark of the Cast Iron Soil Pipe Institute.

B. Pipe and Fittings: ASTM A 74, Service classes.

C. Gaskets: ASTM C 564, rubber.

D. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.03 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following: AB&I Foundry, Charlotte Pipe and Foundry, Tyler Pipe. Cast iron pipe and fittings shall be manufactured in the USA bear the Collective Trademark of the Cast Iron Soil Pipe Institute.

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

C. CISPI, Hubless-Piping Couplings:

1. 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. ANACO Coupling.

   b. Ideal corporation

   c. Mission Rubber Company; a division of MCP Industries, Inc.

   d. Tyler Pipe.

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

   a. ANACO-Husky.

   b. Ideal.

   c. Mission Rubber Company; a division of MCP Industries, Inc.

   d. Tyler Pipe.

2. Standards: ASTM C 1540.

3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.04 GALVANIZED-STEEL PIPE AND FITTINGS

A. Galvanized-Steel Pipe: ASTM A 53, Type E, Standard Weight. Threaded ends joining method.

B. Steel-Pipe Pressure Fittings:

1. Galvanized-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53 or ASTM A 106, Schedule 40, seamless steel pipe. Include ends matching joining method.

2. Galvanized-Gray-Iron, Threaded Fittings: ASME B16.4, Class 125, standard pattern.

C. 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.

2.05 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

B. Cellular-Core PVC Pipe: **Cellular Core Pipe shall not be permitted**.

C. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

D. Adhesive Primer: ASTM F 656.

1. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. Solvent Cement: ASTM D 2564.

1. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.06 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.

2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified-piping-system fitting.

3. Unshielded, Non-pressure Transition Couplings:

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

        1) Dallas Specialty & Mfg. Co.

        2) Fernco Inc.

        3) Mission Rubber Company; a division of MCP Industries, Inc.

        4) Plastic Oddities; a division of Diverse Corporate Technologies, Inc.

    b. Standard: ASTM C 1173.

    c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.

    d. Sleeve Materials:

        1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.

        2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.

        3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

4. Pressure Transition Couplings:

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

        1) Cascade Waterworks Mfg. Co.

        2) Dresser, Inc.

        3) EBAA Iron, Inc.

        4) Ford Meter Box Company, Inc. (The)

        5) JCM Industries, Inc.

        6) Romac Industries, Inc.

7) Smith-Blair, Inc.; a Sensus company.

8) Viking Johnson; c/o Mueller Co.

b. Standard: AWWA C219.

c. Description: Metal, sleeve-type couplings same size as, with pressure rating at least equal to and ends compatible with, pipes to be joined.

d. Center-Sleeve Material: Manufacturer's standard.

e. Gasket Material: Natural or synthetic rubber.

f. Metal Component Finish: Corrosion-resistant coating or material.

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, 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) Hart Industries International, Inc.

4) Jomar International Ltd.

5) Matco-Norca, Inc.

6) McDonald, A. Y. Mfg. Co.

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

8) 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.

PART 3 - EXECUTION

3.01 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Section 31 20 00 - Earth Moving.

3.02 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations from layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Make changes in direction for 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.

K. Lay buried building storm drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

L. Where trenches are excavated such that the bottom of the trench forms the bed for the pipe, solid and continuous load bearing support shall be provided between joints. Bell holes, hub

holes and coupling holes shall be provided at points where the pipe is joined. Such pipe shall not be supported on blocks to grade.

M. 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 2 and smaller; 1 percent downward in direction of flow for piping NPS 3and larger.

N. 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."

O. Install steel piping according to applicable plumbing code.

P. Install underground PVC piping according to ASTM D 2321.

Q. 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 cleanout fitting with closure plug inside the building in storm drainage force-main piping. Comply with requirements for cleanouts in Section 22 14 23 "Storm Drainage Piping Specialties."

2. Install drains in storm drainage gravity-flow piping. Comply with requirements for drains in Section 22 14 23 "Storm Drainage Piping Specialties."

R. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

S. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves in Section 22 04 00 “General Requirements for Plumbing”.

T. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons in Section 22 04 00 "General Requirements for Plumbing Piping".

3.03 JOINT CONSTRUCTION

A. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Hubless, Cast-Iron Soil Piping Coupled Joints: Joints for hubless cast iron soil pipes and fittings shall conform to CISPI 310, latest revision and be certified by NSF for compliance to CISPI 310.

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 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.

D. Plastic, Non-pressure Piping, Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.

2. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

3.04 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: Unshielded, 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 union.

3. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.

4. Dielectric Fittings for NPS 6 and Larger: Use dielectric flange kits.

3.05 VALVE INSTALLATION

A. General valve installation requirements are specified in Section 22 05 23 "General-Duty Valves for Plumbing Piping."

B. Shutoff Valves: Install full-port ball valve shutoff on each sump pump discharge.

C. Check Valves: Install lift-check valve, between pump and shutoff valve, on each sump pump discharge.

3.06 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger and support devices and installation in Section 22 05 53 "Hangers and Supports for Plumbing Piping and Equipment."

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
5. Vertical Piping: MSS Type 8 or Type 42, clamps.
6. Individual, Straight, Horizontal Piping Runs:
    a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer than 100 Feet: MSS Type 43, adjustable roller hangers.
    c. Longer than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
8. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support horizontal piping and tubing within 12 inches of each fitting and coupling.

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.

E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 2: 60 inches with 3/8-inch rod.
2. NPS 3: 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
5. NPS 10 and NPS 12: 60 inches with 7/8-inch rod.
6. Spacing for 10-foot pipe lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

F. Install supports for vertical cast-iron soil piping every 15 feet.

G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4: 84 inches with 3/8-inch rod.

2. NPS 1-1/2: 108 inches with 3/8-inch rod.

3. NPS 2: 10 feet with 3/8-inch rod.

H. Install supports for vertical steel piping every 15 feet.

I. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.07 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.

C. Connect storm drainage piping to roof drains and storm drainage specialties.

1. Install cleanouts in conductors near floor and floor cleanouts with cover flush with floor.

2. Comply with requirements for cleanouts and drains in Section 22 14 23 "Storm Drainage Piping Specialties."

D. Connect force-main piping to the following:

1. Sump Pumps: To sump pump discharge.

E. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

F. Make connections according to the following unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.

3.08 IDENTIFICATION

A. Identify exposed storm drainage piping. Comply with requirements for identification in Section 22 07 00 "Identification for Plumbing Piping and Equipment."

3.09 FIELD QUALITY CONTROL

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

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.

2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test storm drainage piping according to plumbing code:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.

3. Storm Drainage System Water Test: A water test shall be applied to the storm drainage system either in its entirety or in sections. If applied to the entire system, all openings in the piping shall be tightly closed, except the highest opening and the system shall be filled with water to the point of overflow. If the system is tested in sections, each opening shall be tightly plugged except the highest openings of the section under test, and each section shall be filled with water, but no section shall be tested with less than a 10-foot head of water. In testing successive sections, at least the upper 10 feet of the next preceding section shall be tested so that no joint or pipe in the building except the uppermost 10 feet of the system shall have been submitted to a test of less than a 10 foot head of water. This pressure shall be held for at least 15 minutes. The system shall then be tight at all points.

4. Storm Drainage System Air Test: An air test shall be made by forcing air into the system until there is a uniform gauge pressure of 5 psi or sufficient to balance a 10-inch column of mercury. This pressure shall be held for a test period of at least 15 minutes. Any adjustments to the test pressure required because of changes in ambient temperature or the seating of gaskets shall be made prior to the beginning of the test periods. **Plastic piping shall not be tested with air unless manufacturer literature states air testing is acceptable**.

5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

6. Prepare reports for tests and required corrective action.

E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.

2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.

3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

4. Prepare reports for tests and required corrective action.

3.10 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.11 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground storm drainage piping shall be the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.

2. Hubless, cast-iron soil pipe and fittings; CISPI, hubless-piping couplings; and coupled joints.

3. Dissimilar Pipe-Material Couplings: Unshielded, non-pressure transition couplings.

C. Underground storm drainage piping shall be the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.

2. Solid Wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

3. Dissimilar Pipe-Material Couplings: **Unshielded**, non-pressure transition couplings.

D. Aboveground storm drainage force mains shall be the following:

1. Galvanized-steel pipe, pressure fittings, and threaded joints.

END OF SECTION

SECTION 22 14 23

STORM DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Roof drains.

2. Miscellaneous storm drainage piping specialties.

3. Cleanouts.

4. Through-penetration firestop assemblies.

B. Related Sections:

1. Section 01 91 13 – General Commissioning Requirements

2. Section 03 30 00 – Cast-In Place Concrete

3. Section 22 04 00 – General Requirements for Plumbing

4. Section 22 05 29 – Hanger and Supports for Plumbing Piping and Equipment

5. Section 22 05 53 – Painting and Identification for Plumbing Piping and Equipment

6. Section 22 07 00 – Plumbing Insulation

7. Section 22 13 16 – Sanitary Waste and Vent Piping

8. Section 22 13 19 – Sanitary Waste Piping Specialties

9. Section 22 14 13 – Facility Storm Drainage Piping

10. Section 22 14 29 – Sump Pumps

11. Division 26 – Electrical

12. Division 31 – Earthwork

13. Division 33 - Utilities

1.03 SUBMITTALS

A. Product Data: For each type of product indicated [S]. Comply with requirements in Division 01 and Section 22 04 00 “General Requirements for Plumbing”.

1.04 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.01 METAL ROOF DRAINS

A. Cast-Iron, Large-Sump, Primary Roof Drains:

1. Manufacturers: Subject to compliance with requirements.

2. Standard: ASME A112.6.4, for general-purpose roof drains.

3. Body Material: Cast iron.

4. Dimension of Body: Nominal 15-inch diameter.

5. Combination Flashing Ring and Gravel Stop: Not required.

6. Outlet: Bottom.

7. Extension Collars: Required.

8. Underdeck Clamp: Required.

9. Expansion Joint: Not required.

10. Sump Receiver Plate: Required.

11. Dome Material: Cast iron.

12. Vandal-Proof Dome: Not required.

13. Water Dam: Not required.

B. Cast-Iron, Large-Sump, Combination Primary and Secondary Roof Drains:

1. Manufacturers: Subject to compliance with requirements.
2. Standard: ASME A112.6.4, for general-purpose roof drains.
3. Body Material: Cast iron.
4. Dimension of Body: Nominal 15-inch diameter.
5. Combination Flashing Ring and Gravel Stop: Not required.
6. Outlet: Bottom.
7. Extension Collars: Required.
8. Underdeck Clamp: Required.
9. Expansion Joint: Not required.
10. Sump Receiver Plate: One-piece, double drain.
11. Dome Material: Cast iron.
12. Perforated Gravel Guard: Not required.
13. Vandal-Proof Dome: Not required.
14. Water Dam: 3 inches high on secondary drain.

C. Cast-Iron, Small-Sump, General Purpose Roof Drains:

1. Manufacturers: Subject to compliance with requirements.
2. Standard: ASME A112.6.4, for general-purpose roof drains.
3. Body Material: Cast iron.
4. Dimension of Body: Nominal 8-inch diameter.
5. Combination Flashing Ring and Gravel Stop: Not required.
6. Outlet: Bottom.
7. Extension Collars: Required.
8. Underdeck Clamp: Required.
9. Expansion Joint: Not required.

10. Sump Receiver Plate: Required.

11. Dome: Low profile, cast iron.

12. Vandal-Proof Dome: Not required.

13. Water Dam: Not required.

2.02 MISCELLANEOUS STORM DRAINAGE PIPING SPECIALTIES [S]:

A. Open Site Drains:

1. All open site drains shall be provided with backwater valve.

2. Description: Cast iron floor drain with cast iron, extended rim strainer.

a. Size: Refer to drawings.

b. Trap Primer: Not required.

c. Backwater Valve:

(1) OSD-A: Provide coated, cast iron body sewer valve with bronze backwater valve in horizontal piping below grade. Extend access cover flush with finished floor.

(2) OSD-B: Provide coated, cast iron body ball float backwater valve in vertical, on bottom of floor drain.

B. Secondary Discharge Nozzles:

1. Description: Bronze body with threaded inlet, bronze wall flange with mounting holes, and stainless-steel mesh bird screen.

2. Size: Same as connected conductor.

2.03 CLEANOUTS [S]

A. Floor Cleanouts

1. Manufacturers: Subject to compliance with requirements.

2. Standard: ASME A112.36.2M.

3. Size:

a. NPS 4 and smaller: Cleanout same as connected drainage piping.

b. NPS 6: NPS 4 cleanout.

c. NPS 8: NPS 6 cleanout.

d. NPS 10 and larger: NPS 8 cleanout.

4. Type: Adjustable housing.

5. Body or Ferrule Material: Cast iron.

6. Clamping Device: Not required.

7. Flashing Flange: As required.

8. Outlet Connection: Inside caulk.

9. Closure: Brass plug with tapered threads.

10. Adjustable Housing Material: Cast iron with threads.

11. Frame and Cover Material and Finish:

a. Finished Areas: Nickel bronze.

b. Unfinished Areas: Cast iron.

12. Frame and Cover Shape: Round.

13. Top-Loading Classification**:**

a. Finished Areas: Light Duty.

b. Unfinished Areas: Heavy Duty.

14. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

B. Base of Exposed Vertical Stacks Near Floor:

1. Manufacturers: Subject to compliance with requirements.

2. Standard: ASME A112.36.2M and ASTM A74, ASTM A888, 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 cleanout size.

C. Wall Cleanouts:

1. Description: Sanitary tee fitting with cleanout ferrule and plug. Face of cleanout opening shall be located within 1-1/2" of the finished wall surface.

2. Standard: ASME A112.36.2M, for cleanouts. Include wall access.

3. Size: Same as connected drainage piping.

4. Body Material: Hub-and-spigot or Hubless cast-iron as required to match connected piping.

5. Closure: Countersunk, drilled-and-threaded, brass plug.

6. Ferrule and Closure Plug Size:

   a. NPS 4 and smaller: Cleanout same as connected drainage piping.

   b. NPS 6: NPS 4 cleanout.

   c. NPS 8: NPS 6 cleanout.

   d. NPS 10 and larger: NPS 8 cleanout.

7. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.

D. Exterior Cleanouts:

1. Manufacturers: Subject to compliance with requirements.

2. Standard: ASME A112.36.2M**.**

3. Size:

   a. NPS 4 and smaller: Cleanout same as connected drainage piping.

   b. NPS 6: NPS 4 cleanout.

   c. NPS 8: NPS 6 cleanout.

   d. NPS 10 and larger: NPS 8 cleanout.

4. Type: Adjustable Housing

5. Body Material: Cast Iron

6. Closure Plug: Brass with taper thread

7. Frame and Cover: Round Cast Iron

8. Top Loading Classification: Heavy Duty

9. Outlet: No-Hub or spigot

2.04 ROOF FLASHING ASSEMBLIES

A. Comply with requirements for roof flashing.

2.05 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies:

1. Manufacturers: Subject to compliance with requirements.

2. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.

3. Size: Same as connected drainage piping.

4. 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.

5. Stack Fitting: ASTM A 48/A 48M, gray-iron, hubless-pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.

6. Special Coating: Corrosion resistant on interior of fittings.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Comply with requirements in other Division 22 Sections for piping joining materials, joint construction, and basic installation requirements.

B. Install primary, general purpose and combination 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 on 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.

C. Install secondary discharge nozzle at elevation indicated on the drawings.

D. Install cleanouts in aboveground piping and building drain piping according to the following instructions unless otherwise indicated:

1. Locate cleanouts at each change in direction of piping greater than 45 degrees.

2. Locate cleanouts at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.

3. Locate cleanouts at base of each vertical rain conductor.

E. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor. Cleanouts on 6” and smaller pipes shall be provided a minimum clearance of 18” for rodding. Cleanouts on 8” and larger pipes shall be provided a minimum clearance of 36” for rodding.

F. Set exterior cleanouts flush with finished grade and provide 18” square by 6” deep concrete apron around cleanout.

G. For cleanouts located in concealed piping, locate cleanout opening within 1-1/2” of the finished wall surface. Install wall access covers flush with finished wall.

H. Install open site drains and set extend rim of grate to 1-1/2” above finished floor.

I. Install open site drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of water proof membranes where penetrated.

J. Install horizontal backwater valves in piping below slab-on-grade, set access cover flush with finished floor.

K. Install vertical ball-check backwater valves on outlet of open site drains in piping below elevated slab.

L. Install through-penetration firestop assemblies in plastic conductors at concrete floor penetrations.

M. Install sleeve flashing device with each conductor passing through floors with waterproof membrane.

3.02 CONNECTIONS

A. Comply with requirements for piping in Section 22 14 13 “Facility Storm Drainage Piping”. Drawings indicate general arrangement of piping, fittings, and specialties.

3.03 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION

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SECTION 22 14 29

SUMP PUMPS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Submersible sump pumps.

B. Related Sections:

1. Section 01 91 13 – General Commissioning Requirements
2. Section 03 30 00 – Cast-In Place Concrete
3. Section 22 04 00 – General Requirements for Plumbing
4. Section 22 05 13 – General Motor Requirements for Plumbing Equipment
5. Section 22 05 23 – General – Duty Valves for Plumbing Piping
6. Section 22 05 29 – Hanger and Supports for Plumbing Piping and Equipment
7. Section 22 05 53 – Painting and Identification for Plumbing Piping and Equipment
8. Section 22 14 13 – Facility Storm Drainage Piping
9. Section 22 14 23 – Storm Drainage Piping Specialties
10. Division 26 – Electrical
11. Division 31 - Earthwork

1.03 SUBMITTALS

A. Product Data: For each type of product indicated [S]. Comply with requirements in Division 01 and Section 22 04 00 “General Requirements for Plumbing”. 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 indicated [O/M], include in operation and maintenance manuals. Comply with requirements in Division 01 and Section 22 04 00 “General Requirements for Plumbing”.

1.04 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.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with pump manufacturer's written rigging instructions for handling.

PART 2 - PRODUCTS

2.01 SUBMERSIBLE SUMP PUMPS [S] [O/M]:

A. Submersible, Fixed-Position, Single-Seal Sump Pumps:

1. Manufacturers: Subject to compliance with requirements.

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 strainer inlet, legs that elevate pump to permit flow into impeller, and vertical discharge for piping connection.

5. Impeller: Statically and dynamically balanced, bronze, designed for clear wastewater handling, and keyed and secured to shaft.

6. Pump and Motor Shaft: Stainless steel, with factory-sealed, grease-lubricated ball bearings.

7. Seal: Carbon and Ceramic.

8. 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.

    a. Motor Housing Fluid: Oil.

9. Controls:

    a. Control panel, with integral alarm.

        1) Mechanical, float-type pump switch.

        2) Oil level sensor.

2.02 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors.

    1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

    2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26.

B. Motors for submersible pumps shall be hermetically sealed.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine roughing-in for plumbing piping to verify actual locations of storm drainage piping connections before sump pump installation.

3.02 INSTALLATION

A. Pump Installation Standards: Comply with HI 1.4 for installation of sump pumps.

3.03 CONNECTIONS

A. Comply with requirements for piping in Section 22 14 13 "Facility Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

3.04 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection.

2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

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

D. Prepare test and inspection reports.

3.05 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup check according to manufacturer's written instructions.

3.06 ADJUSTING

A. Adjust pumps to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust control set points.

3.07 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain controls and pumps.

END OF SECTION

SECTION 22 16 13

FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Pipes, tubes, and fittings.

2. Piping specialties.

3. Piping and tubing joining materials.

4. Valves.

5. Pressure regulators.

B. Related Sections:

1. Section 01 91 13 – General Commissioning Requirements

2. Section 03 30 00 – Cast-In Place Concrete

3. Section 08 31 00 – Access Doors and Frames

4. Section 22 04 00 – General Requirements for Plumbing

5. Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment

6. Section 22 05 53 – Painting and Identification for Plumbing Piping and Equipment

7. Section 22 34 00 – Fuel– Fired, Domestic–Water Heaters

8. Division 31 – Earthwork

9. Division 33 – Utilities

1.03 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.

1.04 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:

1. Piping and Valves: 100 psig minimum unless otherwise indicated.

B. Natural-Gas System Pressures within Building: Two pressure ranges. Primary pressure is more than 0.5 psig but not more than 2 psig, and is reduced to secondary pressure of 0.5 psig or less.

1.05 SUBMITTALS

A. Product Data: For each type of product indicated [S]. Comply with requirements in Division 01 and Section 22 04 00 “General Requirements for Plumbing”.

B. Field quality-control reports.

C. Operation and Maintenance Data: For Facility natural gas piping indicated [O/M], to include in emergency, operation, and maintenance manuals. Comply with requirements in Division 01 and Section 22 04 00 “General Requirements for Plumbing”.

1.06 QUALITY ASSURANCE

A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1, "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.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.

B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.

D. Protect stored PE pipes and valves from direct sunlight.

1.08 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 Owner no fewer than two days in advance of proposed interruption of natural-gas service.

1.09 COORDINATION

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

B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Section 08 31 00 "Access Doors and Frames."

PART 2 - PRODUCTS

2.01 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A 53, 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 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, 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.

    b. Steel flanges and tube with epoxy finish.

    c. Buna-nitrile seals.

    d. Steelbolts, 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. PE Pipe: ASTM D 2513, SDR 11.

1. PE Fittings: ASTM D 2683, socket-fusion type or ASTM D 3261, butt-fusion type with dimensions matching PE pipe.

2. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D 2513, SDR 11; and steel pipe complying with ASTM A 53, black steel, Schedule 40, Type E or S, Grade B.

3. Anodeless Service-Line Risers: Factory fabricated and leak tested.

    a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet.

b. Aboveground Portion: PE transition fitting.

c. Outlet shall be threaded or flanged or suitable for welded connection.

d. Tracer wire connection.

e. Ultraviolet shield.

f. Stake supports with factory finish to match steel pipe casing or carrier pipe.

4. Plastic Mechanical Couplings, NPS 1-1/2 and Smaller: Capable of joining PE pipe to PE pipe.

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

      1) Lyall, R. W. & Company, Inc.

      2) Mueller Co.; Gas Products Div.

      3) Perfection Corporation; a subsidiary of American Meter Company.

   b. PE body with molded-in, stainless-steel support ring.

   c. Buna-nitrile seals.

   d. Acetal collets.

   e. Electro-zinc-plated steel stiffener.

5. Plastic Mechanical Couplings, NPS 2 and Larger: Capable of joining PE pipe to PE pipe.

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

      1) Lyall, R. W. & Company, Inc.

      2) Mueller Co.; Gas Products Div.

      3) Perfection Corporation; a subsidiary of American Meter Company.

   b. Fiber-reinforced plastic body.

   c. PE body tube.

   d. Buna-nitrile seals.

   e. Acetal collets.

f. Stainless-steel bolts, nuts, and washers.

6. 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 compliance with requirements, 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) <Insert manufacturer's name>.

b. Steel flanges and tube with epoxy finish.

c. Buna-nitrile seals.

d. Steel bolts, washers, and nuts.

e. Factory-installed anode for steel-body couplings installed underground.

2.02 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.

B. Quick-Disconnect Devices: Comply with ANSI Z21.41.

1. Copper-alloy convenience outlet and matching plug connector.

2. Nitrile seals.

3. Hand operated with automatic shutoff when disconnected.

4. For indoor or outdoor applications.

5. Adjustable, retractable restraining cable.

C. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.

2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.

3. Strainer Screen: **40**-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.

4. CWP Rating: 125 psig.

D. 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.

E. 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 50 percent free area.

4. CWP Rating: 750 psig

F. 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.

2.03 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for natural gas.

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

C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F complying with AWS A5.8. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

2.04 MANUAL GAS SHUTOFF VALVES [S]

A. Refer to "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, according to the International Fuel Gas Code and acceptable to authorities having jurisdiction.

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. Listing: Listed and Labeled by an NRTL, according to the International Fuel Gas Code and acceptable to the authorities having jurisdiction.

D. One-Piece, Bronze Ball Valve with Bronze Trim: MSS SP-110.

1. 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. BrassCraft Manufacturing Company; a Masco company.

b. Conbraco Industries, Inc.; Apollo Div.

c. Lyall, R. W. & Company, Inc.

d. McDonald, A. Y. Mfg. Co.

e. Perfection Corporation; a subsidiary of American Meter Company.

2. Body: Bronze, complying with ASTM B 584.

3. Ball: Chrome-plated brass.

4. Stem: Bronze; blowout proof.

5. Seats: Reinforced TFE; blowout proof.

6. Packing: Separate packnut with adjustable-stem packing threaded ends.

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. Service: Suitable for natural-gas service.

E. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.

1. 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. BrassCraft Manufacturing Company; a Masco company.

b. Conbraco Industries, Inc.; Apollo Div.

c. Lyall, R. W. & Company, Inc.

d. McDonald, A. Y. Mfg. Co.

e. Perfection Corporation; a subsidiary of American Meter Company.

2. Body: Bronze, complying with ASTM B 584.

3. Ball: Chrome-plated bronze.

4. Stem: Bronze; blowout proof.

5. Seats: Reinforced TFE; blowout proof.

6. Packing: Threaded-body packnut design with adjustable-stem packing.

7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.

8. CWP Rating: 600 psig.

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

    a. McDonald, A. Y. Mfg. Co.

    b. Mueller Co.; Gas Products Div.

    c. Xomox Corporation; a Crane company.

2. Body: Cast iron, complying with ASTM A 126, Class B.

3. Plug: Bronze or nickel-plated cast iron.

4. Seat: Coated with thermoplastic.

5. Stem Seal: Compatible with natural gas.

6. Ends: Threaded or flanged as indicated in "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. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

G. Cast-Iron, Lubricated Plug Valves: MSS SP-78.

1. 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. Flowserve.

    b. Homestead Valve; a division of Olson Technologies, Inc.

    c. McDonald, A. Y. Mfg. Co.

    d. Milliken Valve Company.

    e. Mueller Co.; Gas Products Div.

    f. R&M Energy Systems, A Unit of Robbins & Myers, Inc.

2. Body: Cast iron, complying with ASTM A 126, Class B.

3. Plug: Bronze or nickel-plated cast iron.

4. Seat: Coated with thermoplastic.

5. Stem Seal: Compatible with natural gas.

6. Ends: Threaded or flanged as indicated in "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. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

2.05 EMERGENCY GAS SHUT-OFF VALVES[S]

A. Gas Shut-Off Valves:

1. 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. ASCO Red Hat, 8040 Series.

2. Body: Aluminum.

3. Ends: Threaded

4. Pressure Rating: 2psig

5. Type: Solenoid, 2 Way - Normally Closed Operation

6. Springs: Type 302 Stainless Steel.

7. Seals, Diaphragm, Disc: NBR.

8. Shading Coil: Copper

9. Approval: CSA, UL Listing.

10. Electrical Requirements:

11. Electrical Requirements: 120V, 60Hz

12. Shutoff: Remote Located 3 Position Momentary Non-illuminated Pushbutton

13. Signage: Red background with white letters reading “EMERGENCY GAS SHUTOFF”.

2.06 PRESSURE REGULATORS [S] [O/M]

A. General Requirements:

1. Single stage and suitable for natural gas.

2. Steel jacket and corrosion-resistant components.

3. Elevation compensator.

4. End Connections: Threaded for regulators NPS 2 and smaller; flanged for regulators NPS 2-1/2 and larger.

B. Line Pressure Regulators: Comply with ANSI Z21.80.

1. 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. Actaris.

   b. American Meter Company.

   c. Eclipse Combustion, Inc.

   d. Fisher Control Valves and Regulators; Division of Emerson Process Management.

   e. Invensys.

   f. Maxitrol Company.

   g. Richards Industries; Jordan Valve Div.

2. Body and Diaphragm Case: Cast iron or die-cast aluminum.

3. Springs: Zinc-plated steel; interchangeable.

4. Diaphragm Plate: Zinc-plated steel.

5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.

6. Orifice: Aluminum; interchangeable.

7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.

8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.

9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.

10. Overpressure Protection Device: Factory mounted on pressure regulator.

11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.

12. Maximum Inlet Pressure: 2 psig.

C. Appliance Pressure Regulators: Comply with ANSI Z21.18.

1. 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. Canadian Meter Company Inc.

b. Eaton Corporation; Controls Div.

c. Harper Wyman Co.

d. Maxitrol Company.

e. SCP, Inc.

2. Body and Diaphragm Case: Die-cast aluminum.

3. Springs: Zinc-plated steel; interchangeable.

4. Diaphragm Plate: Zinc-plated steel.

5. Seat Disc: Nitrile rubber.

6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.

7. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.

8. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.

9. Maximum Inlet Pressure: 2 psig.

2.07 DIELECTRIC FITTINGS

A. Dielectric Unions:

1. 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. Capitol Manufacturing Company.

b. Central Plastics Company.

c. Hart Industries International, Inc.

d. McDonald, A. Y. Mfg. Co.

e. Watts Regulator Co.; Division of Watts Water Technologies, Inc.

f. Wilkins; Zurn Plumbing Products Group.

2. Minimum Operating-Pressure Rating: 150 psig.

3. Combination fitting of copper alloy and ferrous materials.

4. Insulating materials suitable for natural gas.

5. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

B. Dielectric Flanges:

1. 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. Capitol Manufacturing Company.

b. Central Plastics Company.

c. Watts Regulator Co.; Division of Watts Water Technologies, Inc.

d. Wilkins; Zurn Plumbing Products Group.

2. Minimum Operating-Pressure Rating: 150 psig.

3. Combination fitting of copper alloy and ferrous materials.

4. Insulating materials suitable for natural gas.

5. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

C. Dielectric-Flange Kits:

1. 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. Advance Products & Systems, Inc.

b. Calpico Inc.

c. Central Plastics Company.

d. Pipeline Seal and Insulator, Inc.

2. Minimum Operating-Pressure Rating: 150 psig.

3. Companion-flange assembly for field assembly.

4. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or PE bolt sleeves, phenolic washers, and steel backing washers.

5. Insulating materials suitable for natural gas.

6. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

2.08 LABELING AND IDENTIFYING UNDERGROUND PIPE

A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.

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

3.02 PREPARATION

A. Close equipment shutoff valves before turning off natural gas to premises or piping section.

B. Inspect natural-gas piping according to the International Fuel Gas Code to determine that natural-gas utilization devices are turned off in piping section affected.

C. Comply with the International Fuel Gas Code requirements for prevention of accidental ignition.

3.03 OUTDOOR PIPING INSTALLATION

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

B. Install underground, natural-gas piping buried at least 36 inches below finished grade. Comply with requirements in Section 31 20 00 "Earth Moving" for excavating, trenching, and backfilling.

1. If natural-gas piping is installed less than 36 inches below finished grade, install it in containment conduit.

C. Install underground, PE, natural-gas piping according to ASTM D 2774.

D. Steel Piping with Protective Coating:

1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.

2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.

3. Replace pipe having damaged PE coating with new pipe.

E. Install fittings for changes in direction and branch connections.

3.04 INDOOR PIPING INSTALLATION

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

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.

D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

G. Locate valves for easy access.

H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.

I. Install piping free of sags and bends.

J. Install fittings for changes in direction and branch connections.

K. Verify final equipment locations for roughing-in.

L. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

M. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.

1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.

N. Extend relief vent connections for line regulators and overpressure protection devices to outdoors and terminate with weatherproof vent cap.

O. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.

P. Concealed Location Installations:

1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.

2. 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.

3. Prohibited Locations:

a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.

b. Do not install natural-gas piping in solid walls or partitions.

c. Do not install gas valves in ceiling plenums.

Q. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

R. Connect branch piping from top or side of horizontal piping.

S. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.

T. Do not use natural-gas piping as grounding electrode.

U. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

V. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves in Section 22 04 00 "General Requirements for Plumbing."

W. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons in Section 22 04 00 "General Requirements for Plumbing."

3.05 VALVE INSTALLATION

A. Install manual gas shutoff valve for each gas appliance ahead of connecting piping and connectors.

B. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

3.06 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints:

1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.

2. Cut threads full and clean using sharp dies.

3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.

4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.

5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints:

1. Construct joints according to AWS D10.12, using qualified processes and welding operators.

2. Bevel plain ends of steel pipe.

3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

F. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.

G. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, then use wrench. Do not overtighten.

H. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.

1. Plain-End Pipe and Fittings: Use butt fusion.

2. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.07 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hangers and supports in Section 22 05 29 "Hangers and Supports for Plumbing Piping and Equipment."

B. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.

2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.

3. NPS 1-1/2 and NPS 2 Maximum span, 108 inches; minimum rod size, 3/8 inch.

4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.

5. NPS 4 and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.

3.08 CONNECTIONS

A. Connect to utility's gas main according to utility's procedures and requirements.

B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.

C. Install piping adjacent to appliances to allow service and maintenance of appliances.

D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.09 LABELING AND IDENTIFYING

A. Comply with requirements in Section22 05 53 "Painting and 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 Section 22 05 53 “Painting and Identification for Plumbing Piping and Equipment” painting interior and exterior natural-gas piping.

3.11 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Test, inspect, and purge natural gas according to the International Fuel Gas Code and authorities having jurisdiction.

C. Natural-gas piping will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.12 OUTDOOR PIPING SCHEDULE

A. Underground natural-gas piping shall be the following:

1. PE pipe and fittings joined by heat fusion, or mechanical couplings; service-line risers with tracer wire terminated in an accessible location.

B. Aboveground natural-gas piping shall be either of the following:

1. Steel pipe with malleable-iron fittings and threaded joints.

2. Steel pipe with wrought-steel fittings and welded joints.

3.13 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 0.5 PSIG

A. Aboveground, distribution piping shall be the following:

1. NPS 2 and smaller: Steel pipe with malleable-iron fittings and threaded joints.

2. NPS 2-1/2 and larger: Steel pipe with wrought-steel fittings and welded joints.

3.14 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES 0.5 PSIG TO 5 PSIG

A. Aboveground, distribution piping shall be the following:

1. Steel pipe with steel welding fittings and welded joints.

3.15 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. 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.

B. Valves for pipe sizes NPS 2-1/2 and larger shall be the following:

1. Cast-iron, nonlubricated plug valve.

END OF SECTION

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SECTION 22 33 00

ELECTRIC, DOMESTIC-WATER HEATERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Commercial, electric, storage, domestic-water heaters.

2. Domestic-water heater accessories.

B. Related Sections:

1. Section 01 91 13 – General Commissioning Requirements

2. Section 03 30 00 – Cast-In Place Concrete

3. Section 22 04 00 – General Requirements for Plumbing

4. Section 22 05 13 – Common Motor Requirements for Plumbing Equipment

5. Section 22 05 23 – General–Duty Valves for Plumbing Piping

6. Section 22 05 29 – Hanger and Supports for Plumbing Piping and Equipment

7. Section 22 05 53 – Painting and Identification for Plumbing Piping and Equipment

8. Section 22 07 00 – Plumbing Insulation

9. Section 22 11 16 – Domestic Water Piping

10. Section 22 11 19 – Domestic Water Piping Specialties

11. Section 22 34 00 – Fuel-Fired, Domestic-Water Heaters

12. Section 23 09 00 – Instrumentation and Control for HVAC

13. Division 26 – Electrical

1.03 SUBMITTALS

A. Product Data: For each type and size of domestic-water heater indicated [S]. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories**.** Comply with requirements in Division 01 and Section 22 04 00 “General Requirements for Plumbing.

B. Shop Drawings:

1. Wiring Diagrams: For power, signal, and control wiring.

C. Product Certificates: For each type of commercial, electric, domestic-water heater, from manufacturer.

D. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.

E. Source quality-control reports.

F. Field quality-control reports.

G. Operation and Maintenance Data: For electric, domestic-water heaters indicated [O/M], to include in emergency, operation, and maintenance manuals. Comply with requirements in Division 01 and Section 22 04 00 “General Requirements for Plumbing”.

H. Warranty: Sample of special warranty.

1.04 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 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

C. ASME Compliance: Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61, "Drinking Water System Components - Health Effects" and NSF 372, "Drinking Water System Components- Lead Content".

1.05 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of electric, domestic-water heaters that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
    a. Structural failures including storage tank and supports.
    b. Faulty operation of controls.
    c. Deterioration of metals, metal finishes, and other materials beyond normal use.
2. Warranty Periods: From date of Substantial Completion.
    a. Commercial, Electric, Storage, Domestic-Water Heaters:
        1) Storage Tank: Three years.
        2) Controls and Other Components: One year.
    b. Thermal Expansion Tanks: Five years.

PART 2 - PRODUCTS

2.01 COMMERCIAL, ELECTRIC, DOMESTIC-WATER HEATERS [S] [O/M]

A. Commercial, Storage, Electric, Domestic-Water Heaters:
    1. Manufacturers: Subject to compliance with requirements.
    2. Standard: UL 1453.
    3. Storage-Tank Construction: Non-ASME- code, Steel, vertical arrangement.
    4. Factory-Installed Storage-Tank Appurtenances:
        a. Anode Rod: Replaceable magnesium.
        b. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
        c. Insulation: Comply with ASHRAE/IESNA 90.1.
        d. Jacket: Steel with enameled finish.
        e. Heating Elements: Electric, screw-in or bolt-on immersion type arranged in multiples of three.
        f. Temperature Control: Adjustable thermostat.
        g. Safety Controls: High-temperature-limit and low-water cutoff devices or systems.

h. Relief Valves: ASME rated and stamped for combination temperature-and-pressure relief valves. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.

5. Special Requirements: NSF 5 construction.

6. Capacity and Characteristics: Refer to drawings.

2.02 DOMESTIC-WATER HEATER ACCESSORIES [S]

A. Thermal Expansion Tanks:

1. Manufacturers: Subject to compliance with requirements.

2. Description: Steel pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.

3. Construction:

a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.

b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.

c. Air-Charging Valve: Factory installed.

B. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1.

C. Heat-Trap Fittings: ASHRAE 90.2.

D. Combination Temperature-and-Pressure Relief Valves: ASME rated and stamped. Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.

E. Pressure Relief Valves: ASME rated and stamped. Include pressure setting less than domestic-water heater working-pressure rating.

F. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4.

G. Shock Absorbers: ASSE 1010 or PDI-WH 201, Size A water hammer arrester.

2.03 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect domestic-water heaters specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.

B. Hydrostatically test commercial domestic-water heaters to minimum of one and one-half times pressure rating before shipment.

C. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Division 01 Section "Quality Requirements" for retesting and reinspecting requirements and Division 01 Section "Execution" for requirements for correcting the Work.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.01 DOMESTIC-WATER HEATER INSTALLATION

A. Install domestic-water heaters level and plumb on 4” concrete housekeeping pad, 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 22 05 23"General-Duty Valves for Plumbing Piping."

B. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

C. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for electric, domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves in Section 22 11 19 "Domestic Water Piping Specialties."

D. Install thermometers on outlet piping of electric, domestic-water heaters. Comply with requirements for thermometers in Section 22 11 19"Domestic Water Piping Specialties."

E. Install piping-type heat traps on inlet and outlet piping of electric, domestic-water heater storage tanks without integral or fitting-type heat traps.

F. Fill electric, domestic-water heaters with water.

G. Charge domestic-water compression tanks with air.

3.02 CONNECTIONS

A. Comply with requirements for piping in Section 22 11 16"Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to electric, domestic-water heaters, allow space for service and maintenance of water heaters. Provide proper support for thermal expansion tanks and piping. Arrange expansion tanks piping for easy removal of domestic-water heaters.

3.03 IDENTIFICATION

A. Identify system components. Comply with requirements for identification in Section 22 05 53 "Painting and Identification for Plumbing Piping and Equipment."

3.04 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.

4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Division 01 Section "Quality Requirements" for retesting and reinspecting requirements and Division 01 Section "Execution" for requirements for correcting the Work.

C. Prepare test and inspection reports.

3.05 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain commercial, electric, domestic-water heaters.

END OF SECTION

SECTION 22 34 00

FUEL-FIRED, DOMESTIC-WATER HEATERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Commercial, gas-fired, high-efficiency, storage, domestic-water heaters.

2. Domestic-water heater accessories.

B. Related Sections:

1. Section 01 91 13 – General Commissioning Requirements

2. Section 03 30 00 – Cast-In Place Concrete

3. Section 22 04 00 – General Requirements for Plumbing

4. Section 22 05 13 – Common Motor Requirements for Plumbing Equipment

5. Section 22 05 23 – General – Duty Valves for Plumbing Piping

6. Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment

7. Section 22 05 53 – Painting and Identification for Plumbing Piping and Equipment

8. Section 22 11 16 – Domestic Water Piping

9. Section 22 11 19 – Domestic Water Piping Specialties

10. Section 22 16 13 – Facility Natural– Gas Piping

11. Section 22 33 00 – Electric, Domestic – Water Heaters

12. Section 23 09 00 – Instrumentation and Control for HVAC

13. Section 23 10 00 – Facility Fuel Systems

14. Section 23 50 00 – Central Heating Equipment

15. Division 26 - Electrical

1.03 SUBMITTALS

A. Product Data: For each type and size of domestic-water heater indicated [S]. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories. Comply with requirements in Division 01 and Section 22 04 00 “General Requirements for Plumbing”.

B. Product Certificates: For each type of commercial, gas-fired, domestic-water heater, from manufacturer.

C. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.

D. Operation and Maintenance Data: For fuel-fired, domestic-water heaters indicated [O/M], to include in emergency, operation, and maintenance manuals. Comply with requirements Division 01 and Section 22 40 00 “General Requirements for Plumbing”.

E. Warranty: Sample of special warranty.

1.04 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 90.1 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.

2. Where ASME-code construction is indicated, fabricate and label commercial, finned-tube, domestic-water heaters to comply with ASME Boiler and Pressure Vessel Code: Section IV.

D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61, "Drinking Water System Components - Health Effects" and NSF 372, "Drinking Water System Components - Lead Content".

1.05 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of fuel-fired, domestic-water heaters that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including storage tank and supports.

b. Faulty operation of controls.

c. Deterioration of metals, metal finishes, and other materials beyond normal use.

2. Warranty Periods: From date of Substantial Completion.

a. Commercial, Gas-Fired, Storage, Domestic-Water Heaters:

1) Storage Tank: Three years.

2) Controls and Other Components: One year.

b. Thermal Expansion Tanks: Five years.

PART 2 - PRODUCTS

2.01 COMMERCIAL, GAS-FIRED, STORAGE, DOMESTIC-WATER HEATERS [S] [O/M]

A. Commercial, Gas-Fired, High-Efficiency, Storage, Domestic-Water Heaters:

1. Manufacturers: Subject to compliance with requirements.

2. Standard: ANSI Z21.10.3/CSA 4.3.

3. Description: Manufacturer's proprietary design to provide at least 95 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 tank. Attach tappings to 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 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.

c. Lining: Glass complying with NSF 61 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 bottom of tank.

c. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.

d. Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire storage tank except connections and controls.

e. Jacket: Steel with enameled finish.

f. Burner or Heat Exchanger: Comply with UL 795 or approved testing agency requirements for gas-fired, high-efficiency, domestic-water heaters and natural-gas fuel.

g. Temperature Control: Adjustable thermostat.

Safety Controls: Automatic, high-temperature-limit and low-water cutoff

h. Combination Temperature-and-Pressure Relief Valves: ANSI Z21.22/CSA 4.4-M. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.

6. Draft Hood: Draft diverter, complying with ANSI Z21.12

7. Capacity and Characteristic: Refer to drawings.

8. Vent: Provide manufacturer recommended concentric vent kit.

9. Condensate Drainage: Provide manufacturer recommended condensate neutralization kit.

2.02 DOMESTIC-WATER HEATER ACCESSORIES [S]

A. Thermal Expansion Tanks:

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

2. Description: Steel, pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.

3. Construction:

   a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.

   b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.

   c. Air-Charging Valve: Factory installed.

B. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1.

C. Heat-Trap Fittings: ASHRAE 90.2.

D. Gas Shutoff Valves: ANSI Z21.15/CSA 9.1-M manually operated. Furnish for installation in piping.

E. Gas Pressure Regulators: ANSI Z21.18/CSA 6.3, appliance type. Include 1/2-psig pressure rating as required to match gas supply.

F. Automatic Gas Valves: ANSI Z21.21/CSA 6.5, appliance, electrically operated, on-off automatic valve.

G. Combination Temperature-and-Pressure Relief Valves: Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.

   1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4-M.

H. Pressure Relief Valves: Include pressure setting less than domestic-water heater working-pressure rating.

   1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4-M.

I. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4-M.

2.03 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect assembled domestic-water heaters specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.

B. Hydrostatically test commercial domestic-water heaters to minimum of one and one-half times pressure rating before shipment.

C. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Division 01 Section "Quality Requirements" for retesting and

reinspecting requirements and Division 01 Section "Execution" for requirements for correcting the Work.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.01 DOMESTIC-WATER HEATER INSTALLATION

A. Install domestic-water heaters level and plumb on 4” concrete housekeeping pad, 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 22 05 23"General-Duty Valves for Plumbing Piping."

B. Install gas-fired, domestic-water heaters according to The International Fuel Gas Code.

1. Install gas shutoff valves on gas supply piping to gas-fired, domestic-water heaters without shutoff valves.

2. Install gas pressure regulators on gas supplies to gas-fired, domestic-water heaters without gas pressure regulators if gas pressure regulators are required to reduce gas pressure at burner.

3. Install automatic gas valves on gas supplies to gas-fired, domestic-water heaters if required for operation of safety control.

4. Comply with requirements for gas shutoff valves, gas pressure regulators, and automatic gas valves specified in Section 22 16 13 "Facility Natural-Gas Piping.”

C. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

D. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves in Section 22 11 19 "Domestic Water Piping Specialties."

E. Install thermometer on outlet piping of domestic-water heaters. Comply with requirements for thermometers in Section 22 11 19 "Domestic Water Piping Specialties."

F. Install piping-type heat traps on inlet and outlet piping of domestic-water heater storage tanks without integral or fitting-type heat traps.

G. Fill domestic-water heaters with water.

H. Charge domestic-water thermal expansion tanks with air.

3.02 CONNECTIONS

A. Comply with requirements for domestic-water piping in Section 22 11 16 "Domestic Water Piping."

B. Comply with requirements for gas piping in Section 22 16 13 "Facility Natural-Gas Piping."

C. Drawings indicate general arrangement of piping, fittings, and specialties.

D. Where installing piping adjacent to fuel-fired, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.03 IDENTIFICATION

A. Identify system components. Comply with requirements for identification in Section 05 53 "Painting and Identification for Plumbing Piping and Equipment."

3.04 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.

4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Division 01 Section "Quality Requirements" for retesting and reinspecting requirements and Division 01 Section "Execution" for requirements for correcting the Work.

C. Prepare test and inspection reports.

3.05 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain commercial, gas-fired, storage, domestic-water heaters.

END OF SECTION

SECTION 22 40 00

PLUMBING FIXTURES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Water closets.
2. Urinals.
3. Lavatories.
4. Sinks.
5. Showers.
6. Mop Sinks.
7. Laundry Sinks.

B. Related Sections:

1. Section 01 91 13 – General Commissioning Requirements
2. Section 10 28 00 – Toilet, Bath and Laundry Accessories
3. Section 22 04 00 – General Requirements for Plumbing
4. Section 22 05 23 – General – Duty Valves for Plumbing Piping
5. Section 22 11 16 – Domestic Water Piping
6. Section 22 11 19 – Domestic Water Piping Specialties
7. Section 22 13 16 – Sanitary Waste and Vent Piping
8. Section 22 13 19 – Sanitary Waste Piping Specialties

9. Section 22 47 00 – Drinking Fountains and Water Coolers

10. Division 26 - Electrical

1.03 SUBMITTALS

A. Product Data: For each type of plumbing fixture indicated [S]. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates. Comply with requirements in Division 01 and Section 22 04 00 “General Requirements for Plumbing”.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Operation and Maintenance Data: For plumbing fixtures indicated [O/M] to include in emergency, operation, and maintenance manuals. Comply with requirements in Division 01 and Section 22 04 00 “General Requirements for Plumbing”.

D. Warranty: Special warranty specified in this Section.

1.04 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.

C. Fitting: Device that controls the flow of water into or out of the plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.

D. FRP: Fiberglass-reinforced plastic.

E. PMMA: Polymethyl methacrylate (acrylic) plastic.

F. PVC: Polyvinyl chloride plastic.

1.05 QUALITY ASSURANCE

A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.

1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities" for plumbing fixtures for people with disabilities.

D. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.

E. NSF Compliance for fixture materials that will be in contact with potable water: NSF 61, "Drinking Water System Components - Health Effects" and NFS 372, "Drinking Water System Components - Lead Content".

F. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

G. Comply with the following applicable standards and other requirements specified for plumbing fixtures:

1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.

2. Slip-Resistant Bathing Surfaces: ASTM F 462.

3. Stainless-Steel Residential Sinks: ASME A112.19.3.

4. Vitreous-China Fixtures: ASME A112.19.2M.

5. Water-Closet, Flush Valve, Tank Trim: ASME A112.19.5.

H. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:

1. Backflow Protection Devices for Faucets with Side Spray: ASME A112.18.3M.

2. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.

3. Diverter Valves for Faucets with Hose Spray: ASSE 1025.

4. Faucets: ASME A112.18.1.

5. Hose-Connection Vacuum Breakers: ASSE 1011.

6. Hose-Coupling Threads: ASME B1.20.7.

7. Integral, Atmospheric Vacuum Breakers: ASSE 1001.

8. NSF Potable-Water Materials: NSF 61.

9. Pipe Threads: ASME B1.20.1.

10. Sensor-Actuated Faucets and Electrical Devices: UL 1951.

11. Supply Fittings: ASME A112.18.1.

12. Brass Waste Fittings: ASME A112.18.2.

I. Comply with the following applicable standards and other requirements specified for shower faucets:

1. Backflow Protection Devices for Hand-Held Showers: ASME A112.18.3M.

2. Combination, Pressure-Equalizing and Thermostatic-Control Antiscald Faucets: ASSE 1016.

3. Faucets: ASME A112.18.1.

4. Hand-Held Showers: ASSE 1014.

5. Hose-Coupling Threads: ASME B1.20.7.

6. Pipe Threads: ASME B1.20.1.

J. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:

1. Atmospheric Vacuum Breakers: ASSE 1001.

2. Brass and Copper Supplies: ASME A112.18.1.

3. Dishwasher Air-Gap Fittings: ASSE 1021.

4. Brass Waste Fittings: ASME A112.18.2.

5. Sensor-Operation Flushometers: ASSE 1037 and UL 1951.

K. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Disposers: ASSE 1008 and UL 430.

2. Dishwasher Air-Gap Fittings: ASSE 1021.

3. Flexible Water Connectors: ASME A112.18.6.

4. Floor Drains: ASME A112.6.3.

5. Grab Bars: ASTM F 446.

6. Hose-Coupling Threads: ASME B1.20.7.

7. Off-Floor Fixture Supports: ASME A112.6.1M.

8. Pipe Threads: ASME B1.20.1.

9. Plastic Toilet Seats: ANSI Z124.5.

10. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.06 WARRANTY

A. Special Warranties: Manufacturer's standard form in which manufacturer agrees to repair or replace components of whirlpools that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures of unit shell.

b. Faulty operation of controls, blowers, pumps, heaters, and timers.

c. Deterioration of metals, metal finishes, and other materials beyond normal use.

2. Warranty Period for Commercial Applications: One year from date of Substantial Completion.

3. Warranty Period for Residential Applications of Electronic Controls: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 WATER CLOSETS [S]

A. Water Closets:

1. Manufacturers: Subject to compliance with requirements.

2. Description: Floor-mounting, floor-outlet, vitreous-china fixture designed for flushometer valve operation.

a. Style: Flushometer valve.

1) Bowl Type: Elongated with siphon-jet design. Include bolt caps matching fixture.

2) Height: Refer to drawings.

3) Design Consumption: 1.28 gal./flush.

4) Color: White.

3. Flushometer: Brass body with corrosion-resistant internal components, control stop with check valve, vacuum breaker, copper or brass tubing, and polished chrome-plated finish on exposed parts.

   a. Internal Design: Piston operation.

   b. Style: Exposed.

   c. Inlet Size: NPS 1.

   d. Trip Mechanism: Sensor flush with mechanical flush override.

   e. Power Requirement: Self-powered hydroelectric with battery backup.

   f. Consumption: 1.28 gal./flush.

   g. Tailpiece Size: NPS 1-1/2 and standard length.

   h. Handicap accessible assembly mounted on the side of the compartment with the most clear floor space.

4. Toilet Seat:

   a. Material: Molded, solid plastic.

   b. Configuration: Open without cover.

   c. Size: Elongated.

   d. Hinge Type: SC, self-sustaining, check.

   e. Class: Standard commercial.

   f. Color: White.

2.02 URINALS [S]

A. Urinals:

1. Manufacturers: Subject to compliance with requirements.

2. Description: Wall-mounting, back-outlet, vitreous-china fixture designed for flushometer valve operation.

   a. Design Consumption: 0.125 gal./flush.

   b. Color: White.

c. Supply Spud Size: NPS 3/4.

d. Outlet Size: NPS 2.

3. Flushometer: Brass body with corrosion-resistant internal components, control stop with check valve, vacuum breaker, copper or brass tubing, and polished chrome-plated finish on exposed parts.

a. Internal Design: Piston operation.

b. Style: Exposed.

c. Inlet Size: NPS 3/4.

d. Trip Mechanism: Sensor flush with mechanical flush override.

e. Power Requirement: Self-powered hydroelectric with battery backup.

f. Consumption: 0.125 gal./flush.

g. Tailpiece Size: NPS 3/4 and standard 11-1/2" length to top of bowl.

B. Urinal Supports for Stud and Drywall partitions.

1. Manufacturers: Subject to compliance with requirements.

2. Description: Type II, urinal carrier with hanger and bearing plates for wall-mounting, urinal-type fixture. Include steel uprights with feet.

3. Accessible-Fixture Support: Include rectangular steel uprights.

C. Urinal Supports for Masonry Partitions:

1. Description: Rectangular Steel plates 20"L x 4"H x 1/8"D located on back side of partition where urinals are mounted against pipe spaces for holding supporting bolts of fixtures to give added mounting strength to the fixtures. Locate plate in wall construction where no pipe space exists.

2.03 LAVATORIES [S]

A. Lavatories:

1. Manufacturers: Subject to compliance with requirements.

2. Description: Wall-mounting, vitreous-china fixture.

a. Type: With back.

b. Size: 20" x 18" rectangular.

c. Faucet Hole Punching: One hole.

d. Faucet Hole Location: Top.

3. Faucet: Coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.

a. Finish: Polished chrome plate.

b. Maximum Flow Rate: 1.0 gpm.

c. Centers: Single hole.

d. Mounting: Deck, exposed.

e. Valve Handle(s): Not applicable.

f. Inlet(s): NPS 3/8 tubing, with NPS 1/2 male adaptor.

g. Spout: Rigid, gooseneck type.

h. Spout Outlet: Aerator.

i. Operation: Sensor.

j. Power Requirement: Self-powered hydroelectric with battery backup.

k. Drain: Grid.

B. Lavatory Fittings:

1. Description: Chrome finish brass lavatory supply assembly copper sweat 1/2 x OD 3/8, brass "Quarter Turn" ball valve angle stops with convertible – loose key handle, chrome finish copper flexible risers, chrome finish steel escutcheons; NPS 1-1/4 chrome finish cast brass ground joint swivel “P”-Trap with cleanout plug, cast brass slip nuts, 17 gage chrome finish tubular extension to wall, chrome finish steel box or bell wall flange.

2. Water Tempering Valve: Tempering Valve is specified in Section 22 11 19 “Domestic Water Piping Specialties”.

C. Protective Shielding Piping Enclosures:

1. For each accessible lavatory, the drain and water supplies shall be insulated with protective shielding enclosures from bottom of lavatory to wall.

2. Manufacturers: Subject to compliance with requirements.

3. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

D. Lavatory Supports for Stud and Drywall Partitions:

1. Manufacturers: Subject to compliance with requirements.

2. Description: Type I, lavatory carrier with concealed arms and tie rod for wall-mounting, lavatory-type fixture. Include steel uprights with feet.

3. Accessible-Fixture Support: Include rectangular steel uprights.

E. Lavatory Supports for Masonry Walls:

1. Description: Rectangular steel plates 20”L x 4” H x 1/8”D located on back side of partition where lavatories are mounted against pipe spaces to hold supporting bolts for wall hangers. Locate plate in wall construction where no pipe space exists behind fixture.

2.04 SINKS [S]

A. Classroom Sinks:

1. Manufacturers: Subject to compliance with requirements.

2. Description: One bowl, classroom, counter-mounting, stainless-steel kitchen sink.

a. Overall Dimensions: 25” x 17” x 5-1/2” depth.

b. Metal Thickness: 18 gauge.

c. Drain: 3-1/2-inch chrome plated brass with crumb cup.

1) Location: Near back of bowl.

d. Punching: One-hole, centered for faucet and one-hole opposite for bubbler.

3. Faucet: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.

a. Body Material: Commercial, solid brass

b. Finish: Polished chrome plate.

c. Maximum Flow Rate: 2.2 gpm, unless otherwise indicated.

d. Mixing Valve: Two-lever handle.

e. Centers: Single hole.

f. Mounting: Deck.

g. Handle(s): Wrist blade, 4 inches.

h. Inlet(s): NPS 3/8 tubing with NPS 1/2 male adapter.

i. Spout Type: Swivel gooseneck.

j. Spout Outlet: Aerator.

k. Vacuum Breaker: Not required.

4. Bubbler: Chrome plated, lead free construction, flexible guard, self-closing bush button actuator.

B. Clinic Sinks:

1. Manufacturers: Subject to compliance with requirements.

2. Description: One-bowl, counter-mounting, stainless-steel sink.

a. Overall Dimensions: 25” x 21” x 5-1/2” depth.

b. Metal Thickness: 18 gauge.

c. Drain: 3-1/2 inch chrome plated brass grid.

1) Location: Near back of bowl.

d. Punching: Three hole.

3. Faucet: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.

a. Body Material: Commercial, solid brass

b. Finish: Polished chrome plate.

c. Maximum Flow Rate:

1) Faucet: 2.2 gpm.

2) Eyewash: 2.8 gpm.

d. Thermostatic Mixing Valve: Manufacturer provided for emergency eyewash.

e. Centers: Adjustable.

f. Mounting: Deck.

g. Handle(s): Wrist blade, 4 inches.

h. Inlet(s): NPS 3/8 tubing with NPS 1/2 male adapter.

i. Spout Type: Rigid gooseneck with integrated eyewash.

j. Spout Outlet: Aerator.

C. Workroom Sinks:

1. Manufacturers: Subject to compliance with requirements.

2. Description: One-bowl, counter-mounting, stainless-steel sink.

a. Overall Dimensions: 25” x 21” x 5-1/2” depth.

b. Metal Thickness: 18 gauge.

c. Drain: 3½ inch chrome plated brass with crumb cup.

1) Location: Near back of bowl.

d. Punching: Three hole.

3. Faucet: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.

a. Body Material: Commercial, solid brass.

b. Finish: Polished chrome plate.

c. Maximum Flow Rate: 2.2 gpm.

d. Mixing Valve: Two-lever handle.

e. Centers: 8 inches.

f. Mounting: Deck.

g. Handle(s): Wrist blade, 4 inches.

h. Inlet(s): NPS 3/8 tubing with NPS 1/2 male adapter.

i. Spout Type: 8” swivel gooseneck.

j. Spout Outlet: Aerator.

D. Kitchen Sinks:

1. Manufacturers: Subject to compliance with requirements.

2. Description: Two-bowl, counter-mounting, stainless-steel sink.

a. Overall Dimensions: 33” x 22” x 5-1/2” depth.

b. Metal Thickness: 18 gage.

c. Drain: 3½ inch chrome plated brass with crumb cup.

1) Location: Near back of bowl.

d. Punching: Four hole.

3. Faucet: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.

a. Body Material: Commercial, solid brass.

b. Finish: Polished chrome plate.

c. Maximum Flow Rate: 2.2 gpm.

d. Mixing Valve: Two-lever handle.

e. Backflow Protection Device for Side Spray: Required.

f. Centers: 8 inches.

g. Mounting: Deck.

h. Handle(s): Wrist blade, 4 inches.

i. Inlet(s): NPS 3/8 tubing with NPS 1/2 male adapter.

j. Spout Type: 8” swivel gooseneck and side spray.

k. Spout Outlet: Aerator/Spray.

E. Sink Fittings:

1. Description: Chrome finish brass supply assembly copper sweat 1/2 x OD 3/8, brass "Quarter Turn" ball valve angle stops with convertible – loose key handle, chrome finish copper flexible risers, chrome finish steel escutcheons; NPS 1-1/2 chrome finish cast brass ground joint swivel “P”-Trap with cleanout plug, cast brass slip nuts, 17 gage chrome finish tubular extension to wall, chrome finish steel box or bell wall flange.

2. Water Tempering Valve: Tempering Valve is specified in Section 22 11 19 “Domestic Water Piping Specialties”.

2.05 SHOWERS [S]

A. Showers, Accessible:

1. Manufacturers: Subject to compliance with requirements.

2. Description: Accessible, molded reinforced fiberglass enclosure with acrylic finish, slip-resistant bathing surface and shower rod with curtain.

    a. Size: Refer to drawings.

    b. Color: White.

    c. Drain Location: Center.

    d. Accessibility Options: Include grab bars and HPDE fold down seat. Comply with ADA requirements.

    e. Drain: Grid, NPS 2.

3. Control: Single-handle pressure-balance valve. 30” slide bar; flexible metal hose, hand held shower, and adjustable high temperature limit stop. Coordinate faucet inlets with supplies and outlet.

    a. Finish: Polished chrome plated.

    b. Maximum Flow Rate: 1.5 gpm.

    c. Mounting: Concealed.

    d. Backflow Protection Device for Hand-Held Shower: Required.

    e. Handle: Metal Lever.

    f. Antiscald Device: Integral with mixing valve.

    g. Check Stops: Check-valve type, integral with or attached to body; on hot- and cold-water supply connections.

    h. Supply Connections: NPS 1/2 Sweat.

    i. Shower Head Type: Hand held, slide-bar mounted.

    j. Shower Head Material: Combined, metallic and nonmetallic with chrome-plated finish.

4. Drain:

    a. Body: Cast iron.

    b. Outlet Size: NPS 2.

    c. Strainer: 4” round, adjustable.

    d. Strainer Finish: Chrome plated, secured grate.

2.06 MOP SINKS [S]

A. Mop Sinks:

1. Manufacturers: Subject to compliance with requirements.

2. Description: Flush-to-wall, floor-mounting, cast-polymer fixture with rim guard.

a. Shape: Square.

b. Size: 24” x 24”.

c. Height: 10”.

d. Tiling Flange: Not required.

e. Rim Guard: On front top surface.

f. Color: Manufacturers Standard.

g. Drain: Grid with NPS 3 outlet.

3. Faucet: Service sink faucet with stops in shanks, vacuum breaker, hose-thread outlet, and pail hook**.** Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.

a. Body Material: Commercial, solid brass.

b. Finish: Rough chrome plate.

c. Maximum Flow Rate: 2.5 gpm.

d. Mixing Valve: Two-lever handle.

e. Centers: 8 inches.

f. Mounting: Wall.

g. Handles: Lever.

h. Inlets: NPS 1/2 female thread.

i. Spout Type: Rigid, solid brass with wall brace.

j. Spout Outlet: Hose thread.

k. Vacuum Breaker: Required.

l. Drain: Grid.

m. Mounting Height: 4’ – 0” Floor to faucet outlet

4. Accessories:

a. Mop hanger, hose and hose bracket.

2.07 LAUNDRY TUB [S]

B. Laundry Tubs:

1. Manufacturers: Subject to compliance with requirements.

2. Description: Floor-mounting: “Molded Stone” laundry tubs.

a. Size: 20” x 17”.

b. Color: White.

c. Drain: Grid.

d. Stand: Painted steel.

3. Faucet: Laundry sink faucet**.** Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.

a. Body Material: Commercial, solid brass

b. Finish: Polished chrome plate.

c. Maximum Flow Rate: 2.2 gpm.

d. Mixing Valve: Two-lever handle.

e. Backflow Protection Device for Side Spray: Required.

f. Centers: 4 inches.

g. Mounting: Deck.

h. Handles: Wrist blade, 4 inches.

i. Inlets: NPS 3/8 tubing with NPS 1/2 male adapter.

j. Spout Type: 5” swivel gooseneck and side spray.

k. Spout Outlet: Plain end/Spray.

l. Drain: Grid.

C. Laundry Tub Fittings:

1. Description: Chrome finish brass supply assembly copper sweat 1/2 x OD 3/8, brass "Quarter Turn" ball valve angle stops with convertible – loose key handle, chrome finish copper flexible risers, chrome finish steel escutcheons; NPS 1-1/2 chrome finish cast brass ground joint swivel “P”-Trap with cleanout plug, cast brass slip nuts, 17 gage chrome finish tubular extension to wall, chrome finish steel box or bell wall flange.

2. Water Tempering Valve: Tempering Valve is specified in Section 22 11 19 “Domestic Water Piping Specialties”.

2.08 EXTRA MATERIALS

A. Furnish extra materials described that match products installed, and packaged with protective covering for storage, and are identified with labels describing contents. Deliver packaged and labeled extra materials to on-site storage location(s) designated by Owner’s representative and obtain a receipt from Owner for each required extra materials submittal.

1. Lavatory faucets: two (2) faucets of each type installed.

2. Lavatory faucet batteries: one (1) full set for each faucet.

3. Shower faucets: one (1) faucet of each type installed.

4. Sink faucets: one (1) faucet of each type installed.

5. Flushometers: two (2) flushometers of each type installed.

6. Flushometer batteries: one (1) full set for each flushometer.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing fixture installation.

B. Examine cabinets, counters, floors, and walls for suitable conditions where fixtures will be installed.

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

3.02 INSTALLATION

A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.

B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.

C. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.

D. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.

E. Install wall-mounting fixtures with tubular waste piping attached to supports.

F. Install counter-mounting fixtures in and attached to casework.

G. Install fixtures level and plumb according to roughing-in drawings.

H. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.

    1. Exception: Use ball, gate, or globe valves if supply stops are not specified with fixture. Comply with requirements for valves specified in Section 22 05 23 "General-Duty Valves for Plumbing Piping."

I. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.

J. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.

K. Install toilet seats on water closets.

L. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

M. Install shower flow-control fittings with specified maximum flow rates in shower arms.

N. Install traps on fixture outlets.

    1. Exception: Omit trap on fixtures with integral traps.

O. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with requirements for escutcheons specified in Section 22 04 00 “General Requirements for Plumbing”.

P. Set shower receptors in leveling bed of cement grout.

Q. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants."

3.03 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

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

C. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.04 FIELD QUALITY CONTROL

A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.

B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.

C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.

D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

E. Install fresh batteries in sensor-operated mechanisms.

3.05 ADJUSTING

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

B. Adjust water pressure at faucets and flushometer valves to produce proper flow and stream.

C. Replace washers and seals of leaking and dripping faucets and stops.

D. Install fresh batteries in sensor-operated mechanisms.

3.06 CLEANING

A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:

1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.

2. Remove sediment and debris from drains.

B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

3.07 PROTECTION

A. Provide protective covering for installed fixtures and fittings.

B. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION

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SECTION 22 47 00

DRINKING FOUNTAINS AND WATER COOLERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section includes:

1. Electric water coolers.

2. Water Cooler supports.

B. Related Sections:

1. Section 01 91 13 – General Commissioning Requirements

2. Section 22 04 00 – General Requirements for Plumbing

3. Section 22 05 13 – General Motor Requirements for Plumbing Equipment

4. Section 22 05 23 – General – Duty Valves for Plumbing Piping

5. Section 22 11 16 – Domestic Water Piping

6. Section 22 11 19 – Domestic Water Piping Specialties

7. Section 22 13 16 – Sanitary Waste and Vent Piping

8. Section 22 13 19 – Sanitary Waste Piping Specialties

9. Section 22 40 00 – Plumbing Fixtures

10. Section 26 05 19 – Low Voltage Electrical Power Conductors and Cables

11. Section 26 05 26 – Grounding and Bonding for Electrical Systems

1.03 DEFINITIONS

A. Accessible Water Cooler: Fixture that can be approached and used by people with disabilities.

B. Fitting: Device that controls flow of water into or out of fixture.

C. Fixture: Drinking fountain or water cooler unless one is specifically indicated.

D. Water Cooler: Electrically powered fixture for generating and delivering cooled drinking water.

1.04 SUBMITTALS

A. Product Data: For each fixture indicated [S]. Include rated capacities, furnished specialties, and accessories. Comply with requirements in Division 01 and Section 22 04 00 “General Requirements for Plumbing”.

B. Operation and Maintenance Data: For fixtures indicated [O/M] to include in emergency, operation, and maintenance manuals. Comply with requirements in Division 01 and Section 22 04 00 “General Requirements for Plumbing”.

1.05 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. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities for fixtures for people with disabilities.

C. NSF Compliance for fixture materials that will be in contact with potable water: NSF 61, "Drinking Water System Components - Health Effects" and NSF 372, "Drinking Water System Components - Lead Content".

D. ARI Standard: Comply with ARI's "Directory of Certified Drinking Water Coolers" for style classifications.

E. ARI Standard: Comply with ARI 1010, "Self-Contained, Mechanically Refrigerated Drinking-Water Coolers," for water coolers and with ARI's "Directory of Certified Drinking Water Coolers" for type and style classifications.

F. ASHRAE Standard: Comply with ASHRAE 34, "Designation and Safety Classification of Refrigerants," for water coolers. Provide HFC 134a (tetrafluoroethane) refrigerant, unless otherwise indicated.

PART 2 - PRODUCTS

2.01 ELECTRIC WATER COOLERS [S]

A. Electric Water Coolers:

1. Available Manufacturers: Subject to compliance with requirements.

2. Description: Accessible, ARI 1010, Type PB, pressure with bubbler, Style W, wall-mounting water cooler for adult-mounting height.

a. Cabinet: Vinyl-covered steel with stainless-steel top, manufacturer's standard color. Color selected by the Architect.

b. Bubbler: One, with adjustable stream regulator.

c. Control: Front and side push pads.

d. Supply: NPS 3/8 with ball or globe valve.

e. 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 unit peak flow rate.

f. Drain(s): Grid with NPS 1-1/4 minimum horizontal waste and trap complying with ASME A112.18.1.

g. Cooling System: Electric, with hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.

1) Capacity: 8 gph of 50 deg F cooled water from 80 deg F inlet water and 90 deg F ambient air temperature.

2) Electrical Characteristics: 1/6 hp; 120-V ac; single phase; 60 Hz.

h. Support: Type II, water cooler carrier. Refer to "Fixture Supports" Article.

i. Support: Mounting frame or brackets for attaching to substrate.

j. Capacity sized for unit peak flow rate control.

B. Dual-Height, Electric Water Coolers:

1. Available Manufacturers: Subject to compliance with requirements.

2. Description: Accessible, ARI 1010, Type PB, pressure with bubbler, Style W, wall-mounting water cooler for adult-mounting height.

a. Cabinet: Bi-level with two attached cabinets, vinyl-covered steel with stainless-steel top, manufacturer's standard color. Color selected by the Architect.

b. Bubbler: One, with adjustable stream regulator, located on each cabinet deck.

c. Control: Front and side push pads.

d. Supply: NPS 3/8 with ball or globe valve.

e. 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 unit peak flow rate.

f. Drain(s): Grid with NPS 1-1/4 minimum horizontal waste and trap complying with ASME A112.18.1.

g. Cooling System: Electric, with hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.

1) Capacity: 8 gph of 50 deg F cooled water from 80 deg F inlet water and 90 deg F ambient air temperature.

2) Electrical Characteristics: 1/6 hp; 120-V ac; single phase; 60 Hz.

h. Support: Type II, water cooler carrier. Refer to "Fixture Supports" Article.

i. Support: Mounting frame or brackets for attaching to substrate.

j. Capacity sized for unit peak flow rate.

2.02 WATER COOLER SUPPORTS [S]

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

1. Josam Co.

2. Smith, Jay R. Mfg. Co.

3. Zurn Plumbing Products Group; Specification Drainage Operation.

B. Description: ASME A112.6.1M, water cooler carriers. Include vertical, steel uprights with feet and tie rods and bearing plates with mounting studs matching fixture to be supported.

1. Type II: Bi-level, hanger-type carrier with three vertical uprights.

2. Supports for Accessible Fixtures: Include rectangular, vertical, steel uprights instead of steel pipe uprights.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine roughing-in for water and waste piping systems to verify actual locations of piping connections before fixture installation. Verify that sizes and locations of piping and types of supports match those indicated.

B. Examine walls and floors for suitable conditions where fixtures are to be installed.

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

3.02 APPLICATIONS

A. Use chrome-plated brass or copper tube, fittings, and valves in locations exposed to view. Plain copper tube, fittings, and valves may be used in concealed locations.

3.03 INSTALLATION

A. Install off-floor supports affixed to building substrate and attach wall-mounting fixtures, unless otherwise indicated.

B. Install fixtures level and plumb.

C. Install water-supply piping with shutoff valve on supply to each fixture to be connected to water distribution piping. Use ball or globe valve. Install valves in locations where they can be easily reached for operation. Comply with requirements for valves are specified in Section 22 05 23 "General-Duty Valves for Plumbing Piping."

D. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.

E. Install pipe escutcheons at wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding pipe fittings. Comply with requirements for escutcheons are specified in Section 22 04 00 “General Requirements for Plumbing”.

F. Seal joints between fixtures and walls and floors using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants."

3.04 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

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

C. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.05 FIELD QUALITY CONTROL

A. Water Cooler Testing: After electrical circuitry has been energized, test for compliance with requirements. Test and adjust controls and safeties.

1. Remove and replace malfunctioning units and retest as specified above.

3.06 ADJUSTING

A. Adjust fixture flow regulators for proper flow and stream height.

B. Adjust water cooler temperature settings.

3.07 CLEANING

A. After completing fixture installation, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

B. Clean fixtures, on completion of installation, according to manufacturer's written instructions.

END OF SECTION

SECTION 23 00 10

HVAC GENERAL REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

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

B. Work Included:

Every item of labor, materials, equipment and appurtenances for installing complete new Heating, Ventilating and Air Conditioning Systems included in Division 23 of the Specifications.

1.02 DRAWINGS

A. The mechanical Drawings are diagrammatic in nature and show the general arrangement of all ductwork, piping, equipment and appurtenances and shall be followed as closely as actual building construction and the work of other trades will permit. Because of the small scale of the mechanical Drawings, it is not feasible to indicate all offsets, fittings and accessories that may be required. The Contractor shall investigate the construction conditions affecting the work and provide fittings and accessories as required to meet actual conditions.

B. Where discrepancies in scope of work as to which Trade provides specific items, such as starters, disconnects, flow switches, electrical control components, etc. exist, such conflicts shall be reported to the Engineer. If such action is not taken, the Contractor, as applicable, shall furnish such items as part of his work, for complete and operable systems and equipment, as determined by the Engineer.

1.03 REGULATIONS AND STANDARDS

A. The completed installation and all materials and equipment shall conform to local ordinances and codes, other regulations and standards listed herein or in related sections. These are intended as a minimum and shall be exceeded if required by the specifications or the Drawings. In the event of conflict between the codes, standards, or regulations, and information contained in the Contract Documents, the applicable code, standards, or regulation shall take precedence.

B. Refer to Division 1 and Supplementary Instructions to Bidders for construction permitting requirements.

1.04 INSPECTION CERTIFICATES

A. The Contractor shall furnish three copies of certificates of final acceptance to the Engineer from all inspection authorities having jurisdiction.

1.05 SUBSTANTIAL COMPLETION INSPECTION

A. The Engineer will visit the site for the purpose of conducting a substantial completion inspection once the following items have been met by the Contractor:

1. All HVAC systems shall be complete, operational and under automatic control.

2. HVAC systems cleaning, balancing, and testing as described in Section 23 05 93 shall be complete and the final report shall be approved by the Engineer.

3. Letters, signed by representatives of the manufacturer, for the boiler, chiller, cooling tower, air handling units, and air conditioning units shall be provided attesting that their respective equipment has been started, tested, and set to operate safely and at the control points required as an integral part of the systems in which they are installed.

4. A letter, signed by a representative of the temperature controls manufacturer as described in Section 23 09 00, shall be provided attesting that the installation of the temperature controls system is complete, proper control of all equipment, valves, dampers, and the like has been verified, set points have been established to provide proper control of installed equipment, and graphics are accurate with real time data.

5. The Contractor shall provide certification from an authorized official of the equipment manufacturer(s) stating that all refrigerant piping as described in Section 23 20 00 and specialties have been installed in accordance with the manufacturer's recommendations.

6. The noise and vibration control supplier as described in Section 23 05 48 shall provide a letter stating that all items have been installed properly and that all equipment is adequately isolated and/or restrained.

7. The Contractor shall attest by letter that all equipment has been wired and tested to verify that the indicated sequence of motor control is established, that all safety controls function properly, that all motor protective devices are sized correctly, and that the systems are operating at the proper set points.

8. Certificate of inspection for all boilers and pressure vessels shall have been completed.

B. All discrepancies noted in the substantial completion report shall be corrected prior to the final inspection. The Contractor shall provide a detailed item-by-item description of all corrections made for each item on the substantial completion discrepancy list prior to scheduling final inspection by the Engineer. Additional visits required after the final inspection, for the reason that previously documented discrepancies had not been corrected at the time of the final inspection, will be made at the Contractor's expense.

1.06 ASBESTOS

A. Asbestos Free Materials: The intention of these Drawings and specifications is that there are no asbestos-containing materials installed on this project. To the best of the Architects and Engineers knowledge, none of the material or equipment specified herein or shown on the Drawings contains asbestos. The Contractor shall make every effort to prevent any asbestos materials from being installed in or used on the construction of the project. At the completion of the project, the Contractor shall certify by letter that to the best of his knowledge, no asbestos-containing materials were used for or in the construction of this project.

B. Existing Materials:

1. Contractor shall review the Owners asbestos management plan to ensure suspected asbestos containing materials are under surveillance.

2. Discovery: If during the construction of this project, work involving friable asbestos is suspected, or encountered, all work in this area shall be discontinued and the Owner or the Owner's representative, shall be notified immediately and the Owner with his own forces or by separate contract shall be responsible for complete investigation, removal, and disposition of the friable asbestos hazard in accordance with applicable laws and regulations. If the Contractor claims that delay or additional cost is involved because of such action by the Owner, he shall make such claim as provided elsewhere in the Contract Documents.

3. Removal: All work involving the removal of friable asbestos will be done under a separate contract.

1.07 MATERIALS AND WORKMANSHIP

A. Equipment and material used in the project shall be new and undamaged. The mechanical installation shall fit into the space allotted and shall allow adequate and acceptable clearances for entry, servicing and maintenance. Similar types of equipment shall be the products of the same manufacturer unless specified otherwise. Work shall be performed by mechanics or tradesmen skilled in the trade involved.

B. All ductwork, piping and conduit shall be installed in a neat and organized manner, parallel to other work and the nearest building elements, unless specifically shown otherwise on the Drawings.

C. Equipment and materials shall be suitable for use in the environment in which they are installed. Equipment exposed to outside conditions shall be adequately protected from the weather, manufactured from materials suitable for outdoor use, and designed specifically for use in outdoor environments.

1.08 SUBMITTALS

A. Submit shop drawings, product data and samples in accordance with Division 1 for all items as specified in related sections of these specifications. One (1) electronic (PDF) copy of the submittal shall be submitted. One (1) electronic (PDF) copy of the submittal will be returned to the Contractor. If additional copies are required, they will be the responsibility of the Contractor. Where drawings are submitted, the Contractor shall submit a minimum of two (2) sets of full scale prints. One (1) copy will be marked and returned to the Contractor, and the Contractor shall be responsible for all additional copies required for his use. All submittal data shall be correctly identified to show project name, and the exact model, style or size of item being submitted. Improperly identified submittals will not be reviewed by the Engineer. Each item submitted for review shall bear the Subcontractor's stamp which states that they have reviewed the submission, that it is complete, and that in their opinion it meets the contract requirements. Contractor's stamp shall identify the specification section, paragraph, and page number for which the submittal is being made. Shop drawings will be reviewed only for general compliance with the Contract Documents. Review will not include correctness of details, proper configuration, utility connections, dimensions, sizes, quantities, and the like. Any submission which has not been reviewed and stamped by the M/E Subcontractor will not be reviewed by the Engineer. No reviews prior to award of Contract will be considered or accepted. Re-submissions of shop drawings, product data and samples shall include the entire original submittal. **Partial submittals will not be reviewed by the Engineer.**

B. Submissions will be stamped by the Engineer in one of the following ways:

"No Exceptions Taken"	No exceptions are taken and subject to compliance\ with the Contract Documents.
"Make Corrections Noted"	Minor corrections are noted and a re-submittal is not required subject to compliance with the corrections and the Contract Documents.
"Correct and Resubmit "	The submitted material, method or system meets the intent of the specifications, yet has insufficient data to determine compliance with the Contract Documents. Re-submittal is required.
"Rejected"	The submitted material, method or system does not meet the intent of the specifications, or has insufficient data to determine compliance with the Contract Documents.

C. Submission Procedures:

1. If a submission is satisfactory to the Engineer, the Engineer will annotate the submission, "No Exceptions Taken" or "Make Corrections Noted" and transmit the electronic copy to the Contractor. If a resubmission is required, the Engineer will annotate the submission "Correct and Resubmit" or "Rejected" and transmit the electronic copy to the Contractor for appropriate action.

2. The Contractor shall revise and resubmit submissions as required by the Engineer until submissions are acceptable to the Engineer.

3. Approval of a working and/or shop drawings by the Engineer will constitute acceptance of the subject matter for which the drawing was submitted and not for any other structure, material, equipment or appurtenances indicated as shown.

4. The Engineer's review of the Contractor's submissions shall in no way relieve the Contractor of any of his responsibilities under the Contract. An approval of a submission shall be interpreted to mean that the Engineer has no specific objections to the submitted material, subject to conformance with the Contract Documents.

5. Where as-built drawings, record drawings and specifications are available and when provided to the Contractor for use in performing the work, the Contractor shall verify the content of such drawings and specifications, the suitability of their use in performing the work and their accuracy for the purposes in which the Contractor intends to use any record or historical documents which may be obtained. In no case shall the Contractor assume that such documents reflect a true and accurate record of the construction. Acceptance of any such materials, records, and/or drawings shall in no way result in additional cost to the Owner should an error and/or omission in these documents result in additional costs to the Contractor.

6. On the first pages of all submittals, the Contractor shall provide a table showing all individual specification section paragraphs and drawings that apply to the equipment/component and a statement for each paragraph and drawing that the requirements have been met. The table shall be similar in format to the following, but shall include all relevant specification paragraphs and drawings:

Section 23 07 00 (example)	
1.2 A	Comply
1.2 B	Comply
1.3 A	Comply
1.3 B	Comply
1.3 C	Comply
1.4 A	Comply
1.4 A.1	Comply
1.4 A.2	Comply
Drawing M0.01	Comply

D. Equivalents: Manufacturers, trade names, and model numbers indicated herein and on Drawings shall be interpreted as establishing a standard of quality and shall not be construed as limiting competition. Unless definitely stated otherwise and upon complying with Division 1,

the Contractor may use any article which, in his judgment is equal to that specified and is accepted by the Engineer. The ten day prior approval requirements of Instructions to Bidders (AIA Document A701) are waived for this Division of the Specifications, and unless stated otherwise the Contractor may use items that he deems as equivalent in quality and performance to the specified item subject to final acceptance of substituted items by Engineer upon his review of shop drawings. Where three (3) or more manufacturers are named in the specifications for any item, the Contractor shall use one of the named manufacturers. No others will be reviewed or accepted. Manufacturers listed first in these specifications and on Drawings were used as a basis of design. It will be the responsibility of the Contractor to verify all connections, physical sizes, capacities, etc. of all other manufacturer's items, both named or proposed. If the equipment necessitates changes in ductwork, piping, wiring or other building systems from that indicated on the Drawings, the Contractor shall be responsible for all additional costs included and notify other trades. Where such changes are required, detail drawings indicating all required changes shall be submitted for review at the same time the manufacturers drawings are submitted for approval.

E. Shop drawings, diagrams, catalog data and such other data necessary to fully describe and substantiate compliance with these specifications shall be submitted for all equipment and materials where specifically required by specification and all items identified with an [S] behind the product title. Submittals not required by the Contract Documents will not be reviewed.

F. Shop Drawing manual(s) shall be submitted in accordance with Division 1 and shall include a complete product index, a copy of all approved shop drawings, and the name, address and telephone number of supplier or nearest representative. The manual(s) shall be presented to the Engineer for review and transmittal to the Owner before final payment is recommended.

G. Operation and Maintenance manual(s) shall be submitted in accordance with Division 1 and shall include a complete product index in each volume, installation and maintenance data, sequence of controls, parts lists, a copy of all approved shop drawings and the name, address and telephone number of supplier or nearest representative. All mechanical devices, equipment and systems marked [O/M] in these specifications shall be included and all other such mechanical items that will require servicing before the duration of its useful life has been reached. Manual(s) shall be presented to the Engineer for review and transmittal to the Owner before final payment is recommended.

1.09 WARRANTY

A. The Contractor shall provide a warranty for a period of one year for all work provided under the Contract to include, but not necessarily limited to, all systems, equipment, materials, and workmanship. This shall not be construed to limit any extended warranty periods of longer than one year for specific items or systems specified elsewhere in the Contract Documents.

B. The warranty period shall commence on the date of acceptance by the Owner and shall cover all parts and labor as required to fulfill the warranty at no cost to the Owner.

C. Refer to Division 1 for additional warranty requirements.

D. Information on all warranties shall be included in the O&M Manuals specified herein to be provided to the Owner.

E. In phased construction, warranties shall not begin until substantial completion of the FINAL phase. Contractor shall maintain all new equipment and systems until that time. Owner will maintain all existing equipment and systems. Where new systems are connected to existing, the Contractor and Owner shall determine coordination of maintenance responsibilities at the preconstruction meeting.

1.10 EXCAVATION AND BACKFILLING

A. General: Excavation and backfilling shall be as specified in Division 31. Backfilling shall not commence until all tests have been performed and all utility systems conform to the Contract Documents.

B. Protection of Existing Utilities: Existing utility lines to be retained, whether known or unknown and uncovered during excavation operations, shall be protected from damage during excavation and backfilling, and if damaged, shall be restored to original condition.

1.11 VERIFYING MEASUREMENTS AND CONDITIONS

A. The exactness of grades, elevations, dimensions, or locations given on the Drawings, is not guaranteed by the Engineer. The Contractor shall, therefore, satisfy himself as to the accuracy of all grades, elevations, dimensions and locations. In all cases of interconnection of his work with existing or other work, he shall verify at the site all dimensions relating to such existing or other work. Any errors due to the Contractor's failure to so verify all such grades, elevations, locations, or dimensions shall be promptly rectified by him without cost to Owner.

B. The Contractor shall base his bid on site examinations performed by him. This requirement is mandatory. The Contractor shall visit the site of the proposed project where work is scheduled to be performed, visit the existing buildings scheduled to be renovated, inspect piping systems where new-to-existing connections shall be made, etc., and ascertain for himself the amount of work required to fulfill the intent of his Contract and the complexity of the installation. The Contractor shall not hold the Engineer, his Consultants, agents or employees responsible for or bound by, any schedule, estimate or for any plan thereof. The Contractor shall study all Contract Documents to determine exactly the extent of work to be provided under each Section, and in installing new equipment and systems and coordinating the work with the other Trades and existing conditions.

1.12 INTERRUPTION OF UTILITY SERVICES

A. It is necessary that close liaison be maintained with the Administrative Authorities in all matters affecting interruptions of any utility services serving the facility and existing buildings. Prior to interrupting any utility service, the Administrative Authorities shall be consulted and interruptions for connections made at a time (or times) suitable to the Administrative Authorities. Work shall be laid out and planned to limit the interruption times to a minimum.

1.13 COORDINATION OF WORK

A. General: The Contract Documents indicate the extent and general arrangement of the mechanical systems. The Contractor shall be responsible for the coordination and proper relation of the mechanical work to the building structure and to the work of other trades. No additional compensation or extension of completion time will be granted for extra work caused by the lack of coordination.

B. Cooperation: The Contractor shall provide dimensions and locations of all openings, shafts and similar items to the proper trades and install work as required so as not to interfere with, or delay, the building construction.

C. Locations of lines and equipment shall be determined from actual field measurements. The outlines of the building shown on the mechanical Drawings are intended only as a guide to indicate relative locations of the mechanical work. Refer to architectural and structural Drawings for building construction details. The Contractor shall determine the exact routing and location of his systems prior to fabrication or installation of any system component. Accurate measurements and coordination shall be completed to verify dimensions and characteristics for the installation of each system.

D. Unless necessitated by equipment access or otherwise indicated in the Contract Documents, all piping, ductwork, and conduit concealed above ceilings and in finished or utility spaces shall be routed as high as possible.

E. Offsets, transitions and changes of direction in all systems shall be made as required to maintain proper headroom and pitch of sloping lines whether or not indicated on the drawings. The Contractor shall provide manual air vents and drains as required for his work to affect these offsets, transitions and changes in direction, as applicable.

F. Cutting and Patching: See Division1.

G. Roughing-In: Verify the locations of other buildings machines, door swings, block coursing, alignment of tile end and other similar features before roughing-in for mechanical equipment components and/or controls.

H. Damage to Other Work: Each Contractor is responsible for damage to other work caused by his work or workmen. Repairing of damaged work shall be done by the Contractor who installed the work, and as directed by the Architect-Engineer; the cost of which shall be paid for by the Contractor responsible for the damage.

1.14 EQUIPMENT INSTALLATION

A. General: Equipment shall be installed in accordance with manufacturer’s instructions to conform with the details and application indicated. Where manufacturer’s recommendations or installation instructions require options or accessories not specified, they shall be included and installed by the Contractor.

B. Supports: Provide necessary supports for all equipment and appurtenances as required; this includes but is not limited to frames or supports for items such as tanks, compressors, boilers, plumbing fixtures, pumps, valves, fans, and other similar items requiring supports. Floor mounted equipment in Equipment Rooms shall be set on 4-inch high concrete foundation pads unless shown otherwise. All pads shall be poured such that the top of the pad is level. Foundation drawings, bolt setting information and foundation bolts shall be furnished by the subcontractors furnishing the equipment for all equipment required to have concrete foundations. Concrete for foundations shall be provided by mechanical subcontractor unless indicated otherwise. Except where indicated in Section 23 05 48, all equipment shall be anchored to concrete pads. Provide additional structural steel supports under air handlers where required to achieve correct elevation for cooling coil condensate drains. Structural supports shall be firmly anchored to concrete housekeeping pads. Air handler or vibration isolators shall be firmly anchored to structural supports. Rooftop equipment, ductwork, and piping shall be set on pre-manufactured curbs anchored to the roof and flashed into the roofing system. Rooftop equipment, ductwork, piping, etc. shall be anchored to the curb except where vibration isolation is installed between the curb and the equipment.

C. Service Area: All equipment and appurtenances shall be located to permit adequate service clearance in accordance with manufacturer's recommendations and as otherwise required. Service clearance shall include but not be limited to service and removal of filters, coils, motors, controls and removal of equipment sections. Service clearance shall include adequate space for rodding and removing tubes from boilers, chillers, and heat exchangers. All piping, ductwork, and other equipment shall be located outside of the service area or shall be flanged for easy removal to facilitate equipment service. All equipment shall be located with sufficient distance from building features, structural components, and the equipment of other trades. Service clearance in front of electrical panels shall be minimum as required by National Electric Code (NEC) where applicable. Equipment requiring service and located above ceiling shall be located within two feet of the ceiling vertically to allow for proper maintenance access.

D. Temporary Requirements: Temporary filters shall be provided for all fans that are operated during construction. Return openings, grilles, and registers shall be provided with temporary filters to prevent the intrusion of dust and particulate into the return air ductwork. Temporary filter shall have a minimum efficiency of MERV 8 in accordance with ASHRAE 52.2. Openings in equipment shall be kept plugged at all times until connection is made to the system. The ends of all pipes, ducts and equipment openings shall be kept plugged or capped properly with approved devices. Approved devices are items such as specially molded plastic caps, pipe plugs, test plugs and sheet metal caps.

E. All equipment indicated to be installed exposed within finished spaces shall be installed such that all conduit, piping, and appurtenances are concealed. Air conditioning units utilizing gravity condensate drains shall be installed at an elevation necessary for the specified pipe slope.

1.15 EXISTING EQUIPMENT

A. General: Care shall be exercised to protect all existing equipment to be reused. The Contractor shall remove from operation all equipment that is shown to be reused and provide adequate

protection including but not limited to prevention of corrosion, protection of seals, prevention of leaking, and prevention of internal/external contamination. All electronic components shall be protected from weather and moisture, deterioration and loss of programming.

1.16 SLEEVES AND INSERTS

A. General: Sleeves and inserts shall be provided and correctly located in the structure, as require for the work.

B. Inserts shall be steel and proper size for loads encountered.

C. Sleeves shall be provided for all pipes passing through concrete or masonry walls, partitions, concrete beams or slabs installed during construction of the wall, partition, beam or slab. Sleeves through existing concrete walls and slabs may be omitted if wall or slab can be core drilled and properly sealed in a manner acceptable to the Engineer. Sleeves placed horizontally in walls or in any position in beams shall be standard weight ASTM A53 steel pipe of length equal to thickness of wall or beam. Those placed vertically in non-waterproof floors shall be 20 gauge galvanized sheet steel of length equal to thickness of slab, flared and nailed to the form, or fastened to reinforcing fabric and filled with sand during pouring to prevent deformation. Sleeves occurring in floors of rooms where hose bibs or floor drains occur, and in pipe spaces, shall be standard weight steel pipe projecting 2" above the finished floor except in Equipment Rooms they shall project four (4) inches above floor. Sleeves in floors with waterproof membrane shall be provided with flanges or flashing rings and shall be clamped or flashed into membrane. All sleeves (and core drilled openings) shall be of sufficient diameter to clear bare or covered pipes by 1/4" all around except sleeves on lines subject to movement by expansion which shall clear the bare pipe or insulation on insulated pipe at least one inch all around. Pipes through exterior walls below grade and above footings shall be installed in sleeves having a minimum size of two larger pipe diameters and sealed watertight with flexible synthetic rubber seals. Sleeve shall have anchor and water stop plate. The entire assembly shall be tightened and adjusted and made watertight. Sleeves for pipes and conduit, penetrating fire (and smoke) rated partitions, walls and floors shall be sealed in accordance with the terms of U.L. Listed Through-Penetration Firestop Systems XHEZ as published in the U.L. Fire Resistance Directory. Penetrations shall exactly conform to details of the Firestop System indicated for the type of partition, wall and floor construction encountered. All penetrations through nonfireresistance rated floor assemblies and through the ceiling membrane of nonfireresistance rated roof assemblies shall be fireblocked with tightly packed mineral-wool insulation secured in place. All penetrations through equipment room walls and other areas of noise or heat generation shall be tightly sealed with mineral fiber rope. All penetrations through draftstop partitions shall be sealed to maintain the integrity of the partition. All firestopping and draftstopping of sleeves for mechanical work shall be provided under Division 23.

1.17 PENETRATIONS THROUGH PRE-CAST HOLLOW-CORE SLAB SYSTEM

A. General: Contractor shall coordinate work with the pre-cast system. Refer to architectural and structural documents for details. Installation of work shall be in strict accordance with the pre-cast system manufacturer's recommendations, as approved by the Architect.

B. Openings: Holes in the slabs made in the field shall be made by the trade involved. Openings shall be made only through hollow cells, shall not exceed the width of the hollow cells, and shall not penetrate the webs between the cells or the pre-stressed strands unless prior approval is obtained from the Architect and the slab manufacturer. Holes shall not exceed 6" diameter without approval. Certain holes for pipe and duct shafts may be pre-cut. See structural Drawings for locations.

C. Cutting holes: Holes may be drilled or cut and trimmed with a chisel. Generally, holes will be made by cutting the outline of the hole through the lower portion of the slab from the underside and then cutting out the top side. All holes shall be made prior to the installation of the topping slab.

D. Sleeves: Sleeves are not required through pre-cast system slabs except where required to support packing material at hollow cores. Sleeves are required to be placed through concrete topping slab on top of the pre-cast slabs.

E. Supports: Hangers shall be supported from inserts or approved sockets, or toggle bolts in core slab construction. Hanger spacing shall be such that weight on hanger does not exceed 250 pounds for any one hanger. All hanger rods shall be minimum 3/8 inch in diameter. Where hanger rods must extend through slab, they shall be secured by two bolts over steel washers or plates on top of the slab in the floor fill or roof insulation space. Washers or plates shall not be less than 2" size and 1/4" thick. Larger plates are required for larger pipe supports. Cumulative thickness of plates, washers and bolts shall be 1/4" less than thickness of topping slab.

F. Explosives: Inserts set with explosives shall not be used.

1.18 ESCUTCHEONS

A. Where pipes pass through floors, walls or ceilings in finished rooms, they shall be fitted with chromium plated escutcheons of suitable pattern to effectively cover the rough opening. Where sleeves project above floors, special deep type escutcheons shall be provided.

1.19 ACCESS DOORS

A. Provide for all concealed valves, controls, dampers, junction boxes, equipment, or any item requiring access. Doors shall be of sufficient size and so located that the concealed items may be serviced or completely removed and replaced. Doors required for Mechanical work shall be furnished as a part of this Division to the General Contractor for installation. The Mechanical Contractor shall provide locations of all access doors such that service may be safely performed from a ladder, lift, or platform without the need for support from the ceiling system. Doors in

acoustic tile ceilings shall be furnished in multiples of tile sizes. Doors are not required in exposed grid type ceilings where tiles are removable. Doors shall be metal access doors with cam lock, style to match ceiling or wall construction. Doors occurring in rated construction shall be fire rated U.L. labeled access doors correlated to preserve the integrity of the rated construction. Doors leading to concealed spaces shall be provided with means to open from the inside. Doors shall be prime finish steel except those in toilets, shower rooms, locker rooms, kitchens and other similar areas shall be stainless steel with brushed finish.

1.20 ELECTRICAL WIRING AND EQUIPMENT

A. Wiring, low voltage (100 volts or less) control wiring shall be provided as a part of (Section 23 09 00 Instrumentation and Control for HVAC) (Division 23) in strict accordance with Division 26 and shall be in accordance with manufacturer's recommendations to comply with the sequence of control indicated. Verify that wiring of all motors and controls required by equipment furnished is accomplished for the correct sequence of operation.

B. Wiring, line voltage (101 volts or higher) power or control wiring shall be furnished and installed under Division 26.

C. Disconnects shall be provided for each item of equipment under Division 26 unless specified otherwise in other sections.

D. Miscellaneous manual or automatic control and protective or signal devices required for the sequence of operation indicated for mechanical equipment shall be provided under the section of the specifications where the item of equipment is specified unless indicated otherwise.

1.21 PROTECTION FROM MOVING PARTS

A. Belts, pulleys, chains, gears, shafts, couplings and other rotating or moving parts located so that any person may come in close proximity thereto shall be fully enclosed or properly guarded.

1.22 RECORD OF UNDERGROUND LINES

A. On completion of the project, the Contractor shall prepare and submit to the Engineer a drawing on tracing paper and one blue line print to show the location of any underground lines installed in locations different from those on the Architect-Engineer's Drawings. The location of cleanouts, and the distance from the building to outside sewers, mains, and manholes shall be dimensioned.

1.23 CHARTS AND DIAGRAMS

A. General: Material as listed below shall be provided by the Contractor and shall be mounted in separate hardwood frames where directed in the field or folded and stored in a plastic document folder and located in the control cabinets. All charts, diagrams and schemes shall be

photographic positives prepared from original tracings. A copy of charts and diagrams shall be included with O/M manuals.

B. Automatic Temperature Control Diagrams identified as to name, sequence of operation, location and number of systems. Components of a control system shall be identified as to location, function, temperature setting and manufacturer's part number.

C. Electric Sequence Control Diagrams of entire Mechanical system.

D. Charts for identification of valves.

1.24 INSTRUCTION OF OWNER'S REPRESENTATIVE

A. Contractors shall instruct the representative of the Owner in the proper operation and maintenance of all elements of the Mechanical systems. Competent representatives of the Contractor shall spend such time as necessary to fully prepare the Owner to operate and maintain the Mechanical and Electrical systems.

1.25 COMMISSIONING OF HVAC SYSTEMS:

A. Commissioning of this project will be coordinated and managed by the Owner's Commissioning Agent. Refer to the Commissioning Plan and Division 1 for the scope and requirements for commissioning of mechanical systems.

1.26 CONSTRUCTION STATUS REPORT

A. Each item of discrepancies noted on Construction Status Report prepared by the Engineer shall be answered in detail in writing by the Contractor before payment can be recommended.

1.27 GRAPHICS DATABASE

A. This project's Computer Aided Design & Drafting (CADD) drawing files may be obtained through the Architect/Engineer for use in preparing computer graphics specific to this project. See Appendix A at the end of this Section for Letter of Indemnification and ordering instructions.

1.28 DEMOLITION

A. Contractor shall visit site before bidding to determine extent of demolition.

B. Removal of Ducts, Piping and Equipment: Remove all ductwork and piping connections, plugging outlets, etc., such that are not required for present equipment and fixtures, or are not reused or needed for reconnecting new equipment and fixtures. Remove all equipment, fixtures, etc., indicated to be removed, or not reused or needed after the renovations are

complete. Equipment to be removed shall include the concrete housekeeping pads. Floors shall be patched to match existing.

C. Where piping, conduit, ductwork or other similar items passing through rated assemblies are removed; the assemblies shall be patched in accordance with UL so as to maintain the integrity of the assembly.

D. Unless systems are being connected to new, piping and ductwork shall be capped and sealed at all locations where ductwork and piping are being removed.

E. The Owner will select and retain such existing equipment and materials which are indicated to be removed and not reused, as he desires. All other existing equipment and materials indicated to be removed and not reused shall become the property of the Contractor, who shall promptly remove them from the premises. All existing equipment and fixtures indicated to be relocated shall be disconnected, removed, relocated and reconnected. All equipment and fixtures shall be protected from damage during demolition.

F. Miscellaneous: In all altered portions of the buildings, the Contractor shall remove or alter as necessary all existing mechanical work that is not coordinated to operate with the new construction. Demolition shall not begin until the work schedule is approved by the owner. The work shall be scheduled to prevent any disruption to the normal operations of the building.

1.29 ALTERNATES

A. Refer to the bid form and bidding documents for a description of Bid Alternates.

1.30 PHASING OF WORK

A. Coordinate phasing requirements with Division 1.

B. Refer to the Phasing Plans.

C. The Contractor shall provide temporary heat and cooling as necessary to maintain space temperatures between 70°F and 75° F for all occupied spaces during all occupied periods.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION – NOT USED

END OF SECTION

APPENDIX A
LETTER OF INDEMNIFICATION

Project Name: Salem High School – Phase 1 Renovations

Project Location: Salem, VA

The Contractor may obtain from Ascent Engineering Group a CD-ROM or electronic mail version of the projects Revit / CADD database. All seals, details, schematics, tables, controls, etc. will be deleted. All drawings will be provided in Autocad™ 2014 format.

Ascent Engineering Group reserves all rights to the original drawing files.

The Recipient agrees, to the fullest extent permitted by the law, to hold harmless and indemnify Ascent Engineering Group, as defined in the Bid Documents, from and against all claims, liabilities, losses, damages, and costs, including but not limited to attorney's fees, arising out of or in any way connected with the use, modification, misinterpretation, misuse, or reuse by the Recipient or others of the machine readable information and data provided by Ascent Engineering Group under this Agreement. The foregoing indemnification applies, without limitation, to any use of the project documentation on other projects, for additions to this project, or for completion of this project by others, excepting only such use as may be authorized, in writing, by Ascent Engineering Group.

The electronic drawing files are not part of the Contract Documents for the Project. The Recipient assumes all risks associated with the use of the transmitted files. Ascent Engineering Group will not be responsible for any differences in the information included in the transmitted files and the information shown on the Contract Documents. Modifications to the Contract Documents made before or during construction may or may not be included in the transmitted electronic drawing files.

The Recipient further agrees that the drawing files will only be used in graphics preparation for the above-referenced project.

Company Name of Recipient: _____

Recipient's Designated Representative: _____

Title: _____

Signature: _____

Address: _____

Return to: Ascent Engineering Group
5228 Valleypointe Parkway, Suite 4
Roanoke, VA 24019
AEG # 18410

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SECTION 23 01 00

OPERATION AND MAINTENANCE OF HVAC SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

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

B. Work Included:

1. To aid the continued instruction of operating and maintenance personnel, and to provide a source of information regarding the products incorporated into the work, furnish and deliver the data described in this section and in pertinent other sections of these specifications.

C. Related Sections:

1. Section 23 00 10 – HVAC General Requirements
2. Section 23 05 00 – Common Work Results for HVAC
3. Section 23 10 00 – Facility Fuel Systems
4. Section 23 20 00 – HVAC Piping and Pumps
5. Section 23 30 00 – HVAC Air Distribution
6. Section 23 50 00 – Central Heating Equipment
7. Section 23 60 00 – Central Cooling Equipment
8. Section 23 70 00 – Central HVAC Equipment
9. Section 23 80 00 – Decentralized HVAC Equipment

1.02 SUBMITTALS

A. Unless otherwise directed in other sections, or in writing by the Engineer, submit three copies of the final manual to the Engineer for approval prior to indoctrination of operation and maintenance personnel.

B. Operation and Maintenance manual(s) shall be submitted in accordance with Division 1 and shall include a complete product index in each volume, installation and maintenance data, sequence of controls, parts lists, a copy of all approved shop drawings and the name, address and telephone number of supplier or nearest representative. All mechanical devices, equipment

and systems marked [O/M] in these specifications shall be included and all other such mechanical items that will require servicing before the duration of its useful life has been reached. Motor driven equipment shall include data for the motor. Manual(s) shall be presented to the Engineer for review and transmittal to the Owner before final payment is recommended.

1.03 QUALITY ASSURANCE

A. In preparing data required by this section, use only personnel who are thoroughly trained and experienced in the operation and maintenance of the described items, completely familiar with the requirements of this section, and skilled communicating the essential data.

PART 2 - PRODUCTS

2.01 INSTRUCTION MANUALS

A. Where instruction manuals are required to be submitted under other sections of these specifications, prepare in accordance with the provisions of this section.

B. Format:

Size: 8-1/2" x 11"
Paper: White bond, at least 20 lb. weight.
Text: Typed (Hand printed or written is not acceptable)
Drawings: 11" x 8-1/2" preferable; bind in with text; foldouts are acceptable; larger drawings are acceptable if folded to fit within the manual and provide a drawing pocket inside rear cover or bind in with text.
Fly Sheets: Separate each portion of the manual with neatly prepared Fly Sheets or tabbed index sheets briefly describing the contents of the ensuing portion. Fly sheets or index tabs may be in color.
Binding: Use heavy-duty plastic covers with binding mechanism concealed inside the manual; 3-ring binders are required. All binding is subject to the Engineer's approval.

C. Provide front and back covers for each manual, using durable plastic material approved by the A.E, and clearly identified on the front cover with at least the following information:

OPERATING AND MAINTENANCE INSTRUCTIONS

FOR

(Item/system name and description)

(Name and address of Contractor and sub-contractor)

(General subject of this manual)

(Name and address of Engineer)

(Engineer's approval and date approved)

D. Contents:

Neatly prepared and typewritten detailed table of contents.
Complete instructions regarding operation and maintenance of all equipment involved including lubrication, disassembly, and reassembly.
Complete nomenclature of all parts of all equipment.
Complete nomenclature and part number of all replaceable parts, name and address of nearest vendor, and all other data pertinent to procurement procedures.
Copy of all guarantees and warranties issued.
Manufacturer's bulletin, cuts, and descriptive data, where pertinent, clearly indicating the precise items included in this installation and deleting, or otherwise clearly indicating, all manufacturers' data with which this installation is not concerned.
Such other data as required in pertinent sections of these specifications.

PART 3 - EXECUTION

3.01 INSTRUCTION MANUALS

A. Revisions:

1. Following the indoctrination and instruction of operation and maintenance personnel, review all proposed revisions of the Manual with the Engineer.

END OF SECTION

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SECTION 23 05 00

COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.01 SUMMARY

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

B. Work Included:

1. Common Motor Requirements for HVAC Equipment
2. Variable Frequency Drives
3. Expansion Fittings for HVAC Piping
4. Meters and Gages for HVAC Piping
5. General-Duty Valves for HVAC Piping
6. Hangers and Supports for HVAC Piping and Equipment
7. Heat Tracing for HVAC Piping

C. Related Sections:

1. Division 01 -- Commissioning
2. Section 23 00 10 – HVAC General Requirements
3. Section 23 05 48 – Vibration and Seismic Controls for HVAC Systems
4. Section 23 05 53 – Identification for HVAC Piping and Equipment
5. Section 23 05 93 – Testing, Adjusting and Balancing for HVAC
6. Section 23 09 00 – Instrumentation and Control for HVAC
7. Section 23 20 00 – HVAC Piping and Pumps
8. Section 23 30 00 – HVAC Air Distribution
9. Section 23 50 00 – Central Heating Equipment
10. Section 23 60 00 – Central Cooling Equipment

11. Section 23 70 00 – Central HVAC Equipment

12. Section 23 80 00 – Decentralized HVAC Equipment

1.02 REFERENCES

A. General: The following standards or codes form a part of this specification to the extent indicated by the reference thereto.

B. American Society of Mechanical Engineers (ASME):

C. ASME 95 Boiler and Pressure Vessel Code

D. B16.3 Malleable Iron Threaded Fittings

E. B16.4 Cast Iron Threaded Fittings

F. B31.9 Building Services Piping

G. National Electrical Manufacturers Association (NEMA)

H. Underwriters Laboratories, Inc. (UL)

1.03 COMMISSIONING OF HVAC SYSTEMS:

A. The Contractor shall provide contact information to the Commissioning Agent indicated in Division 1 for all major items of Equipment.

B. Provide additional submittal copy of major equipment for Commissioning Agent specified in Division 1.

1.04 SUBMITTALS

A. Submit shop drawings and product data in accordance with Division 1 and Section 23 00 10.

B. Shop drawings, diagrams, catalog data and such other data necessary to fully describe and substantiate compliance with these specifications shall be submitted for all equipment and materials marked with notation set forth in Section 23 00 10.

C. Operation and maintenance data shall be submitted in accordance with Division 1, for all items of equipment and materials marked with notation set forth in Section 23 01 00.

PART 2 - PRODUCTS

2.01 COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

A. Motors shall be provided in place as an integral part of the driven equipment, ready for electrical connections. Motors shall be in accordance with NEMA Standards and of design suitable for the starting and running characteristics of the driven equipment. Motors over 5 HP shall be "premium" efficiency as defined by NEMA MG-1, latest edition.

B. All three phase motors over 5 HP shall be provided with minimum power factor of 90%. Power factor correction capacitors shall be provided if required and shall be furnished to the electrical subcontractor for installation. Shop Drawing submittals for motors over 5 HP shall list efficiency and power factor. Unless specified otherwise, all motors shall have continuous duty classification, 40° Centigrade ambient temperature, shall have enclosure suitable for indicated application and shall be wound for 120 volt, single phase, 60 cycle current, except motors above 1/2 horsepower (unless indicated otherwise) shall be wound for 200V or 230V/460V as required by the secondary voltage specified for main service in Division 26. Each motor shall be selected and rated at the voltage indicated so that the driven load does not exceed the nameplate rating and service factor of the motor. All motors 460V/480V 20 HP and above and 208V/230V 10 HP and above shall be wound for wye-delta (6 or 12 lead) starting with capabilities of being wired for across-the-line starting.

C. Motors for use with variable frequency drives (VFD) shall be wound for across-the-line type starting and shall be rated for "VFD-duty" or shall be Premium Efficiency type with Class F (1500 volt) insulation and thermal overload protection. Motors for VFD applications shall meet or exceed IEEE 519-1992. Motors for VFD applications shall have maximum 4:1 speed range corresponding to 60 Hz and 15 Hz. Power factor correction is not required when motor is used with VFD. Motors for VFD service shall be Inverter Duty Rated with internal shaft grounding to prevent common mode voltage (shaft current) bearing failures.

D. Motor starters and motor protective switches shall be provided under Division 26 except where specified to be furnished specifically with the driven equipment. Accessories such as auxiliary contacts, hand-off-automatic switches, start-stop switches, pilot lights, control power transformers and other similar items shall be provided in or on the controllers as required by the control sequence indicated. Starting equipment, unless factory mounted on the equipment, shall be installed under Division 26.

2.02 VARIABLE FREQUENCY DRIVES [S] [O/M]:

A. Variable Frequency Drives (VFD) shall convert primary power to adjustable voltage/frequency three phase AC power for stepless motor control from 5% to 105% of motor base speed. Units shall be pulse-width-modulation (PWM) type. Units shall be UL listed and suitable for installation in return air plenums, complete with Hand/Off/Auto switch, Run or Stop switch and display to indicate unit status, frequency and fault diagnostics. Unit shall have automatic soft restart after power outage, soft start/stop, and interface provisions for start/stop and control from the DDC system specified in Section 23 09 00 interconnections. Unit shall have all motor

protective devices as required by NEC. Unit shall have line circuit breaker, bypass switch, motor thermal overload relay, phase-loss protection, ground-fault protection, harmonic compensated load side reactor and control transformer.

B. Drives shall be suitable for operation without damage to the connected motor. Drives shall have multiple, adjustable deadbands across the entire speed range for operation of connected equipment without vibration. Units shall have display on each drive to indicate all faults and diagnostics.

C. Drives shall be matched to driven motors in accordance with motor and drive manufacturers' recommendations.

D. Drives shall be suitable for speed control by the DDC System specified in Section 23 09 00 using any of the following signals, 3-15 psi, 0-5 vdc, 0-10 vdc or 4-20 ma dc.

E. Drives shall be provided with current sensing device to indicate abnormal conditions such as broken belt.

F. Where wiring to the driven motor exceeds 150 feet or as otherwise recommended by the manufacturer, a load side drive filter shall be furnished and installed. Where drives have remote disconnects at the driven motor, a run contact shall be provided to stop the drive without harm if the remote disconnect is opened.

G. Drives shall be installed in NEMA classified cabinets suitable for the location in which installed. Units located outdoors shall be NEMA 3R or NEMA 4.

H. Harmonics: The drives provided shall not add significant voltage harmonic distortion to the electrical system. If voltage harmonic distortions exceed 5%, line reactors or isolation transformers shall be provided in a separate enclosure.

I. VFD shall be provided with communication interface to allow two-way communication with the DDC System specified in Section 23 09 00.

J. Warranty: Provide parts and labor warranty for a period of five (5) years.

K. Installation and Start-up:

1. The services of a qualified manufacturer's technical representative shall supervise the contractor's installation, testing, and start-up of all the drives furnished under this specification. A maximum total of one (1) supervision day (8 hours) shall be provided by the manufacturer's representative.

2. System start-up shall include a checkout of vibration at various frequencies through field observation and manufacturer's data on the driven equipment. Frequency deadbands shall be set-up for each point of equipment vibration.

3. Upon acceptance of the drive equipment, training of the operators shall consist of one (1) training day (8 hours).

2.03 EXPANSION FITTINGS FOR HVAC PIPING

A. Expansion joints [S] shall be Flexonic internally guided, corrugated bellows, expansion compensator, type H or HB, 2" minimum stroke, suitable for hot water service. Expansion joints may be used in lieu of pipe loops in hot or cold water recirculating systems.

B. Anchors and guides for pipe shall be provided as indicated or as required at the job site to localize expansion and contraction of pipe. Anchors shall consist of heavy steel or brass collars bolted or welded to the pipe and rigidly connected to the building structure unless indicated otherwise. Anchor braces shall not be attached in places where they will damage or injure the structure during installation or by the weight or expansion force of the pipe line after installation. Detail drawings of pipe anchors shall be approved before anchor installation.

C. Flexible pipe joints at chillers, pumps, air handling units or other pieces of equipment isolated from the structure by vibration isolators as specified elsewhere shall be pipe line size and shall be Flexonics standard 125 psi, Series PCS, stainless steel or bronze, flanged, screw or sweat type connectors with longitudinally welded stainless steel bellows and braided jacket.

2.04 METERS AND GAGES FOR HVAC PIPING

A. Thermometers shall be 5" diameter adjustable angle, industrial type complete with stainless steel case, bezel, union (or 360° swivel) and stem, shatterproof lens, brass well, aluminum scale plate with black numbers and accurate to $\pm$1°F.

B. Pressure gauges shall be equal to Ashcroft bourdon tube type suitable for 125 psi service. Gauges shall be not less than 4" dial type with aluminum case and bar stock needle type gauge cock. Gauges shall be graduated in feet of water and psi. Minimum range 1.5 times normal operating pressure.

2.05 GENERAL-DUTY VALVES FOR HVAC PIPING

A. General: Valves shall be Apollo, Bray, Center Line, Crane, Jenkins, Jamesbury, Nibco, Milwaukee, Stockham, or Weco. All valves shall be suitable for 150 psi working pressure. Class 125 is not acceptable. Valves shall have threaded connections; except where flanges are specified they shall have fully lugged flanged connections suitable for dead-end service connections, and where installed in hard drawn copper lines they may have sweat connections. All valves shall be line size for the piping section indicated.

1. Equipment Service Valves over 4" [S]: Valves shall be carbon steel or iron body fully lugged flanged high performance butterfly (HPBV) double offset type with 316 stainless steel disc and reinforced PTFE or RTFM replaceable seats, pressure assisted for tight shutoff. Butterfly valves shall provide bi-directional service, with downstream flange removed, and API 609 blow-out proof stem retention. Valves shall have upper and lower stem bearings of 316 stainless steel with PTFE seals.

2. Equipment Service Valves up to and including 2" [S]: Valves shall be full port ball valves with stainless steel ball, 2-piece or 3-piece, brass body, bronze body, LF bronze body, or iron body, or shall be HPBV.

3. Equipment Service Valves 2-1/2" to 4" [S]: Valves shall be full port ball valves with chromium plated brass ball, 2-piece or 3-piece, brass body, bronze body, LF bronze body, or iron body, or shall be HPBV.

4. Piping Branch Line Service Valves over 4" [S]: Valves shall be iron body fully lugged flanged butterfly disc type with aluminum-bronze disc and EPT Nordel seats.

5. Piping Branch Line Service Valves up to and including 4" [S]: Valves shall be full port ball valves, as specified for equipment service valves.

6. All valves for chilled water service shall have integral insulated handle equal to Nibco Nibseal. All valves for hot water service shall have stem extension for lever handle operator to accommodate up to 2" thick insulation.

7. Globe valves ([S]) shall be all brass or bronze, with brass disc except globe valves over 2" size may be butterfly valves as specified above, under service valves. Non-rising stems are not acceptable.

B. Check valves shall be brass or iron body, swing type, regrinding seat and shall be suitable for 125 psi working pressure.

C. Balancing cocks shall be all brass or bronze, venturi type, plated ball valves with Teflon seats, Tee handles, memory stops, and temperature/pressure ports. All balancing cocks shall be suitable for positive shut-off at 125 psi working pressure.

D. Circuit setter [S] [O/M] shall be Bell & Gossett, Armstrong, or Taco. Those 2-1/2" and smaller shall be bronze, ball type or brass, globe type balancing valves. Valves 3" and larger shall be cast iron globe or ball type. All circuit setters shall have provisions for connecting a portable differential pressure meter. Meter connections shall have built-in check valves. An integral pointer shall register degree of valve opening. Each balance valve shall be constructed for 125 lbs. working pressure at 250°F. Furnish one differential meter model RO-2 complete with meter, cutoffs, piping, fitting and dual hoses. Circuit setters shall not be intended for use as shutoff valves. A circuit setter with memory stop is not a substitute for service valves.

E. Automatic Flow Control Valves [S] [O/M] shall be Griswold, Flow Design, or Bell & Gossett and shall be provided at all (chilled water cooling coils) (and hot water heating coils). Valves shall be automatic pressure compensating type and factory set to provide specified flow rates within ten (10) percent regardless of system pressure. Valves shall be selected to provide specified flow rates with a minimum pressure differential of 2 psig. Where system differential exceeds 32 psig, valves shall be selected for a range of 4-57 psig. Valve body shall be suitable for use with piping system and internal working parts shall be stainless steel, nickel plated brass or elastomeric diaphragm. All valves shall be provided with strainer, union and pressure-temperature test ports suitable for connecting differential pressure measuring devices. All valves shall be wye configuration for removal of controlling element without removing valve

from piping. Each valve shall be identified as to direction of flow and flow rate. Each valve shall be provided with strainer in piping upstream of the coil. One differential pressure meter shall be provided complete with dual hose kit, valves, flow conversion chart and carrying case. Meter and accessories shall be turned over to the Owner upon final acceptance of the project. Valves shall be suitable for use with glycol/water configuration specified.

F. Triple Duty Valves [S]: Units shall be equal to Bell & Gossett straight pattern type for installation in vertical piping as indicated. Units shall provide functions of check valve, throttling valve, shut-off valve and calibrated valve with differential pressure ports. Valves shall be suitable for 125 psig and 250°F service. Valves shall be fitted with brass or bronze seat, replaceable bronze disc, stainless steel stem and spring. Valve rating shall not exceed 5 feet of water pressure drop at 100% flow and shall not exceed manufacturer's recommendations.

G. Safety Valves [S]:

1. Safety relief valves for water heating and cooling systems shall be equal to Watts ASME rated, series 740 or 174A. Valves for heating systems shall be sized to relieve the full heating capacity of the heater installed in the heating system at set pressure of 5 psi over operation pressure. Valves for cooling systems shall be 125 psi set pressure, 3/4" x 1" size. Pipe discharge port full size to floor and support so that no strain is on the valve body.

2.06 HANGERS AND SUPPORTS FOR HVAC DUCTWORK, PIPING AND EQUIPMENT

A. Suspended horizontal piping shall be supported by adjustable wrought steel clevis hangers except that straight runs of hot piping (>100°F) with 40 ft. or more between anchor and expansion device shall be supported on roller type hangers or supports. See Section 23 07 00 for calcium silicate hanger inserts at clevis hangers. All piping connected to motor driven reciprocating or rotating equipment shall have vibration isolation hangers as specified in Section 23 05 48. Protection saddle, welded to pipe, shall be provided at each roller support except on chilled water lines, saddle shall be external metal shield with calcium silicate preformed section as specified in Section 23 07 00, vapor sealed. Calcium silicate inserts may be omitted for pipe smaller than 2 inches. Where supports bear on copper pipe they shall be copper plated. Chain, strap or other makeshift devices will not be permitted as hangers of supports.

B. Maximum pipe support spacing for steel piping shall be ten feet on center, -copper and brass tubing 1-1/4" and smaller shall be supported six feet on center.

C. Vertical steel piping shall be guided or supported in the center of each riser and not over 15 feet on center, copper or brass tubing shall be supported at not over 10 feet on center; and supported at the base of each riser and/or at the top of each riser as required by the piping run. All vertical piping shall be guided or braced where required to prevent lateral movement. Bracing shall include auxiliary stanchions where piping is not in close proximity to suitable structure.

D. Refrigerant piping smaller than 3/4" shall be supported using B-Line Armafix clamps by Cooper Industries or equal.

E. Rigid support sway bracing shall be provided at changes in direction greater than 45 degrees for all pipe 4 inches and larger.

F. Pipe and suspended equipment hanger rods shall be attached to the top chord only on steel joists and beams by joist or beam clamps without welding. Welding of support rods and connection at any place other than the top chord will not be permitted unless written approval is granted by the Engineer and the Architect. C-clamp hangers shall be limited to 50 lb. or less when used at joists. Threaded rod shall be used through joist chords for loads greater than 50 lb.

G. Pipe and suspended equipment supported from concrete structure shall be high-strength screw anchor and threaded rod system. Anchor shall be zinc plated, heat treated, carbon steel with integral flanged head to accept threaded rod. Anchor shall be selected to provide a minimum safety factor of 2 for the load to be supported and shall be approved for use in cracked and uncracked concrete applications. Anchor shall be Simpson Strong-Tie Titen HD or equal.

H. Duct supports shall consist of not less than 1" by 1/16" galvanized strap iron hangers spaced not over 4 feet on center, except medium and high pressure flat-oval ducts wider than 48 inches shall be supported by trapeze angles. Straps shall be lapped across the bottom ducts a minimum of 1 inch. Ductwork shall be supported from the building structure. Ductwork shall not be supported from the ceiling system or any other building services. Heavy ductwork such as medium or high pressure duct supported by hanger rods, shall be attached to the top chord only on steel joists and beams by joist or beam clamps without welding. Welding of support rods and connection at any place other than the top chord will not be permitted unless written approval is granted by the Engineer and the Architect. All ductwork shall be braced as required to prevent lateral movement.

I. Roof mounted piping and duct supports shall be factory fabricated mounting pedestals as manufactured by Roof Products and Systems, Inc. (RPS) or equal. Pedestals shall be minimum 12 inches high, complete with equipment rail, slide channel "U" shaped mounting brackets, 18 gauge threaded galvanized rods, lateral spacer bracket and galvanized slide assembly. Supports shall be located to adequately support duct with no more than 4 feet of duct unsupported. Piping shall be secured to supports using accessories furnished by the support manufacturer.

J. Where piping is to be installed on an existing roof, pipe supports shall be pre-manufactured rubber pedestal supports, manufactured specifically for mounting on top of existing roofing systems. Pedestals shall be minimum 2.5 inches high complete with galvanized steel slide channel attached to the base. Two ½ inch diameter threaded rods 10 inches in length shall attach a galvanized steel slide channel to the base channel with the pipe being secured by a rigid steel pipe clamp. The support height shall be adjustable to accommodating a sloping pipe. Rooftop support shall be equal to RTSPUCES Rooftop Support Systems manufactured by Eberl Iron Works, Inc.

2.07 HEAT TRACING FOR HVAC PIPING

A. Pipe Heat Trace [S] shall be equal to Chromalox, UL Listed, RAPID-TRACE, Type SRL self-regulating heating cable. Buss wires shall be 16 AWG copper. Heating matrix shall be semi-

conductive polymer for self regulation. Jacket shall be water and chemical resistant, flame-retardant thermoplastic rubber with protective tinned-copper braid. Provide all accessories required for a safe watertight installation. Heat Trace shall protect piping indicated to -10°F.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Install products in accordance with manufacturer's recommendations.

B. Support riser piping independently from the connected horizontal piping.

C. Hangers shall be spaced so that the supported load does not exceed the load recommended by the manufacturer. The supported load shall not overstress the building structural members. Where required hangers for the suspension of heavy items do not correspond with the building structural members, provide supplemental steel members fastened to the building structural members.

D. Valves in horizontal lines shall be installed with stems horizontal or above. Flanged butterfly valves shall be provided with spacer or spool piece between valve and adjacent appurtenance. Isolation service valves shall be installed on each side of each major piece of equipment such as a pump, cooling tower, boiler, chiller, coil, and other similar items; and at any other points indicated or required for draining, isolation or sectionalizing purposes. Control valves shall be installed in accordance with control manufacturer's recommendations.

E. Install all thermometers and gages such that they can be easily readable standing on floor. Gages subject to vibration or physical damage shall be adequately supported and protected.

F. Where pressure/temperature ports are indicated on the drawings, they shall be provided with full port gauge cocks that allow penetration of instrument probes.

G. All outdoor water piping that does not contain glycol shall be provided with heat trace under insulation. All accessories shall be provided as necessary for a complete operating system.

H. Butterfly valves in horizontal lines shall be installed with the stem horizontal.

END OF SECTION

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SECTION 23 05 48

VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

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

B. Work Included:

1. Vibration Isolators

C. Related Sections:

1. Section 23 00 10 – HVAC General Requirements
2. Section 23 10 00 – Facility Fuel Systems
3. Section 23 20 00 – HVAC Piping and Pumps
4. Section 23 30 00 – HVAC Air Distribution
5. Section 23 50 00 – Central Heating Equipment
6. Section 23 60 00 – Central Cooling Equipment
7. Section 23 70 00 – Central HVAC Equipment
8. Section 23 80 00 – Decentralized HVAC Equipment
9. Division 26 - Electrical

1.02 QUALITY ASSURANCE

A. All vibration control apparatus shall be supplied by a single recognized manufacturer. The supplier of noise and vibration control equipment shall supervise, inspect and approve the installation of their equipment. The supplier shall submit a letter to the Engineer at the conclusion of the project stating that all items have been installed properly and that all equipment is adequately isolated.

1.03 SHOP DRAWINGS

A. Submit shop drawings and product data in accordance with Division 1.

B. Shop drawings, cuts, diagrams, catalog data sheets or such other data necessary to fully describe and substantiate compliance with the specifications shall be submitted for all vibration isolation equipment and materials. The Contractor shall submit drawings for review stating the static deflection, load capacity and location of the isolators, inertia slab dimensions and installation instructions.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Kinetics Noise Control, Vibration Mountings and Control, Inc., Vibration Eliminator Co., Mason Industries, Vibro-Acoustics or Amber/Booth Company.

B. Model numbers used in this specification are those of Kinetics Noise Control and are included to establish a standard of quality.

2.02 ISOLATOR TYPES

A. Floor Mounted Equipment:

1. Type S spring vibration isolators shall be free-standing, unhoused, laterally stabile, steel springs, wound using high strength heat treated spring alloy steel, and shall have a horizontal spring stiffness equal to or greater than 1.0 times the rated vertical spring stiffness. Springs shall be selected to provide the tabulated minimum operating static deflections and shall provide a 50% overload capacity before reaching a solid state. Springs shall be designed to reach a solid state before exceeding the spring steel fatigue point. Springs used to isolate floor mounted equipment shall include a drilled and tapped steel top load plate, and a steel bottom load plate bonded to a 1/4" thick ribbed neoprene noise stop pad. Each spring mount shall include a steel leveling bolt, locknuts, and washers for attachment to supported equipment. Type S units shall be Kinetics Model FDS. Springs shall have the following minimum outside diameters:

Spring Deflection,	Rated Capacities, Lbs.		
Inches	Up to 370	371 to 1600	1601 to 11000
Up to 1.5	1.75" dia.	3.00" dia.	3.00" dia.
1.51 to 2.25	3.50"	5.0"	5.0"

2. Type NIP neoprene isolation pads shall be single rib or crossed, double rib neoprene in shear pads in combination with steel shims. Neoprene pads shall be molded using 2500 psi tensile strength, oil resistant compounds. Type NIP units shall be Kinetics Model NPS, NPD, NGS, or NGD.

B. Suspended Equipment:

1. Type 2 hangers shall consist of a steel spring and a elastomer-in-shear isolator placed in series and encased in a welded steel bracket. The spring element of the hangers shall meet all specified characteristics of a "Type S" spring as previously specified. Springs shall be color coded for ease of load capacity identification and removable for field correction of overloaded hangers. The elastomer noise stop pad shall be selected to operate within the published load range for the pad for each spring capacity when placed in the bracket used. The hanger bracket shall be designed to carry five (5) times overload without failure, and shall allow up to 15° rod misalignment without metal to metal contact. Type 2 units shall be Kinetics Model SRH.

2. Type F hangers shall consist of an elastomer-in-shear isolator encased in a welded steel bracket. The elastomer shall be bonded to the hanger bracket and shall be selected to support the load within its published load rating. The hanger bracket shall be designed to carry a five (5) times overload without failure and allow up to 15° rod misalignment without short circuiting. Type F hanger shall be Kinetics Model RH.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Equipment: All equipment listed hereinafter shall be isolated from the structure and fixed parts by means of resilient vibration and noise isolators. Isolators for floor and roof mounted equipment shall be solidly anchored to the support base or floor and to the supported equipment unless indicated otherwise.

B. Piping and Conduit: All piping and electrical conduit connected to the chillers (including refrigerant piping), pumps, air handling units, or other pieces of moving equipment which are isolated from the structure by spring type vibration isolators shall be isolated from these units by flexible pipe connectors and shall be suspended on isolation hangers to a point 10 feet away. Use Type 2 hangers for suspended piping, Type S mounts for floor mounted piping. Flexible pipe connectors are specified as part of the piping work.

C. Ductwork: Flexible connections shall be incorporated in the ductwork adjacent to all air moving units as part of the sheet metal work. Ductwork shall be suspended on Type F hangers for a distance of 30 feet from these units.

3.02 MINIMUM VIBRATION ISOLATOR STATIC DEFLECTION

Type of Equipment	Base Type	Isolator Type	Deflection Inches
Chiller	N/A	NIP	0.25
Fans (Suspended)	N/A	S	0.75

3.03 EQUIPMENT WITH INTERNAL ISOLATION

A. Where air handling units have fan and motor assembly internally isolated from the unit casing, using both spring isolators and flexible fan discharge connections, external isolators for the air handling unit shall not be provided.

END OF SECTION

SECTION 23 05 53

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

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

B. Work Included:

1. Prepare and paint Division 23 equipment, accessories, ductwork, piping and miscellaneous materials located in Equipment Rooms, Boiler Rooms, pipe trenches and other utility areas housing mechanical equipment and materials.

2. Identification of piping in exposed and accessible locations.

3. Marking and designation of equipment.

C. Work Not Included:

1. Painting of ductwork, piping or equipment located on the building exterior.

2. Painting of ductwork, piping or equipment exposed in finished areas other than those listed under WORK INCLUDED above.

3. Painting of existing equipment, piping or ductwork.

D. Related Sections:

1. Section 09 90 00 – Painting and Coating

2. Section 23 00 10 – HVAC General Requirements

3. Section 23 05 00 – Common Work Results for HVAC

4. Section 23 07 00 – HVAC Insulation

5. Section 23 09 00 – Instrumentation and Control for HVAC

6. Section 23 20 00 – HVAC Piping and Pumps

7. Section 23 30 00 – HVAC Air Distribution

8. Section 23 50 00 – Central Heating Equipment

9. Section 23 60 00 – Central Cooling Equipment

10. Section 23 70 00 – Central HVAC Equipment

11. Section 23 80 00 – Decentralized HVAC Equipment

12. Division 26 - Electrical

1.02 REFERENCED STANDARDS:

A. General: The following standards or codes (latest edition) form a part of this specification to the extent indicated by the reference thereto.

B. American National Standards Institute (ANSI):

1. ANSI A13.1 Scheme for Identification of Piping Systems

C. American Society for Testing and Materials (ASTM):

1. ASTM E 84 Standard Test Method for Surface Burning Characteristics of Building Materials

2. ASTM C 411 Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation

D. National Fire Protection Association (NFPA):

1. Standard 255 Method of Test of Surface Burning Characteristics of Building Materials

E. Underwriters Laboratories, Inc. (UL)

1. Standard 723 Tests for Surface Burning Characteristics of Building Materials

F. California Department of Health Services

1. Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

A. Except as otherwise specified, materials shall be the products of the following manufacturers:

1. Sherwin-Williams

2. Pratt and Lambert

3. Pittsburgh Paints (PPG)

4. Benjamin Moore

5. Porter Paints

6. Seton Identification Products

2.02 MATERIALS:

A. Deliver all paints and materials to the project site in their unopened original containers with all labels intact and legible at the time of use.

B. All coatings exposed to supply and return airstreams and where applied to exposed surfaces in a return air plenum, shall have a composite flame spread rating not exceeding 25, and a smoke developed rating not exceeding 50 as tested under procedure ASTM E-84-75, NFPA 255 and UL 723. Coatings shall not flame, glow, smolder or smoke when tested in accordance with ASTM C411, latest edition.

C. Sherwin-Williams Industrial Maintenance Coatings System 4000 products are listed below to establish color and a standard of quality.

1. All Hangers and Supports: One coat Series 54 Gloss Black Alkyd Enamel.

2. All major equipment supports including boilers, cooling tower, pumps, tanks, air handling units, condensers, fans and all other similar items shall be painted as follows:

a. Uninsulated hot surfaces on equipment, operating at or above 150°F, shall be painted with two coats of No. B59S8 Heat Resistant Aluminum.

b. Other equipment surfaces of aluminum, iron and steel shall be primed with one coat of No. B50Y1 Zinc Chromate Primer. Galvanized surfaces shall be chemically prepared and primed with one coat of Galvite B50W3 Primer. Field insulated surfaces shall be primed with No. B28W200 Wall Primer. Where equipment is furnished with factory prime or finish coat, only patch priming is required at any damaged areas before finish coats are applied. Finish all equipment with two coats of Series 54 Alkyd Gloss Enamel, No. SW4063 Robotic Blue. Exterior of belt guards and other protective guards shall be finished with two coats of Series 54 Alkyd Gloss Enamel, No. SW4084 safety yellow color. Interior of and all items covered by belt guards and other protective guards shall be finished with two coats of No. SW4083 safety orange color.

c. Nameplates and Testing Agency Labels on equipment or machinery shall not be painted.

3. Ducts:

a. Interior duct behind all grilles, registers and diffusers shall be painted with one coat of flat black prime or flat black finish paint.

b. Exposed in equipment rooms and other unfinished areas such as storage areas and utility type spaces; uninsulated galvanized steel ducts shall be chemically prepared and primed with one coat of Galvite B50W3 Primer. Aluminum ducts and insulated ducts with aluminum jacket shall be primed with one coat of No. B50Y1 Zinc Chromate Primer. Canvas or paper insulation jacket shall be primed with one coat of No. B28W200 Wall Primer. Finish with Series 54 Alkyd Gloss Enamel, gray No. SW4028 Gypsum applied in sufficient number of coats to effectively cover the prime coat.

4. Piping: Exposed in equipment rooms and where connections are made to equipment located in storage rooms and other utility type areas.

a. Priming:

1) Insulation Canvas or Paper Jacket: One coat No. B28W200 Wall Primer.

2) Insulation Aluminum Jacket: One coat No. B50Y1 Zinc Chromate Primer.

3) Bare Iron or Steel or Copper: One coat No. B50Y1 Zinc Chromate Primer.

4) Galvanized Steel: Pipes and ductwork shall be chemically prepared and primed with one coat of Galvite B50W3 Primer.

b. Finish: All pipe lines and the supports or hangers therefore, shall be finished with Series 54 Alkyd Gloss Enamel, gray No. SW4028 Gypsum applied in sufficient number of coats to effectively cover the prime coat. Painting of pipe hangers is specified hereinbefore.

c. Materials shall be as recommended by the manufacturer for the surface to be finished.

d. Unless otherwise specified, primer shall be by the same manufacturer as the finish coat.

e. Materials shall not be thinned or cut except as recommended by the coating manufacturer. Thinners shall be by the same manufacturer as the primer and finish coat.

D. Valve tags shall be neat circular brass with designations stamped thereon, attached with solid brass jack chain to each valve stem or handle.

E. Each item of equipment such as pumps, air handlers, etc., and equipment control devices such as motor starters, disconnect switches, etc. shall be properly marked with laminated engraved plastic nameplates fastened with sheet metal screws, bolts or permanent adhesive. Pressure sensitive tape is not acceptable.

F. All piping, insulated and uninsulated, shall be identified ([S]) with Seton Ultra-Mark or equal wrap around piping system markers and arrow flow directional marker. Markers shall be pre-coiled, semi-rigid plenum-rated plastic or polyester with sealed color graphics. Markers shall

be minimum 12 inches long with 1-¼ inch high letters, formed to cover entire circumference of the pipe. Markers shall be attached to piping using plenum-rated plastic tie wraps. Pipe identification shall use the same designations or abbreviations used on the drawings. Marker colors shall be in accordance with ANSI.

G. For field applications within the weatherproofing system, all paints, adhesives and sealants shall comply with the requirements of the California Health Services Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers.

PART 3 - EXECUTION

3.01 WORKMANSHIP:

A. The work shall be accomplished by qualified mechanics skilled in the painting trade. Painting of equipment, piping, ductwork and other materials shall not commence until all testing is complete and systems are ready for operation. Materials shall be applied according to manufacturer's directions. All containers shall be securely closed when not in use. Flammable materials shall not be stored on premises. Flammable waste shall be disposed of daily in devices approved for such purposes. Materials shall be evenly spread, and smoothly flowed on without runs or sags. Each coat shall be thoroughly dry before application of succeeding coats.

3.02 PROTECTION OF WORK:

A. The painters shall protect all adjacent surfaces with drop covers during the process of painting. Upon completion, paint spots, if any, shall be removed from all surfaces.

3.03 PREPARATION OF SURFACE:

A. Surfaces to be painted shall be completely dry before applying paint. Metal surfaces shall be cleaned with mineral spirits before applying materials. Rust and scale shall be removed by wire brushing or sanding. Galvanized surfaces shall be chemically pretreated with crystalline (zinc phosphate) phosphate in strict accordance with the manufacturer's recommendations. Surfaces shall not be painted when the temperature is, or is likely to be, near the freezing point, nor when they are exposed to hot sun.

3.04 IDENTIFICATION OF PIPES AND EQUIPMENT:

A. Equipment: After <u>all</u> other painting is completed, each major item of equipment shall be properly identified with nameplates. Identification symbols and designations shall be the same as shown on the Contract Documents. Where equipment is installed above lay-in ceilings (VAV boxes, cabinet unit heaters, fan coil units, or similar), the plastic nameplate shall be adhered to the face of the T-bar support so that it can be identified from within the space.

B. Apply piping system markers after completion of required insulation and finishes on piping systems. Markers shall be applied in the following locations and where identified by the Engineer:

1. At each valve and at connection to equipment.

2. At every tee and branch connection.

3. At each riser including branch risers from mains.

4. At each side of a pipe passage through floors, walls and partitions.

5. Every 15 feet on straight runs of piping mains and branches.

6. Within 6 feet of elbows (each side).

7. At access doors or similar points that permit view of concealed piping.

8. Markers shall be provided on all piping above lay-in ceilings.

9. Provide arrow markers showing direction of flow incorporated into, or adjacent to, each piping system marker.

10. Apply all piping system markers where view is unobstructed, and legends can be read and easily identified.

11. Apply all tags and piping system markers in accordance with the supplier's instructions.

END OF SECTION

SECTION 23 05 93

TESTING, ADJUSTING AND BALANCING FOR HVAC

PART 1 - GENERAL

1.01 SUMMARY

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

B. Work Included:

1. Cleaning

2. Adjusting and Balancing

C. Related Sections:

1. Division 01 -- Commissioning

2. Section 23 00 10 – HVAC General Requirements

3. Section 23 05 00 – Common Work Results for HVAC

4. Section 23 07 00 – HVAC Insulation

5. Section 23 09 00 – Instrumentation and Control for HVAC

6. Section 23 10 00 – Facility Fuel Systems

7. Section 23 20 00 – HVAC Piping and Pumps

8. Section 23 30 00 – HVAC Air Distribution

9. Section 23 50 00 – Central Heating Equipment

10. Section 23 60 00 – Central Cooling Equipment

11. Section 23 70 00 – Central HVAC Equipment

12. Section 23 80 00 – Decentralized HVAC Equipment

1.02 REFERENCES

A. General: The following publications listed below, form a part of this specification to the extent indicated by the reference thereto.

B. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA):

Balancing and Adjustment Manual

C. Associated Air Balancing Council (AABC):

National Standards for Total System Balance

D. National Environmental Balancing Bureau (NEBB):

Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.

1.03 QUALIFICATIONS

A. For the air conditioning, heating and ventilation systems the Contractor shall obtain the services of a qualified, independent testing organization specializing in total system air and water testing and balancing. The Contractor shall be responsible for making changes in pulleys, belts and dampers where necessary to obtain the required air volume as determined by the Testing and Balancing Contractor. The Testing and Balancing Contractor shall provide all labor, engineering and test equipment required to adjust, test and balance all heating, ventilating, air conditioning and exhaust systems as hereinafter specified. All personnel involved in the execution of the work under the balancing contract shall be experienced and factory trained specifically in the total balancing of mechanical systems, as well as being regular employees of the Balancing Contractor. The Test and Balance Contractor shall work in close coordination with the Controls Contractor to ensure that the system is operating as designed and to aid in adjusting setpoints as necessary for proper system operation.

1.04 TAB COORDINATION AND RESPONSIBILITIES

A. The TAB Agent shall provide the following:

1. All instrumentation used in the course of testing and balancing shall be accurate and shall have been calibrated within the six months prior to commencing test and balance work for this project.

2. Where existing air or hydronic systems are to be renovated, the TAB Contractor shall provide a complete measurement of air and water flow for systems indicated to remain prior to any construction or demolition of existing systems. For air systems, the data shall be taken and recorded for each piece of air handling equipment serving the area of renovation and those indicated on the drawings for ductwork or other mechanical renovations. Data shall be provided as outlined for balancing data hereinafter. For hydronic systems, pump flow data for each system shall be provided as well as flow to each terminal device being modified, replaced, or removed. Any discrepancies in the data shall be reported to the Architect/Engineer prior to commencing any mechanical work.

3. The TAB Agent shall conduct a pre-TAB inspection two weeks prior to commencing the test and balance. The TAB Agent shall notify the Contractor in writing of any deficiencies

that would affect the ability to successfully complete the test and balance or result in an incomplete or unacceptable report.

4. During the course of the test and balance, the TAB Agent shall immediately notify the Contractor of any equipment or system discrepancies discovered that need to be corrected prior to the satisfactory completion of the test and balance procedures.

5. Equipment settings, including damper positions, valve positions, fan speed controls, and similar devices shall be marked to show final settings.

B. The Contractor shall provide the following:

1. Prior to the commencement of testing and balancing, the installation of building systems shall be fully complete. Building controls systems shall be complete, operational, and verified by the Contractor.

2. The Contractor shall resolve any discrepancies noted by the TAB Agent in the Pre-TAB Inspection prior to commencing the test and balance. The Contractor shall provide written confirmation of the corrective action that was taken to correct each deficiency.

3. The Contractor shall make available qualified personnel during the period in which the test and balance is being conducted for the purpose of problem resolution and controls support.

4. The Contractor shall resolve any deficiencies noted by the TAB Agent prior to the submission of the report and prior to any subsequent visits required by the TAB Agent.

1.05 SUBMITTALS

A. Prior to commencing work under this section, the Contractor shall submit the name of the testing organization, a proof of certification by the Associated Air Balance Council or National Environmental Balancing Bureau, and a list of five local projects on which testing and balancing has been completed for two years, for approval by the Architect/Engineer. The submittal shall include TAB procedures proposed for the systems specific to this project.

B. Heating, Air Conditioning and Ventilation Systems Balance and Performance Data: At a time no later than the Substantial Completion Inspection, the Contractor shall provide the Architect/Engineer with two (2) typewritten copies of schedules containing air and water system balance and performance data.

C. Equipment and System Verification: Letters, signed by representatives of boiler, chiller, cooling tower, heat pump, air conditioning unit, and temperature control manufacturers, shall attest that their respective equipment installed on this project has been started, tested and set to operate safely and at the control points required as an integral part of the systems specified herein. The Contractor shall attest by letter that all equipment has been wired and tested to see that the indicated sequence of motor control is established, that all safety controls function properly, that all motor protective devices are sized correctly and that the systems are operating at the points set on the controls. The Engineers will not conduct a site visit for the purpose of determining the status of final payment until these letters are received.

D. Test data shall be submitted for all equipment and systems where specifically required by this specification and all items identified with [TD] behind the product data.

1.06 COMMISSIONING OF HVAC SYSTEMS

A. Participate in Commissioning Meetings designated by the Commissioning Agent.

B. Participate in resolving controls issues identified by the Commissioning Agent.

C. Notify Commissioning Agent a minimum of 2 weeks in advance of start-up of Testing, Adjusting and Balancing (TAB) work. Arrange and attend meeting between Commissioning Agent and TAB agency for review of TAB procedures, TAB work plan, and TAB schedule. Refer to Division 1 for complete scope of Commissioning work.

D. Provide Commissioning Agent with a copy of preliminary and final balance reports.

1.07 CONDITIONS

A. Partial Testing: As much as practical, systems shall be tested as complete systems. Tests on portions of a system will be permitted to facilitate proper progress scheduling. When systems are tested in segments, a system diagram indicating portion tested and a separate and complete report including the date of test is required for each segment.

B. Concealed Work:

1. All concealed work shall be tested and approved by the Architect/Engineer prior to the application of insulation or construction of chase walls.

2. Covering shall not be applied to any piping nor shall any piping be concealed or covered until pipes have been tested, all leaks stopped, retested and approved.

C. Work in Existing Buildings: Where new piping systems are connected to existing systems, test the new system prior to making connections to existing system. Connections to existing systems are not to be tested unless required by local authorities.

PART 2 - PRODUCTS

2.01 GENERAL

A. All equipment, instruments, materials and utilities required for cleaning, testing and balancing of the air and hydronic systems shall be provided by the Contractor.

2.02 INSTRUMENTATION

A. All instruments used by this Contractor shall be accurately calibrated and maintained in good working condition.

2.03 TESTS OF MATERIALS

A. Manufacturers' certificates will be accepted in lieu of tests of materials. If individual laboratory tests are desired by the Architect-Engineer, they will be secured by this Contractor and paid for by the Owner.

PART 3 - EXECUTION

3.01 CLEANING

A. Each boiler shall be cleaned in accordance with manufacturer's instructions before being connected to the system.

B. Equipment shall be wiped clean to remove all dust, oil, dirt or paint spots. Trash, plaster, mortar or paint shall be removed from all coils, plenums and end pockets.

C. Heating Piping, Cooling Piping and Ductwork shall be thoroughly blown out or flushed and cleaned of all foreign matter before connections are made to equipment. Temporary bypasses shall be provided around coils, control valves, heat exchangers and other similar items to prevent trash from being flushed into these items. Care shall be taken at time of installation to prevent pipe compound, scale or other objectionable matter from entering the piping systems. Strainers shall be cleaned. After all construction dirt has been removed from the building, new filters shall be installed in all air units.

3.02 ADJUSTING AND BALANCING:

A. Equipment: Before attempting to adjust and balance the air and water systems, the Contractor shall verify that the following items have been completed and are correct.

1. Motor and bearings are properly lubricated.

2. Direction of rotation of motors.

3. Belt tension.

4. Electric current flow in each phase of motors and electric heating elements.

5. Motor protective devices are sized to properly protect installed motors.

6. Thermostats, controls, accessories and other items requiring setting or adjustment shall be set as indicated.

B. Air System Balancing Procedure:

1. Place all related supply, exhaust and return air systems in operation with the fans running at design RPM.

2. Establish system conditions for the maximum demand in airflow; generally, a cooling application. Variable volume systems shall be set and balanced such that the systems are operating at minimum static pressure necessary to maintain proper airflow at the terminal devices.

3. Measure supply air volumes by means of the duct traverse method, making a minimum of sixteen (16) readings. Test holes shall be in straight duct as far as possible downstream from elbows, takeoffs, dampers, etc. Seal duct access holes with metal snap-in plugs. The use of duct tape to seal access holes will not be permitted.

4. Adjust balancing dampers for required branch duct air quantities. Ducts with multiple branches shall have at least one branch with volume damper(s) completely open.

5. Adjust grilles and diffusers to within 10% of individual requirements specified, and also adjust so as to minimize drafts and sound in all areas. Restriction imposed by flow regulating devices in or at terminals shall be minimal. Final measurement of air quantity shall be made after optimum air pattern has been achieved.

6. The total air delivery in any particular fan system shall be obtained by adjustment of the particular fan speed. The drive motor of each fan shall not be loaded over the corrected full load amperage rating of the motor involved. Where belt drive fans are used in conjunction with VFD's, the fan speed shall be adjusted by changing pulleys such that fan speed to achieve design airflow occurs at 60 Hz.

7. Adjust quantity of air on each zone to the values given in the specifications and/or plans.

8. If the supply fan volume is not within plus or minus 10% of the design capacity at design RPM, determine the reason by reviewing all system conditions, procedures and recorded data. Check and record the air pressure drop across filters, coils, eliminators, sound traps, etc., to see if excessive loss is occurring. Particularly study duct and casing conditions at the fan inlet and outlet.

9. Any changes that are required for the final balancing results will be provided for by the respective Contractors who supplied and installed such equipment under their contractual obligations. Such changes may encompass, but are not necessarily restricted to, the changing of pulleys, belts, dampers or adding dampers or access holes.

C. Water Systems Balancing Procedure.

1. Prior to commencing water balancing, the TAB Agent shall confirm that all systems have been properly filled and bled of air; strainers have been cleaned, and balancing valves (except bypass valves) are fully open.

2. All heating, cooling and condensing water systems shall be adjusted to provide required quantity to or through each component as indicated on drawings.

3. Venturi tubes, orifices or other metering fittings and pressure gauges shall be used to measure water flow rates and balance systems.

4. Systems shall be adjusted to provide the approved pressure drops through the heat transfer equipment (coils [except room units], etc.) prior to the capacity testing.

5. Where flow metering fittings are not installed, flow balance shall be determined by measuring temperature differential across the heat transfer equipment.

6. Automatic control valves shall be positioned for full flow through the heat transfer equipment of the system during tests. Flow through by-pass circuits at three-way valves shall be adjusted to balance that through the supply circuit.

7. Adjustment of distribution shall be effected by means of balancing devices (cocks, valves and fittings) and automatic flow control valves as provided; service valves shall not be used.

8. Where automatic flow control valves are utilized only pressure differential need be recorded, provided that the pressure is at least the minimum applicable to the tag rating.

9. Where available pump capacity (as designed) is less than total flow requirements of individual heat transfer units of system served, full flow may be simulated by the temporary restriction of flow to portions of the system; specific procedures shall be delineated in the agenda.

10. Water flows through multiple boilers shall be balanced.

11. Water flows through multiple chillers shall be balanced.

12. Domestic hot water system shall be balanced to provide indicated temperature hot water at all times to the point where the hot water return pipe connects to the hot water pipe.

3.03 BALANCE AND PERFORMANCE DATA REPORT [TD]:

A. General: Each heating, ventilating and air conditioning system shall be operated and tested continuously for at least two consecutive days to verify that the system is operating satisfactorily and safely and that all equipment is producing the required capacity. To be successful, this test must be conducted with all controls in automatic position and all lights on or off to simulate day time or night time use of the building. Submit two typewritten copies of reports covering air and water system balance and performance. Reports must be received by the Architect-Engineer at least one week prior to the Contractor's request for a substantial completion inspection. Reports that contain deficiencies related to incomplete or improper system installation will be rejected by the Engineer without further review.

B. Calibration Data: The report shall include a list of all instrumentation used and the date of the most recent calibration for each instrument.

C. Balance Data: The following balance data shall be provided. Design and actual water and air flows shall be provided in tabular form.

1. All Air Handling and Air Conditioning Equipment Used for Heating, Cooling and Ventilating:

a. System nomenclature and identification.

b. Nameplate information: Manufacturer, model and serial number, horsepower, rpm, voltage, phase, maximum amperage.

c. Fan speed.

d. Static pressure profile – reading between all components and total external static pressure.

e. Outside, return, and supply air quantities.

f. Actual running motor amperage.

g. For all VAV units, provide location of downstream static pressure sensor, set point (if applicable), and reading.

2. Fans:

a. System nomenclature and identification.

b. Nameplate information: Manufacturer, model and serial number, horsepower, rpm, voltage, phase, maximum amperage.

c. Fan speed.

d. Total external static pressure.

e. Air quantity.

f. Actual running motor amperage.

3. VAV boxes:

a. Box identification.

b. Manufacturer and size.

c. Air handling system associated with VAV box.

d. Cooling airflow.

e. Minimum airflow.

f. Heating airflow.

g. Fan airflow and speed setting (if applicable).

h. Correction factor for calibration of flow ring.

4. Air Outlet and Inlet:

a. Room identification.

b. Manufacturer.

c. Size.

d. Free area factor.

e. Air quantity.

f. Velocity.

5. Kitchen Hoods:

a. Nameplate information: Manufacturer, model and serial number.

b. Total exhaust airflow, total supply airflow (where applicable).

c. Hood face velocities.

6. Pumps:

a. System nomenclature and identification.

b. Nameplate information: Manufacturer, model and serial number, impeller diameter, horsepower, rpm, voltage, phase, maximum amperage.

c. Pump discharge and suction pressures along with total dynamic head (ft. H2O) at dead head and operating point.

d. Final operating GPM plotted on the appropriate pump curve.

e. Actual running motor amperage.

f. Triple duty valve position.

g. For all variable volume pumping systems, provide location of downstream static pressure sensor, set point, and reading.

7. All Hydronic Coils and heat exchangers:

a. Coil nomenclature and identification.

b. Flow control valve nameplate information: Manufacturer, model and serial number.

c. Differential pressure across flow control valve.

d. Design and actual GPM.

8. Cooling Tower:

a. Nameplate information: Manufacturer, model and serial number, fan horsepower.

b. Water flow through each cell.

9. Chillers:

a. Nameplate information: Manufacturer, model and serial number.

b. Water flow through each evaporator and condenser (where applicable).

10. Boilers:

a. Nameplate information: Manufacturer, model and serial number.

b. Water flow through each boiler (hot water).

D. Performance Data: The following information shall be recorded twice each day and twice each night during the performance test. Reading shall be taken for each item at a different time each succeeding day at least two hours later than the time the reading was taken on the preceding day.

1. Water Boiler:

a. Nameplate information: Manufacturer, model and serial number.

b. Boiler identification number.

c. Boiler water flow.

d. Water supply and return temperature.

e. Boiler stack temperature and CO_2.

2. Air cooled chiller:

a. Nameplate information: Manufacturer, model and serial number.

b. Water temperature entering/leaving the evaporator.

c. Water flow through evaporator.

d. Pressure drop through the evaporator.

3. Water cooled chiller:

   a. Nameplate information: Manufacturer, model and serial number.

   b. Water temperature entering/leaving the evaporator.

   c. Water flow through the evaporator.

   d. Pressure drop through the evaporator.

   e. Water temperature entering/leaving the condenser.

   f. Water flow through the condenser.

   g. Pressure drop through the condenser.

4. All Air Handling and Air Conditioning Equipment Used for Heating, Cooling and Ventilating (except for unit heaters, VAV boxes, and cabinet unit heaters):

   a. System nomenclature and identification.

   b. Dry bulb and wet bulb temperatures entering and leaving all coils.

   c. Water flow through all coils.

   d. Water temperatures entering and leaving all coils.

   e. Water pressure drop through all coils.

   f. (Test all electric heating coils for operation of low airflow interlock.)

5. Heat pumps:

   a. System nomenclature and identification.

   b. Nameplate information: Manufacturer, model and serial number.

   c. Dry bulb and wet bulb temperatures entering and leaving indoor and outdoor coils.

6. Cooling tower:

   a. System nomenclature and identification.

   b. Water temperatures entering and leaving the tower.

   c. Water flow through each cell.

   d. Outside air dry and wet bulb temperatures.

7. Space Pressurization:

    a. Measure and record space pressurization in corridor served by each major air handling unit.

    b. Coordinate with Controls Contactor for fan speed adjustments to achieve space pressurization setpoint of 0.05" w.c. (adjustable).

8. Temperature: Each Room in Building. Temperature measurements shall be taken with the Contractor's calibrated equipment. Trended data from the temperature control system is not acceptable.

E. Control Setting: During the performance and balance tests, control settings may require adjustment, and if so, shall be adjusted to produce the best balanced system operation. The final setting of each operating and safety control shall be recorded. This shall include, but not be limited to, thermostats, limit controls, damper position switches, firestats, freezestats, humidistats, aquastats and other similar items.

3.04 HVAC SYSTEMS FINAL TESTS:

A. Upon completion of the work, in accordance with these drawings and specifications, the Contractor shall make a final test in the presence of the Architect-Engineer. With all equipment energized and all controls in automatic position, the systems and equipment specified herein shall be proven to operate safely and to heat and cool the structure uniformly. If not, adjustments and corrections shall be made until satisfactory operation is achieved.

B. At the time of final inspection, the Contractor shall recheck, in the presence of the Engineer and Owner, random selections of water and air quantities, and air motion recorded in the certified report. In general, selections for recheck will not exceed 25 percent of the total number tabulated in the report.

C. If random tests elicit a measured flow deviation of ten percent or more from that recorded in the certified report listings, at ten percent or more of the rechecked selections, the report may be rejected at the sole discretion of the Engineer. In the event the report is rejected, all systems shall be readjusted and tested, new data recorded, new certified reports submitted, and new inspection tests made.

D. Following final acceptance of certified reports by the Engineer and Owner, the settings of all valves, dampers, and other adjustment devices shall be permanently marked by the Contractor so that adjustment can be restored if disturbed at any time. Do not mark devices until after final acceptance.

3.05 HVAC SYSTEM POST ACCEPTANCE TESTS:

A. Should completion of the building occur at such time that the required performance test must be conducted and test data recorded and submitted during a season when both heating and cooling system performance cannot be checked, the Contractor shall perform the tests and

record all such data as is available with system operating automatically under the prevailing weather conditions. That part of the system portion which cannot be recorded because of the prevailing weather shall be delayed until the weather is appropriate at which time the remaining part of the required tests shall be conducted and data recorded accordingly. Portions of the tests may not be delayed without written consent of the Engineer.

END OF SECTION

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SECTION 23 07 00

HVAC INSULATION

PART 1 - GENERAL

1.01 SUMMARY

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

B. Work Included:

1. Piping Insulation

2. Ductwork Insulation

3. Equipment Insulation

C. Related Sections:

1. Section 23 00 10 – HVAC General Requirements

2. Section 23 05 00 – Common Work Results for HVAC

3. Section 23 20 00 – HVAC Piping and Pumps

4. Section 23 30 00 – HVAC Air Distribution

5. Section 23 50 00 – Central Heating Equipment

6. Section 23 60 00 – Central Cooling Equipment

7. Section 23 70 00 – Central HVAC Equipment

8. Section 23 80 00 – Decentralized HVAC Equipment

1.02 SUBMITTALS:

A. Submit shop drawings in accordance with Division 1 and Section 23 00 10.

B. Submit shop drawings and catalog data for each type of material proposed for this project. Indicate thickness of material for individual services, and installation methods.

1.03 REFERENCES:

A. General: The following standards or codes (latest edition) form a part of this specification to the extent indicated by the reference thereto.

B. American Society for Testing and Materials (ASTM):

ASTM E 84 Standard Test Method for Surface Burning Characteristics of Building materials.

ASTM C 411 Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation

C. National Fire Protection Association (NFPA):

Standard 255 Method of Test of Surface Burning Characteristics of Building Materials

D. Underwriters Laboratories, Inc. (UL)

Standard 723 Tests for Surface Burning Characteristics of Building Materials

E. California Department of Health Services

Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers

PART 2 - PRODUCTS:

2.01 GENERAL

A. Acceptable Manufacturers:

1. Manville, Owens Corning, Armstrong, IMCOA, Knauff or Certain-Teed except where specific manufacturer is named.

B. All insulation materials, jackets and fitting covers shall have a composite flame spread rating not exceeding 25, and a smoke developed rating not exceeding 50 as tested under procedure ASTM E-84-75, NFPA 255 and UL 723. Duct coverings and linings shall not flame, glow, smolder or smoke when tested in accordance with ASTM C411.

2.02 MATERIALS

A. Piping:

1. Cold Water (0°-95°F): Fine heavy density fibrous glass or rigid phenolic foam insulation with factory applied foil-scrim-white kraft paper vapor barrier jacket, molded to conform to piping, 0.24 btu•in./sq.ft./°F/hr. maximum “K” value at 75° F.

2. Hot Water (100°-225°F): Fine heavy density fibrous glass, rigid phenolic foam or calcium silicate insulation with general purpose jacket, molded to conform to piping, 0.25 btu•in./sq.ft./°F/hr. maximum "K" value at 75°F.

3. Refrigerant Piping: Closed cell flexible elastomeric insulation, 0.28 btu•in./sq.ft./°F/hr. maximum "K" value at 75°F., maximum water vapor transmission rating of 0.1 perms-inch. Insulation located outside the building shall have a selective finish to protect insulation from ultra violet (UV) solar radiation, unless specifically designed to withstand UV radiation.

B. Ductwork:

1. Exposed Rectangular Ducts: Rigid fibrous glass insulation, 3.0 lb. density, 0.24 btu•in./sq.ft./°F/hr. maximum "K" value at 75°F, with factory applied reinforced aluminum foil vapor barrier.

2. Round Ducts, Flat Oval Ducts and Concealed Rectangular Ducts: Flexible fibrous glass insulation, 1.0 lb. density, 0.27 btu•in./sq.ft./°F/hr. maximum "K" value at 75°F, with factory applied reinforced aluminum foil vapor barrier.

3. Acoustic Lining (where indicated and/or noted on Drawings): Fiberglass insulation, 0.26 btu•in./sq.ft./°F/hr. maximum "K" value at 75°F, absolute roughness of exposed surface shall not exceed 0.005 ft., coated to prevent erosion at air velocities up to 2000 fpm, 1.5 lbs/cu.ft. minimum density. Noise reduction co-efficient shall average not less than 0.60 when tested by Acoustical Material Association procedure mounting 6. Liner shall be provided with EPA approved biocide in the erosion coating to protect against microbial growth. Liner shall meet or exceed requirements of ASTM G21 (fungi resistance) and ASTM G22 (bacterial resistance). Acoustic lining shall be one inch thick unless specifically noted otherwise.

C. Hot Equipment:

1. Calcium silicate block insulation molded to conform to shape of equipment, 0.40 btu•in./sq.ft./°F/hr. maximum "K" value at 150°F., suitable for 1000°F service.

2. Finish, two 1/2" thick coats of insulating cement, last coat mixed 2 to 1 by weight with Portland cement.

D. Cold Equipment: Rigid fibrous glass insulation molded or fitted to conform to equipment, 0.24 btu•in./sq.ft./°F/hr. maximum "K" value at 75°F.

Sealants, Mastics and Adhesives: Products either manufactured by or recommended by the insulation material manufacturer. For field applications within the weatherproofing system, adhesives and sealants shall comply with the requirements of the California Health Services Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers.

PART 3 - EXECUTION:

3.01 PREPARATION

A. Do not install insulation before piping, medium pressure ductwork, and equipment have been tested and approved.

B. Ensure surface is clean and dry prior to installation. Ensure insulation material is undamaged and dry before application. Finish with system at operating conditions and temperature.

3.02 INSTALLATION

A. General: Ensure insulation is continuous through inside walls and partitions. Insulated piping passing through smoke partitions, fire walls, fire partitions, and fire rated floors shall have insulation of type, thickness and density to match U.L. Through-Penetration Firestop Systems as specified in Section 23 00 10 under Sleeves and Inserts. Insulated piping passing through nonfireresistance rated floors shall be fireblocked as specified in Section 23 00 10 under Sleeves and Inserts. Insulated ducts passing through smoke partitions and fire rated assemblies where a fire damper is not required shall be insulated with calcium silicate for a length equal to twice the thickness of the wall with all voids between the sleeve and duct insulation tightly packed with mineral-wool insulation or U.L. approved packing with sealant. All penetrations through equipment room walls and other areas of noise or heat generation shall be tightly sealed with mineral fiber rope. Finish insulation neatly at hangers, supports and other protrusions.

B. Piping:

1. General:

a. All pipe insulation (except refrigerant piping) shall be secured with outward clinching stainless steel staples and sealer.

b. Fittings and valves shall be insulated and jacketed with the same material as the adjacent piping or it may be finished with a smooth coat of approved insulating cement and jacketed with an approved recovering cloth and vapor sealed. Where PVC fitting covers are used, insulation shall be wrapped tightly using sufficient quantities to prevent deformation of covers.

c. Mitering of straight pipe insulation to form elbows will not be acceptable or allowed.

d. All jacket joints and seams shall be lapped not less than 2”.

e. Insulation exposed to weather (and insulation exposed to abuse in finished spaces) shall be covered with minimum 0.016 aluminum jacket with all joints sealed weather-tight.

f. Insulation at pipe hangers for chilled water shall be CoolDry insulated saddles by Buckaroos, Inc or equal. Insulation at pipe hangers for hot water shall be calcium

silicate as manufactured by Pipe Shields, Inc., Bergen-Power Pipe Supports, Inc., Rilco Mfg. Co., Inc. or Valued Engineered Products, Inc. Installation shall be preformed sections 12" long enclosing pipe around entire circumference. Pipe hangers shall be oversized to enclose pipe and insulation. Provide sheet metal saddle between hanger and insulated pipe.

g. Elastomeric and other foam insulations shall be installed without stretching or compressing individual lengths.

2. Cold Piping:

a. Insulation shall be terminated one inch each side of unions and flanges. Larger size removable sections of insulation shall be secured over the flange or union and lapped over the pipe insulation not less than 3" each side of pipe insulation termination point.

b. All joints, voids and punctures in jacket and all exposed edges of insulation material shall be vapor sealed.

3. Hot Piping:

a. Insulation shall be terminated neatly at unions, flanges, and valves. All exposed edges of insulation materials shall be sealed.

b. Where heating coils are located downstream from cooling coils and at variable air volume units, piping shall be insulated continuously up to the coil. Insulation shall be vapor sealed and installed as specified for cold piping for a distance of 5 feet from the coil.

4. Refrigerant Piping: Cover all valves and fittings with equivalent thickness of insulating material. All edges shall be tightly butted. Seal all joints vapor tight.

C. Ductwork:

1. External:

a. Rigid duct insulation shall be secured to rectangular ducts with mechanical fasteners such as metal stick clips or cupped head weld pins located a maximum of 3" from each edge and spaced a maximum of 12" on center each way. All insulation joints shall be tightly butted. All joints, voids and punctures in facing shall be sealed vapor tight with pressure sensitive foil tape or mastic.

b. Flexible duct insulation shall be provided with a minimum 2" facing flap overlapping adjacent and connecting insulation. Seams shall be stapled approximately 6" on center with ½" outward clinching staples. Where rectangular ducts are 24" in width or greater, insulation shall be secured to the bottom of the duct with mechanical fasteners to prevent sagging. All insulation joints shall be tightly butted. All joints, voids and punctures in facing shall be sealed vapor tight with mastic.

2. Internal: The lining shall be applied to cut-to-size pieces fastened to the entire interior of the duct with mastic, stick clips and speed washers. Edges and joints shall be coated with fire resistant mastic. External duct insulation is not required on ducts with internal lining unless noted otherwise. (External duct insulation shall be provided on all ducts with, or without internal lining in unheated attic spaces and where exposed to outside conditions.)

3. Ductwork exposed to outside conditions shall be insulated as specified herein and covered with minimum .025 inch thick aluminum jacket with seams lapped a minimum 3", sealed with silicon caulk. Covers shall be neatly finished and completely watertight.

4. Where duct mounted heating coils are located downstream from cooling coils and at variable air volume terminal units the coil shall be provided with vapor-sealed external duct insulation on sides, top and bottom.

5. Where ductwork is indicated to have internal acoustic lining, sheet metal drops to diffuser and register necks shall be unlined and shall be externally insulated.

6. See Section 23 30 00 for insulation on kitchen exhaust ducts.

D. Hot Equipment: Apply insulation with edges tightly butted, joints staggered and secured in place by steel bands not over 12" on center. Provide sufficient clearance around openings for normal operation of equipment. Finish with two 1/2" thick coats of insulating cement over chicken wire. Second coat shall be mixed 2 to 1 by weight with Portland cement and troweled smooth.

E. Cold Equipment: Insulation shall be secured in place with 16 gauge annealed tie wire, finish with 1/2" thick coat of insulating cement and vapor barrier mastic applied over entire body.

F. Chilled Water Pumps: Install 18 gauge sheetmetal enclosure with all seams and joints soldered watertight and lined with 2-inch thick rigid fiberglass insulation board. Enclosure shall be fabricated and installed to facilitate removal for servicing pump and components.

G. Damaged Insulation: All existing thermal coverings that are removed or damaged during construction shall be replaced or repaired to not less than original condition. Repaired sections shall provide equal or better thermal performance and vapor protection.

H. Patching: Where existing control, monitoring or other penetrating devices are removed from ductwork or piping, the insulation shall be patched to match thickness, type and finish of existing insulation.

I. Where existing insulation has been removed under the scope of asbestos removal, insulation shall be replaced as indicated for new work. Refer to the drawings for the extent of the existing piping to be reinsulated.

3.03 INSULATION THICKNESS SCHEDULE

A. Piping:

	Insulation

Type	Size, Inches	Thickness, Inches
Chilled water	1” and Under	1
	1-1/2”	1-1/2
	2” and Over	2
Condenser Water (Exposed to Outside)	All	1-1/2
Heating Water	1-1/4” and Under	1-1/2
	1-1/2” and Over	2
	*Runouts 1” and Under	1
Refrigerant Suction	All	1
Heat Pump Refrigerant Liquid	All	1
Waste Lines Carrying Condensate from A/C Units, Ice Makers, etc.	All	1/2

*Runouts to individual terminal units less than 4 feet in length (between the control valve and coil for HVAC piping).

B. Ductwork:

Type	Insulation Thickness Inches, External
Outside Air Intake and Untempered Supply	2
Supply (Heating and Cooling)	1-1/2
Return (Equip. Room Only)	1-1/2
Plenums	1-1/2
Exhaust (Between MOD & Louver)	2
Supply & Return Exposed to Outside Air Conditions	2

C. Hot Equipment:

Type	Insulation Thickness, Inches
Expansion Tanks	1
Air Separator	1

D. Cold Equipment:

Type	Insulation Thickness, Inches
Chilled Water Pumps	2
Compression Tanks	1
Air Separator	1

END OF SECTION

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SECTION 23 09 00

INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.01 SUMMARY

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

B. Work Included:

1. Complete System of Automatic Controls

2. Electric Appurtenances

3. Direct Digital Controls (DDC)

C. Related Sections:

1. Division 01 -- Commissioning

2. Section 23 00 10 – HVAC General Requirements

3. Section 23 05 00 – Common Work Results for HVAC

4. Section 23 05 53 – Identification for HVAC Piping and Equipment

5. Section 23 05 93 – Testing, Adjusting, and Balancing for HVAC

6. Section 23 09 93 – Sequence of Operations for HVAC Controls

7. Section 23 20 00 – HVAC Piping and Pumps

8. Section 23 30 00 – HVAC Air Distribution

9. Section 23 50 00 – Central Heating Equipment

10. Section 23 60 00 – Central Cooling Equipment

11. Section 23 70 00 – Central HVAC Equipment

12. Section 23 80 00 – Decentralized HVAC Equipment

13. Division 26 - Electrical

1.02 SUBMITTALS:

A. Submit shop drawings and product data in accordance with Division 1 and Section 23 00 10.

B. Provide complete shop drawings, catalog data sheets and such other data necessary to fully describe and substantiate compliance with these specifications for all control items and systems included in this section.

C. Shop drawings shall indicate the exact location(s) of the outdoor temperature sensor(s).

D. Operation and maintenance data shall be submitted in accordance with Division 1, for all items of equipment and materials indicated in this Section.

E. Application Software Documentation: Contractor shall provide a blueprint documentation of the software application program for each stand-alone digital controller. Documentation shall include block software flowchart showing the interconnection between each of the control algorithms and sequences. A program listing shall be printed on the same blueprint, along with the program flowchart, and description of the sequence of operation. This blueprint shall be stored and maintained in each stand-alone digital controller. System acceptance shall not be completed until this documentation is provided and located in each panel.

1.03 QUALITY ASSURANCE:

A. When all temperature controls have been installed, the temperature control contractor shall completely commission the system to verify that all systems and components are operating in accordance with the specifications. Where corrections or adjustments to the controlled equipment are required, the temperature control contractor shall document such changes to the Contractor, and recheck the control system once the changes have been made.

1. All equipment and subsystems shall be operated through all specified modes of control and sequences of operation, including full load and part load conditions.

2. All physical valve and damper positions shall be visually verified to correspond with the positions indicated by the controls software.

3. All instrumentation shall be properly calibrated.

B. Final point-to-point check-out and commissioning of the Temperature Control System shall be by the temperature control manufacturer or its exclusive authorized representative.

C. At the completion of this project, the Contractor shall submit a letter to the Engineer stating that all controls have been installed as specified, that each system has been calibrated and that each system is operating in a safe and efficient manner. Included with the letter, the Contractor shall provide a printout of all status control and monitoring points for a 48-hour period at 4-hour intervals, one printout of each type report available, and a copy of the completed start-up checklist used by the technician during system verification.

1.04 SCOPE OF WORK:

A. Furnish and install complete direct digital temperature control systems (DDC). The direct digital control system shall be comprised of a network of various independent, stand-alone digital controllers, together with Centralized Control Stations, and Centralized Host Stations as specified to provide centralized access and facility wide control functions. The stand-alone digital controllers shall be interconnected in a communicating network to provide facility wide access and sharing of information. A Local Area Network (LAN) shall be provided to interconnect the stand-alone digital controllers for high-speed data transmission within each building.

1. The Temperature Controls Subcontractor shall provide technical support for the Testing and Balancing Subcontractor. The technicians shall be fully qualified in all aspects of the system and shall have extensive knowledge of the project. Support shall include, but not be limited to the following:

2. Assistance in determining hydronic and air systems pressure setpoints.

3. Assistance in determining proper automatic damper positions for all air handling units, air conditioning units, and VAV units.

4. Simulating conditions as necessary for proper and optimized testing and balancing of the air and hydronic systems.

B. Programming shall be provided in accordance with commonly accepted industry standards and practices to ensure proper and efficient control of all equipment and systems. Where ASDC's with factory programming are not capable of operating systems in the sequence described herein, the Contractor shall provide a digital controller with custom programming.

C. Programming shall be provided to accomplish the sequence of operations as described in Section 23 09 93. Changes to the operational sequences shall be made only with written approval from the Engineer.

1.05 COMMISSIONING OF HVAC SYSTEMS:

A. Refer to Division 1 for work of Commissioning Agent and coordination with work of Division 23.

B. Notify Commissioning Agent a minimum of two weeks in advance of controls work for the following procedures:

1. Point-to-point wiring check-out,

2. Owner verification of controls graphics, setpoints, and alarms,

3. System start-up and check-out,

4. Initial system tuning,

5. Owner training.

1.06 SPARE PARTS:

A. Provide spare controllers of the following types and quantities:

1. Air Handlers – one (1) of each type controller

2. VAV Controllers – two (2)

3. Fan Powered VAV Controllers – two (2)

4. Damper Actuators – one (1) of each size/type

5. Valve Actuators – one (1) of each size/type)

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

A. Component parts of this system shall be manufactured by Trane, no substitute.

B. Installation shall be by qualified employees or authorized representative of the temperature control manufacturer. Temperature control work by independent contractors performing work without direct supervision from the authorized representative will not be accepted. The existing head end and building architecture shall be upgraded to support the new scope of work.

2.02 SYSTEM REQUIREMENTS:

A. The system shall be a complete system of automatic temperature regulation of the DDC type with electric and electronic accessories and components as indicated.

B. The software shall not require any licensing fees or annual fees. The host must be able to support a minimum of 50 simultaneous users with the ability to expand the system to accommodate an unlimited number of users.

C. All control items except thermostats, sensors and transmitters located in rooms shall be properly identified with engraved plastic nameplates permanently attached.

D. Room thermostat, sensor and transmitter locations shall be coordinated to align vertically or horizontally with adjacent light switches or control instruments. Room thermostats and sensors shall be mounted with bottom 5’-4” above the floor.

E. All components and materials shall be UL or ASTM rated for use in air plenums.

2.03 MATERIALS:

A. Sensors, Transmitters and Thermostats:

1. Temperature sensors for the Direct Digital Control (DDC) System shall be precision RTD's or thermistor. Accuracy shall be plus or minus 1 degree F over the entire control range. Sensors for pipe applications shall be immersion type, provided with pipe well. Sensors for duct application shall be of the averaging type, with a 5 foot or a 22 foot length element. Duct element length shall be adequate to serpentine across the entire duct area. Where sensors are located downstream of fans or at least 10 duct diameters downstream of coils, elbows, junctions, or dampers, single point sensors may be used. Outdoor temperature sensors shall be provided with sunshield of copper or painted aluminum on a northern exposure. Space temperature sensors shall be compatible with unit controller and shall be provided in a decorative metal or plastic enclosure. Sensors located in gymnasiums or multi-purpose rooms shall be provided with heavy-duty wire guards. Sensors located in public spaces such as corridors and public toilets shall be recessed type with flush mounted stainless steel blanking cover. Space sensors shall be provided with set-point adjustment and override switch/button.

2. Differential pressure transmitters for measuring duct system pressures, shall have an approximate range of no greater than two times the maximum operating pressures of the duct system.

3. Differential pressure sensors for measuring space static pressure relative to outside static pressure shall have a range of -0.1 to 0.1" w.c. and an accuracy of $\pm$1%. The low port shall be connected to an outside air static sensing probe, such as a Dwyer A-306, designed to mitigate the effects of wind. The high port shall be connected to a tube terminating through the ceiling into the occupied space.

4. Differential pressure transmitters for measuring hydronic system differential pressure shall be two-wire type with true differential pressure sensing, ceramic sensor technology, stainless steel housing, NEMA 4 rated, and shall have an approximate range of no greater than two times the maximum differential pressure of the piping system. Unit shall be equal to Kele DPW-692.

5. Humidity sensors shall provide a range of 0-100% relative humidity and an accuracy of plus or minus 2% RH from 0 to 93.8% RH at 25 degrees Celsius. Accuracy shall be plus or minus 1% RH within 10% RH of the user setpoint. Operating temperatures shall be from -40 degrees Fahrenheit to +176 degrees Fahrenheit. The unit shall not be damaged when exposed to 100% relative humidity.

6. High temperature thermostat for detection of excessive temperature in the duct shall be U.L. listed, manual reset type with an adjustable temperature setting. Set at 136°F.

7. Low temperature thermostat for detection of low temperature in the duct shall be manual reset type with 20' temperature sensitive element, located downstream from the coil. If any portion of the element senses a temperature below its setting, the contacts shall break. Set

at 35°F. Units shall be double pole for connection to the fan starter circuit and for monitoring by the DDC.

8. Electric thermostats shall be line voltage type complete with auto-off switch. The thermostat shall be rated for 6 amps at 120 volts.

9. Surface-mounted aquastats shall have adjustable set point and 10° differential. Contacts shall be rated 10 amps at 120 volts.

10. Flow switches for water shall be McDonnell Miller.

11. Carbon dioxide sensors shall be auto-calibration type with LCD display. Units shall utilize non-dispersive infrared (NDIR) and shall have a range of 0-2000 ppm CO2. Units shall have accuracy of ±3%. Operating range shall be 32°F to 122°F. Outputs shall be 0-10 VDC or 4-20 mA. Unit housings shall be suitable for installation in return air plenums (where applicable) and shall have a standard one (1) year element warranty with lifetime warranty on calibration.

12. Space mounted combination carbon dioxide/relative humidity/temperature sensors. Where the drawings indicate multiple space sensors at a single location, a combination sensor shall be used. The combination sensor shall provide the functions matching the sensor annotations on the drawings. Operating range shall be 32°F to 122°F. Outputs shall be 0-10 VDC or 4-20 mA. Unit shall be provided with a one (1) year warranty.

    a. Temperature accuracy shall be $\pm$ 1 degree. Sensors shall be provided with set-point adjustment and override switch/button.

    b. Carbon dioxide sensing (where indicated) shall be auto-calibration type with utilizing non-dispersive infrared (NDIR) with gold-plated optical chamber. Range shall be 0-2000 ppm CO2. Units shall have accuracy of ±3%. Field replaceable carbon dioxide element shall be provided with a lifetime warranty on calibration.

    c. Humidity sensors (where indicated) shall provide a range of 10-90% relative humidity and an accuracy of plus or minus 2% RH with an operating range of 0 to 100% RH at 25 degrees Celsius. Field replaceable relative humidity element shall be provided with a one (1) year warranty

13. Current relays shall be Hawkeye 700 Series or approved equal. Units shall be self-induced powered, solid state electronic with status and power LED's and binary output. Units shall be automatically self adjusting to detect loss-of-load and under current conditions (broken belt, etc.) with a range of 3 to 135 amps. Units shall be suitable for use with variable frequency drives, automatically compensating for changes in frequency and voltage. Operating range shall be 5°F to 185°F. Units shall have a limited five (5) year warranty.

14. Airflow Measuring Stations shall be constructed of aluminum or stainless steel. Units shall be ASHRAE Traversing design with shrouded impact sensors, accuracy of ± 2% and repeatability of ± 0.25% at minimum airflow of 400 FPM and maximum airflow of 10,000

FPM. Units shall have 1/4 inch NPT pressure connections and shall be suitable for maximum 200°F airstream.

B. Valves shall be sized by the control manufacturer and shall have threaded connections except valves over 2" which shall have flanged connections. Valve packing shall be U-cup silicone or reinforced Teflon except where indicated. Maximum allowable pressure drop shall be 5 psi for water valves. All valves shall be equipped with positive positioners where indicated.

1. DDC valve actuators shall be electronic, low voltage modulating type, hydraulic or gear train, with spring return. Actuators shall be sized to provide smooth and positive operation and tight shutoff against full design system pressure. Valves for VAV boxes shall be drive-open, drive-closed type.

2. Valves for heating water service shall be normally open type. Valves for cooling water service shall be normally closed type. Valve bodies 2" and smaller shall be bronze or high grade red brass in sizes 1/2" through 2". Valve bodies 2-1/2" and larger shall be iron.

3. All modulating valves shall have a minimum rangeability of 25 to 1. Water valves shall be equal percentage type. All modulating valves 4" and below shall be globe type. Modulating valves larger than 4" shall be butterfly type. Modulating valves 2" and smaller may be ball type.

4. All valves shall have stainless steel stems with replaceable packing, stem, seats and disk, ball or plug.

5. The pressure characteristics of all valves shall be the same or better than the piping in which installed and shall be suitable for the design system pressures indicated. Valve bodies shall have minimum ratings of 125 psig water service unless noted otherwise.

6. Cooling tower diverting valve shall be Continental, Fisher, or accepted equal, water butterfly valve. Valves and electric actuator shall be factory mounted and linked on a cast iron "T" ready for installation in the condenser water line. Valve and actuator shall be provided suitable for installation outdoors.

C. Dampers and Damper Motors:

1. Control dampers shall be Ruskin Model CD36 low leakage type manufactured specifically to control the air flow in heating, ventilating and air conditioning systems. Frames shall be made of galvanized sheet steel, formed into channels and riveted. In addition to the rigid frame construction, corner brackets shall be used to maintain alignment of the damper. Blades shall consist of formed galvanized sheets, formed for extra strength to withstand high velocities and static pressures. Square or hex blade pins shall be furnished to assure non-slip pivoting of the blades when a damper is used as a single module or is interconnected with others. Motor operated dampers shall be Class 1A with maximum leakage rate of 4 cfm/ft2 at 1.0 inch water gauge when tested in accordance with AMCA 500D. Maximum blade width shall be 8".

2. Damper actuators shall be provided for all automatic dampers. Damper actuators controlled from the DDC shall be electronic (pneumatic) modulating type, low voltage, spring return and shall be of sufficient capacity to operate the connected damper. Outside air and relief air damper actuators shall be spring return normally closed. Line voltage motors shall be two-position type.

D. Transformers are required for low voltage control items. Control manufacturer shall provide transformers with adequate capacity to operate connected equipment.

E. Panels: Control cabinets shall be furnished for each a.c. unit, major equipment components and elsewhere as indicated. Control cabinets shall be fabricated of extruded aluminum or steel. The cabinets shall have a face panel for flush mounting gauges, switches, pilot lights, etc. and sub-panel for mounting controllers, relays, etc. Controls which require manual positioning or visual indication shall be flush mounted and identified with engraved nameplates on the face panel. Controls which are required to be accessible only for maintenance and calibration are to be mounted on the sub-panel in the cabinet. Each item shall be identified by engraved nameplates.

F. Miscellaneous relays, transformers, switches and other devices shall be provided as required for the sequence of control indicated. Relays shall be located adjacent to the controlled device such as motor or motor starter. Relays may be located within starters and equipment control panels where space is available and where approved by NEC. Relays outside of the controlled device shall be provided with NEMA enclosure suitable for location where installed.

G. Disconnect Switches shall be provided for each 120V power connection to Stand-Alone Digital Controllers, Application-Specific Digital Controllers and all other electronic devices provided under this Section.

H. Uninterruptible power supply (UPS) with power conditioning shall be provided for each Building Network Controller and Stand-Alone Digital Controller. UPS power shall be capable of providing a minimum of 15 minutes backup power.

I. Direct Digital Control System:

1. Building Network Controllers:

a. Central Building Controllers shall be provided as required by the system architecture for network communication with, and supervision over the control system. The controller shall provide for custom programming, global management, and overriding control of the all components of the control system via a LAN or communications link. Controller shall provide seamless communication with all Stand-Alone Digital Controllers, Application Specific Digital Controllers, unitary controllers, and third party controllers where indicated. Controllers shall be provided with Ethernet card capable of 10/100/1000 megabits for connection to Owner's LAN/WAN.

2. Stand-Alone Digital Controllers:

a. Stand-Alone Digital Controllers shall be programmable controllers capable of custom programming provided for air handling units, heating water systems, chilled water systems, and other similar equipment/systems.

b. Stand-Alone Digital Controllers shall be 16-bit microcomputer based, providing a multi-tasking operating system for control functions simultaneous with all other facility management, operator interface, and system communications functions. Stand-alone digital controllers shall provide true floating point arithmetic calculations, to accommodate accumulation of large totalized valves, and shall support calculation and accumulation of values up to 10 to the thirty-eighth power. Controllers connected to the local area network shall provide communications to all connected stand-alone digital controllers. Controllers shall be tested and certified to operate in ambient temperature of -40°F to + 140°F. Stand-alone digital controllers shall provide interface for portable operator access to password controlled access to all levels of operational capability, from simple information access, to full programmability of all functions.

c. Stand-Alone Digital Controllers shall be provided with operator display and touch pad to allow for viewing of system operation and modification of operating setpoints.

d. All programming defining the functions to be performed by the stand-alone digital controller, including but not limited to application programs and point database, shall be protected from loss due to power failure for a minimum of thirty days. Systems providing non-volatile memory for these functions are preferred. Systems not providing non-volatile memory shall provide battery backup sufficient to provide protection for the specified period.

e. Each Stand-Alone Digital Controller shall be provided with a minimum of 8 spare inputs and outputs. These spare points shall be allocated as follows: 2 spare binary outputs, 2 spare binary inputs, 2 spare analog outputs, and 2 spare analog inputs.

f. Stand-Alone Digital Controller operating system software shall be multi-tasking. Multi-tasking capability shall be provided to simultaneously perform at least, but not limited to, the following functions:

1) Downloading of application program changes to the stand-alone digital controller without affecting the simultaneous operation of existing operating application programming.

2) Printing of scheduled or on-demand reports without pre-empting operator functions.

3. Application Specific Digital Controllers:

a. Application Specific Digital Controllers (ASDC) with factory programming and no time clock may be provided for equipment such as VAV units, fan coil units, unit heaters, exhaust fans, small unitary equipment, etc. provided they are capable of controlling the equipment in accordance with the Drawings and the specified sequence of operations. ASDC's shall be capable of receiving program changes and time functions via the LAN

or communications link. ASDC's shall be capable of making monitored point available to the DDC.

b. DDC control, monitoring and alarm functions may be extended to remote equipment by the use of ASDC's. Use of ASDC's shall be transparent to the central DDC without effect on DDC functions or color graphic displays.

c. Each ASDC shall be microprocessor based DDC and shall perform all sequences as indicated and shall communicate with all other DDC controllers via the LAN or communications link. Each ASDC shall also be capable of stand-alone operation and as directed by the central DDC system.

d. Each ASDC shall provide for portable operator interface either through connection to the space sensor or connection directly to the ASDC.

e. Programmable ASDC's shall be provided with 72 hour battery back-up or non-volatile EEPROM memory and self-contained clock. The clock shall be capable of time synchronization from the DDC.

4. Unitary Control Interfaces:

a. Where unitary controls of packaged equipment are capable of communicating with the specified control system, they may be integrated into the network in lieu of Stand-Alone Digital Controllers. All specified functions and monitoring points shall be provided as specified in the Drawings and/or sequence of operations. Where required control and monitoring points are not provided as part of the unitary controls, DDC control and monitoring shall be provided.

5. Portable Operator Interface (Laptop or Notebook Computer): Provide one portable operator interface for the Owner's use in on-site analysis and control of stand-alone units and network. Unit shall operate on batteries as well as AC line voltage, and shall provide minimum 14-inch WLED display with 1366 x 768 resolution. Unit shall be provided with the latest version of Windows 7 Professional™ operating system, Intel Core iX or AMD processor at 2.2 GHZ or higher, 16X DVD+/-RW optical drive, minimum 320 GB hard drive, 2 GB of DDR3 memory, Ethernet card capable of 10/100/1000 megabits, and an 802.11 b/g/n compatible wireless LAN card. Unit shall provide a full size typewriter-style keyboard, with a minimum of eight programmable function keys and thumb pad. Unit shall be provided with a data communications cable for direct connection to the stand-alone control unit or network. Interface ports shall support RJ-11, RJ-45, RS-232, RS-485, or all types as required to interface with specified controllers.

6. Centralized Host Stations:

a. The digital control system shall have capacity to support a Centralized Host Station. Centralized Host Stations shall, in conjunction with the network of stand-alone digital controllers, and additional computers or components, provide the performance requirements within this specification. The centralized host station shall include all hardware and software components to serve as a centralized facility operator station

providing color graphics, facility wide access and coordination of global control strategies, and centralized documentation. The centralized host station is existing.

7. Web Browser Access Interface/Controller: Provide a Web Browser Access Interface/Controller to allow real time access to the DDC system from a remote location via the Internet. Device shall be capable of supporting Internet Explorer and Netscape Navigator web browsers and provided with a minimum of two Ethernet (RJ-45) ports for connection to the Owner's LAN/WAN and the dedicated DDC network. Secure Sockets Layer (SSL) security protocol shall be provided with a minimum of two levels of security. Privileges allowed at each level of security shall be adjustable and programmed by the Temperature Controls Subcontractor as defined by the Owner. The following functions shall be available through the web browser:

   a. View operation of all systems controlled by the DDC.

   b. Modify system setpoints and schedules.

   c. View and acknowledge alarms.

   d. Define, save, plot, and print trend data.

J. Centralized Host Station Performance Requirements:

1. Color Graphic Operator Interface: The color graphic terminal shall be driven by software allowing the operator to access any system information via a "system penetration" method. "System penetration" shall allow the operator to begin at an entire site plan color graphic display and progressively select portions of the site plan to be chosen for closer inspection or selection of a more detailed color graphic display of a desired portion of the facility. The operator shall be able in this manner to "penetrate" to any desired system information without being required to enter any commands via the keyboard.

2. Dynamic Color Graphic Displays: Color graphic floor plan displays and system schematics for each piece of mechanical equipment including air handling units, chilled water systems, hot water systems and similar shall be provided to optimize system performance analysis and speed alarm recognition. All mark numbers for equipment, controller and sensor designations shall exactly match those indicated on the Contract Drawings unless otherwise directed by the Owner. All software and hardware upgrades shall be provided as required to integrate color graphics of this Contract with the Owner's existing color graphics. All Campus, Building and Floor Plan graphic conceptuals shall be approved by the Owner prior to creation of screen graphics. Names and numbers for rooms, wings, and buildings shall be in accordance with the Owner's final numbering systems. Color graphic display shall include, but not be limited to:

   a. The real-time value dynamic display of any connected point in the network of stand-alone digital controllers.

   b. The alarm status condition of any desired system alarm point.

c. Any software parameter such as setpoints for control sequences, minimum position adjustments, or throttling ranges.

d. All systems having air-side economizer shall display calculated or measured return air and outside air enthalpies.

3. Appearance of color graphics shall follow the below-listed order of penetration progression:

a. Entire color floor plan of the building on one screen without scrolling, and showing all equipment rooms with tags of all equipment located therein, and locations of all major system space sensors.

b. Large scale color floor plan view of each equipment room showing actual locations of controlled or monitored equipment.

c. Each item of equipment with dynamic color graphic system schematic display.

d. Each system schematic display shall be "linked" to the previous graphic, and to the system parameters of each monitored and controlled point.

e. All screen graphics for systems with economizers shall show calculated values of enthalpy for outdoor air and return air.

f. All graphics shall have user definable background, line and text colors for all screens.

4. Centralized Scheduling and Modification: The color graphic terminal shall support operator access to the global scheduling screens which allow the operator to review and modify any or all controlled schedules as desired. The centralized scheduling function shall allow modification of equipment and lighting operating schedules, modification of facility holiday schedules, and when desired allow assignment of temporary schedules for designated portions of the facility or specific equipment.

5. Global Electrical Demand Limiting Control shall have the capability to allow the operator to review and modify the parameters affecting global demand control strategies. Demand control shall utilize sliding window control algorithm with provision for multiple load shed facility wide as appropriate to owner's requirements. Time of day demand limits shall be assignable to appropriate billing period time slots.

6. Energy Management Reporting shall have the capability to provide daily, weekly, monthly, and/or yearly formatted reports of facility, metered electrical consumption. Reports shall provide detail information for hourly KWH consumption, daily peak hour of consumption, daily time of peak demand, demand setpoint in use at time of peak, daily degree days, and outside air temperature and relative humidity at time of peak. Reports shall be created to provide individual reporting as desired by the owner for multiple facility meters, multiple sites, or aggregate facility metering combining multiple meters. The centralized host station shall retain daily summary energy data for up to five years. Reports can be designated as automatically printed, or called-up for report printout demand. The centralized host station shall support auto dial polling for remote sites for individual energy

reporting and histories of multiple sites and have sufficient capacity to accommodate auto polling and report accumulation of a minimum of 100 sites. Reporting parameters, formatting, and frequency shall be in accordance with the Owners preferences.

7. Optimum Start Control programs shall be self-learning and shall adapt the algorithm parameters to the optimum values for each applied zone. Optimum start/stop shall provide separate control outputs for heating, cooling, fan and ventilation control sub-systems to maximize energy efficiency. The Centralized Host Station shall provide operator access to all optimum start parameters for designated items, equipment, or scheduled systems. Trend Reports: The Centralized Host System shall support logging and historical accumulation of trended data from the entire facility, or multiple sites with capacity for acquiring trend data from a minimum of 100 sites. The system shall be capable of utilizing dedicated logging printers and provide the capacity to document printed trend data accumulated from any or all of the stand-alone digital controllers in connected on-site network, or from any number of remote sites which connect to the centralized host system dedicated logging printer via dial-up modem or Ethernet connection. The centralized host system shall provide capacity to store to disk a directory of at least 150 trend logs. Such trend logs can be accessed from the directory by the operator at any time for analysis of selected sets of the trended data, display onto the screen, or hard copy documentation.

8. Third Party Software Packages: The Centralized Host System shall provide the capacity to run specific third party software packages for word processing, spreadsheets, or database management programs.

9. Database Archiving: The Centralized Host System shall provide capability to up-load or download global control functions and programs being performed by the network of stand-alone digital controllers, and the individual database and application programming resident in each controller in the facility, or on remote sites. The up-load programs shall be retained on the centralized host system's hard disk for system backup. Programs may be modified using editor functions, and downloaded to individual units as desired.

10. Database Maintenance Reports: The centralized host system shall provide a daily report of all modifications made to any software function in the system. Report shall include the specific setpoints, schedules, sequence parameters, or limits that were modified and the time and location of the modification, and the identification of the operator making the modification.

11. Override Report: The centralized host system shall provide a daily report of all overrides issued, and/or in force on the system. Override reports shall allow tracking of operator functions and maintenance of desired operational conditions.

12. System Maintenance Report: The centralized host system shall provide a report of maintenance items on an automatic printout basis. Maintenance events shall be settable by the user based on event, elapsed run time, number of cycles or calendar day/date.

13. All operator access shall have multiple-level password protection. All setpoints for safeties shall be protected by the highest level password.

14. All help files imbedded in the software as well as all auxiliary software necessary for full access and to allow programming and other functions shall be provided and made accessible to the operator.

K. Control Panels shall be a fully electronic analog control or digital control system, providing all control functions for the equipment specified to be controlled from that panel. Each control panel shall serve one or more equipment systems. Multiple control panels serving a single piece of equipment are prohibited. Each control point shall serve a single, distinct input or output. Control functions to be performed by control panels are as described hereinafter in the sequences of operation and on the drawings. Each panel shall service one or more equipment systems.

L. All signals between the DDC control panel and the monitored or controlled devices shall be low voltage (less than 100 volts).

M. Sensing of temperature, humidity, differential pressure, and all other inputs shall be industry standard signals by one of the following types:

1. 0-20 mA

2. 4-20 mA

3. 0-5 VDC

4. 0-12 VDC

5. Resistance Signals

All inputs shall be compatible with the controllers used, and with the requirements for readout of variables.

N. On/Off Outputs: The control panel shall internally provide test points for the circuit driving the equipment contactor, for troubleshooting the low voltage circuit to the contactor. All relays or digital output modules shall provide a pilot light or LED display of this same status.

O. Modulating Outputs shall be industry standard 0-5 VDC, 0-12 VDC or Milliamp outputs of 0-20 mA or 4-20 mA, or drive open/drive closed type modulating outputs. Drive open/drive closed type controllers shall include sufficient components and control algorithms.

P. Standard Software Function Libraries: Complete libraries of control algorithms for DDC, Energy Management, and Facilities Management functions shall be resident for all stand-alone digital controllers and shall be drawn from for the creation of the application programming.

Q. Energy Management Control: The network of stand-alone controllers shall individually perform Time of Day Scheduling, Optimum Start/Stop, Enthalpy Optimization, and all Control Optimization strategies, such as Supply Air Reset, and Soft Start Ramp-up, for their connected systems of equipment. Coordination of strategies involving multiple systems of equipment shall be performed by sharing of necessary data between the stand-alone controllers on the communicating network.

R. Electric Demand Limiting Control: The stand-alone controllers shall have the capability to communicate and provide coordination for global electric demand limiting control. Demand limiting algorithm shall be resident within a selected stand-alone digital controller and shall issue load shed commands to the network for control of specific items of equipment. Demand limiting shall be sliding window demand control with a minimum of three user definable time of day demand limit setpoints. Multiple load shed tables shall be definable, and be shed for rotational or sequential restoration as appropriate for the loads within each designated shed table. The stand-alone digital controller to which electrical consumption meters may be installed shall provide for daily, and monthly formatted reports of metered electrical consumption. Reports shall be individually named and identified with a title line definable for each report, and shall provide information as detailed as hourly KWH consumption, daily peak hour of consumption, daily time of peak demand, demand setpoint in use at time of peak, daily degree days, and outside air temperature and relative humidity at time of peak. Reports shall be created to provide individual reporting as desired by the Owner for multiple facility meters, multiple sites, or aggregate facility metering combining multiple meters. System shall have capability to designate reports for automatic print, or call-up for report printout on demand, as well as upload to selected centralized host system for historically archiving.

S. Alarm Occurrence Status: Alarm condition reports shall provide a printout listing the status of specific items associated with the equipment generating the alarm. Report shall be routed to a specific printer or combination of printers at the Centralized Host Station or the on-site programming unit. Report shall record time and status information and allow operational personnel to use this information to diagnose the alarm situation.

T. Telecommunications Support: Each building network shall be provided with the necessary equipment, programming, and connections to communicate with remote host computers through one auto dial/auto answer modem and through an Ethernet connection to the Owner's LAN/WAN.

U. Remote Access and Notification: The system shall be installed such that access to the entire facility can be accomplished through both the modem and the Owner's LAN/WAN. The modem and Ethernet connection shall each be capable of providing the following functions:

1. Access to the entire facility control system by the Contractor to provide service and diagnostic support.

2. Access by the Owner from off-site for similar purposes, and for remote operation, monitoring, and adjustment of facility functions.

3. Notification of desired exceptions and alarms to multiple remote sites scheduled as necessary for business hours, or off-hours reporting.

V. Off Hours Exception Reporting shall provide the Owner a means of specifying up to two remote sites for which off hours exceptions shall be reported. Selection of the site to be connected shall be programmed by the Temperature Controls Subcontractor as directed by the Owner, and set to change automatically per time of day and day of week.

W. Generally, the stand-alone digital controller and control panel shall be located on or near the unit, which they control as indicated on the Drawings.

X. Lightning arrestors shall be provided on all wiring, which exists or enters the building. Arrestors shall be located adjacent to the protected equipment.

Y. As a part of this contract the Temperature Control Subcontractor shall provide forty (twenty four) (sixteen) (eight) hours of classroom instruction in operation, programming and maintenance of the system to owners operating and maintenance personnel. Instructors shall be fully qualified in all aspects of the system. Training shall be scheduled as required by the owner and shall take place at an owner-designated location. Training shall be video recorded and provided to the Owner in DVD format.

PART 3 - EXECUTION

3.01 WORK BY OTHERS:

A. All line voltage wiring (101 volts or more) shall be furnished and installed as a part of Division 26.

B. All low voltage wiring (100 volts or below) shall be furnished and installed as an integral part of this section of the specification in strict accordance with Division 26. (Refer to Division 26 for special requirements of separation between Control and Instrumentation wiring from Communications/Data Cabling.)

C. All dampers, valves, immersion wells and pipe pressure tappings will be installed by the Mechanical Contractor.

D. All relays, firestats, sensors, annunciators, alarms, or other electrical devices not indicated to be installed by Division 26, shall be installed under Division 23. Coordinate with Division 26 for locations as necessary.

3.02 GENERAL SEQUENCE REQUIREMENTS:

A. Refer to Section 23 09 93 for Sequence of Operation for HVAC Controls.

3.03 INTERFACE WITH PACKAGED UNITARY EQUIPMENT CONTROLLERS:

A. Where packaged equipment is indicated elsewhere within the Contract Documents to provide unitary control with BACNET or similar interface, the DDC shall communicate with and monitor the packaged controllers. Coordinate with available equipment protocols, BACNET MS/TP (or BACNET IP if approved by Owner). At a minimum, the DDC system shall:

1. Provide signals to the packaged controllers for occupancy and all setpoints necessary. Setpoints adjustment shall be available through the graphics interface. Occupancy scheduling shall be as indicated for equipment with DDC control.

2. Monitor all unit alarms and provide an alarm within the BAS of any alarm conditions within the unit. Alarm indications shall be specific to the type alarm occurring with the unit.

3. Monitor all points indicated within this section, all points indicated within the respective equipment specifications and all points shown on the controls schematic Drawings. Additional points shall include monitoring of actual unit percent capacity or stages of capacity where available. Where any control or data point is not provided within the equipment controls, the DDC shall provide the necessary input/output, sensor, etc. necessary for control or monitoring of that point.

4. Provide graphics displays for all packaged equipment to include: all points indicated within this section, all points indicated within the respective packaged equipment specifications, and all points shown on the controls schematic Drawings. The main graphics display for the respective unit shall include all points shown on the controls schematic Drawings. Any data available in excess of that indicated above shall be available outside the main graphics screen.

3.04 SYSTEM MONITORING AND ALARM

A. The DDC shall provide an alarm for the following points as applicable to each unit, system, or piece of equipment. Where points occur in more than one unit or system, an alarm shall be provided for each system in which it occurs. The alarm indication shall be specific as to the parameter that has either exceeded or fallen below limits or provides indication that the system is not operating as commanded. The alarm indication shall identify the system in which the alarm occurs. Limits for alarm indication shall be coordinated with the Owner's representative and shall not be so tight as to cause nuisance alarms.

1. Economizer Fault Detection and Diagnostic (FDD) alarms

2. High/low discharge air temperature for all VAV units

3. Return air humidity

4. Discharge static pressure for all VAV units (exceeds high limit)

5. Differential static pressure across filters

6. Minimum outside airflow on VAV units (below setpoint)

7. High return or space CO2

8. VFD alarm indication

9. Current relays

10. High/low space temperature

11. Duct smoke detectors

12. Differential pressure across fans or pumps

13. Chilled water system supply water temperature

14. Chiller supply water temperatures

15. Chiller alarms

16. Condenser water supply temperature

17. Low condenser water basin temperature

18. Boiler alarm(s)

19. Heating water system supply temperature

20. VAV box low airflow condition

21. Activation of freeze protection

22. Float switch alarms

23. Activation of generator

24. Kitchen refrigerator temperature alarm

25. Kitchen freezer temperature alarm

3.05 INSTALLATION

A. The location of all control items on the exterior of the building shall be approved by the Architect prior to installation.

B. Where the condition occurs, provide insulated sub bases for all space temperature sensors located on exterior walls.

C. All sensors located in equipment, ductwork and piping shall be installed with appropriate fittings such that devices are securely attached to coils, duct, pipe, or similar and are not free to move, rotate, or become dislodged. The use of adhesives for attachment is not permitted.

3.06 SERVICE AND GUARANTEE

A. The entire control system shall be serviced and maintained in first class condition by the control manufacturer for a period of one year after acceptance at no extra cost to the Owner.

END OF SECTION

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SECTION 23 09 93

SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 - GENERAL

1.01 SUMMARY

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

B. Work Included:

1. Sequence of Operations for HVAC Systems

C. Related Sections:

1. Division 01 -- Commissioning
2. Section 23 00 10 – HVAC General Requirements
3. Section 23 05 00 – Common Work Results for HVAC
4. Section 23 05 53 – Identification for HVAC Piping and Equipment
5. Section 23 05 93 – Testing, Adjusting, and Balancing for HVAC
6. Section 23 09 00 – Instrumentation and Control for HVAC
7. Section 23 20 00 – HVAC Piping and Pumps
8. Section 23 30 00 – HVAC Air Distribution
9. Section 23 50 00 – Central Heating Equipment
10. Section 23 60 00 – Central Cooling Equipment
11. Section 23 70 00 – Central HVAC Equipment
12. Section 23 80 00 – Decentralized HVAC Equipment

1.02 GENERAL REQUIREMENTS

A. Programming shall be provided in accordance with commonly accepted industry standards and practices to ensure proper and efficient control of all equipment and systems.

B. Control sequences shall be accomplished in accordance with control drawings and the sequences specified in this section and described on the drawings. It is the intent of this section to utilize sequences included in pre-programmed controllers when such sequences provide the intended operation. Where factory programming is incapable of providing the sequence specified in the Contract Documents, a custom controller with custom programming shall be provided.

1.03 SUBMITTALS

A. Refer to Section 23 09 00, Instrumentation and Control for HVAC.

1.04 WARRANTY

A. Refer to Section 23 09 00, Instrumentation and Control for HVAC.

1.05 COMMISSIONING OF HVAC SYSTEMS:

A. Refer to Section 23 09 00, Instrumentation and Control for HVAC.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.01 GENERAL SEQUENCE REQUIREMENTS:

A. Set points: All control setpoints shall be provided with appropriate deadbands where necessary to prevent the excessive cycling of equipment, valves, dampers, etc.

B. Failure of Digital Control System: The control system shall be installed to fail safe to the heating mode.

1. All air handling and air conditioning units shall fail on with outside air damper closed, heating valves open to the coil and the reset valve open to the boilers.

2. Night setback shall fail to day (occupied) mode.

3. Heating water system shall fail with boiler energized to boiler control and heating water pump on.

4. All interlocked exhaust fans shall be de-energized with the dampers closed.

C. Unoccupied Period Freeze Protection: When outdoor air temperature falls below 35°F during unoccupied periods, the following sequence shall occur.

1. Heating and chilled water pumps shall be energized (pumps should be energized whenever any space requires heat).

2. All air unit heating and cooling valves shall be fully open when the fan is off.

3. Preheat coil circulation pumps shall be energized.

4. All outdoor air dampers shall be closed and verified.

5. All exhaust fans shall be de-energized with dampers closed (should already be de-energized during unoccupied periods).

D. Occupied Period Freeze Protection: When temperature entering the cooling coil falls below 40°F (adjustable) during occupied periods, chilled water pumps shall be energized, and chilled water control valves shall be fully opened on all units (chiller shall remain de-energized except upon a call for cooling).

E. Unoccupied Periods: At times when the building is unoccupied, the DDC shall control all systems to maintain an adjustable night setting for both heating and cooling. Unless otherwise specified, all outside air dampers shall be closed and all exhaust fans shall be de-energized. Where fan powered VAV boxes are utilized, night heating shall be performed as required by the individual terminal units without energizing the associated air handling units. Terminal units such as cabinet unit heaters and fan coil units shall cycle the fans as necessary to maintain unoccupied setpoints. The DDC shall stagger the occupied/unoccupied schedules for all air handling units to prevent large fluctuations in heating or cooling demand. Activation of the manual override on a space temperature sensor, where applicable, shall result in the following: the space temperature setpoint shall be indexed to the occupied setpoint for that space and the system serving that space shall be indexed to the occupied mode. All other spaces shall be maintained at unoccupied temperature setpoints.

F. Morning Warm-up: All air systems shall bring space up to occupied temperature before opening outside air dampers as part of the optimal start sequence.

G. System Start-up: Following any type of system shutdown, the DDC shall stagger the starting of all electrical loads to reduce electric peak demand.

H. System Shut-down: At any time air systems are de-energized, the DDC shall disable all ancillary systems dependent upon air movement such as electric heaters, humidifiers and direct expansion cooling. Ancillary systems required for freeze protection (except electric coils) shall remain operational.

I. Direct Expansion (DX) Cooling: Where the Sequence of Operation calls for DDC control of refrigeration compressors, condensing units or packaged compressor-cooling, the DDC shall provide “minimum-on” and “minimum-off” times in accordance with the equipment manufacturer’s recommendations.

J. Duty/Standby and Lead/Lag Control: All equipment indicated to be operated as duty/standby or lead/lag shall be sequenced based on run time and alternated bi-monthly or as otherwise

required in accordance with the Owner's preferred schedule. Sequencing shall occur as scheduled without the need for shutdown, if necessary. Sequencing for individual equipment shall occur so as not to impact the operation of the entire system. The DDC shall automatically energize the standby or lag device in the event of a failure in the duty or lead equipment.

K. Smoke Detection Control: Upon activation of an air handling unit duct smoke detector, all fan powered VAV boxes associated with that unit shall be deenergized.

L. Refer to the Electric Sequence Controls Schematics on the drawings for automatic control of fans, ancillary heating equipment, and other similar items. The following hard-wired interlocks shall be provided in addition to any others indicated on the Electric Sequence Controls Schematics:

1. Activation of kitchen hood suppression system as sensed by the suppression system microswitch shall energize the kitchen hood exhaust fan and de-energize the kitchen hood make-up air unit (where applicable).

2. Emergency boiler shutoff shall de-energize all boilers upon activation of the emergency break glass switch provided under Division 26.

3. Activation of duct smoke detectors shall de-energize associated supply fans and return/relief fans (where applicable).

4. Where refrigerant machines are installed in the same room as fuel fired devices, the detection of a refrigerant leak, as sensed by the refrigerant monitor, shall prevent and terminate the firing of all fuel fired appliances.

5. Low air flow condition indicated by the air flow switch shall prevent the operation of electric heating coils.

6. Cooling coil condensate drain pans shall be provided with safety switches to de-energize the unit and alarm the DDC upon accumulation of water.

M. All screen graphics for systems with economizers shall show calculated values of enthalpy for outdoor air and return air.

3.02 EUQIPMENT SEQUENCE OF OPERATION:

A. Refer to Drawings.

END OF SECTION

SECTION 23 20 00

HVAC PIPING AND PUMPS

PART 1 - GENERAL

1.01 SUMMARY

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

B. Work Included:

1. Pipe and Pipe Fittings
2. Hydronic Pipe Specialties
3. Air Control Fittings
4. Miscellaneous Piping Specialties
5. Pumps
6. HVAC Water Treatment

C. Related Sections:

1. Division 01 -- Commissioning
2. Section 23 00 10 – HVAC General Requirements
3. Section 23 05 00 – Common Work Results for HVAC
4. Section 23 05 48 – Vibration and Seismic Controls for HVAC Equipment and Piping
5. Section 23 05 53 – Identification for HVAC Piping and Equipment
6. Section 23 05 93 – Testing, Adjusting, and Balancing for HVAC
7. Section 23 09 00 – Instrumentation and Control for HVAC
8. Section 23 50 00 – Central Heating Equipment
9. Section 23 60 00 – Central Cooling Equipment
10. Section 23 70 00 – Central HVAC Equipment
11. Section 23 80 00 – Decentralized HVAC Equipment

1.02 REFERENCES:

A. General: The following standards or codes form a part of this specification to the extent indicated by the reference thereto.

B. American Society for Testing and Materials (ASTM):

A53-88a Pipe, Steel, Black and Hot-dipped, Zinc-coated, Welded and Seamless

A106-88a Seamless Carbon Steel Pipe for High Temperature Service

A120-88a Pipe, Steel Black and Hot-dipped, Zinc-coated, Welded and Seamless for Ordinary Uses

A126-84 Gray Iron Castings for Valves, Flanges and Pipe Fittings

A254-88 Copper Brazed Steel Tubing

A420-88 Piping Fittings of Wrought Iron Carbon Steel and Alloy Steel for Low Temperature Service

A539-88 Electric-Resistance-Welded Coiled Steel Tubing for Gas and Fuel Oil Lines

B32-89 Solder Metal

B42-88 Seamless Copper Pipe, Standard Sizes

B75-86 Seamless Copper Tube

B88-95a Seamless Copper Water Tube

C. American Society of Mechanical Engineers (ASME):

ASME 95 Boiler and Pressure Vessel Code

B16.3 Malleable Iron Threaded Fittings

B16.4 Cast Iron Threaded Fittings

B31.9 Building Services Piping

D. International Ground Source Heat Pump Association (IGSHPA) Installation Manuals.

E. National Electrical Manufacturers Association (NEMA)

F. Underwriters Laboratories, Inc. (UL)

1.03 COMMISSIONING OF HVAC SYSTEMS:

A. The Contractor shall provide contact information to the Commissioning Agent indicated in Division 1 for all major items of Equipment.

B. Provide additional submittal copy of major equipment for Commissioning Agent specified in Division 1.

1.04 SUBMITTALS:

A. Submit shop drawings, product data and samples in accordance with Division 1 and Section 23 00 10.

B. Shop drawings, diagrams, catalog data and such other data necessary to fully describe and substantiate compliance with these specifications shall be submitted for all equipment and materials marked with notation set forth in Section 23 00 10.

C. Operation and maintenance data shall be submitted in accordance with Division 1, for all items of equipment and materials marked with notation set forth in Section 23 00 10.

PART 2 - PRODUCTS

2.01 PIPE AND FITTINGS:

A. Material Standards:

1. Steel pipe shall be manufactured in accordance with ASTM A53 and shall be so labeled.

2. Copper pipe shall be manufactured in accordance with ASTM B88 and shall be so labeled.

B. Heated and Chilled Water Lines: Pipe 4” and smaller shall be type L hard drawn copper tubing or standard weight schedule 40 black steel pipe over 4” shall be standard weight black steel. Fittings for steel pipe shall be standard weight, threaded, black, malleable in accordance with ASME B16.3 or cast iron in accordance with ASME B16.4 except fittings over 2” size may be welding type. Flanges shall be weld neck type. All fittings shall be suitable for 125 psi water service.

C. Condenser water pipe located above grade or inside the building shall be standard weight schedule 40 black steel. Joints shall be threaded or welded. Fittings shall be standard weight galvanized, cast or malleable iron, threaded type suitable for 125 psi service.

D. Cooling coil condensate drain lines shall be type L hard drawn copper tubing. Fittings shall match the piping.

E. Refrigerant piping shall be type “ACR” hard drawn copper tubing, factory cleaned, dehydrated and capped with wrought copper fittings. Provide all accessories including, but not limited to,

refrigerant duty ball type shutoff valves, solenoid valves, expansion valves, moisture indicating sight glass, replaceable core filter dryers, access ports with gasketed screw-on covers for charging and measuring subcooling, hot gas bypass valve (where indicated) and other accessories recommended by the refrigeration equipment manufacturer. Expansion valves shall be balanced port, externally equalized type. Provide heat exchangers for subcooling and suction line accumulator as recommended by the manufacturer. All components shall be selected and sized for the lowest pressure drop at the capacities indicated. Prior to offering the system for final acceptance, the Contractor shall submit a written certification from an authorized official of the equipment manufacturer stating the complete system, to include refrigerant piping, has been installed in accordance with the manufacturer's recommendations.

2.02 HYDRONIC PIPE SPECIALTIES:

A. Manual air vents on 3/4" piping shall be chromium plated brass 1/8" NPT coin operated type. Provide extension tube if required to maintain access to vent operator. Manual air vents on 1" and larger branch piping and hydronic mains shall be a minimum 1/2" ball valve with hose thread adaptors. Extend vent piping as necessary to locate valves in accessible locations. Air vents and vent piping shall be suitable for 150 psi working pressure.

B. Automatic air vents [S] shall be Hoffman No. 78, suitable for 150 psi service and shall provide venting operation under all conditions. Exhaust port from each shall be extended with a concealed 1/4" copper tubing to floor of equipment rooms, to a drain, or to 6" above grade at building exterior.

2.03 AIR CONTROL FITTNGS [S] [O/M]:

A. All air control fittings shall be provided by the same manufacturer and are based on Bell & Gossett models.

B. Air Separator [S]: Coalescing removal separator top air outlet and bottom drain with flanged connections and flanged removable head. The Air & Sediment Separator shall have an internal coalescing medium consisting of stainless steel tubes with 3/16" perforations and 51% open area. The coalescing medium shall be made of 304 Stainless Steel.

C. Pressurized Vertical Expansion Tanks [S] shall be pre-charged steel type with replaceable heavy duty butyl rubber bladder. The tank shall have a 1-1/2 in. NPT system connection, ¾ in. drain, and a .302-32 charging valve connection (standard tire valve) to facilitate the on-site charging of the tank to meet system requirements. The tank shall be constructed in accordance with Section VIII of the ASME Boiler and Pressure Vessel Code and stamped 125 PSIG working pressure. The tank shall be fitted with lifting rings and a floor mounting skirt for vertical installation.

2.04 MISCELLANEOUS PIPING SPECIALTIES:

A. Strainers shall be Y type with stainless steel basket suitable for 125 psi service. All strainers shall be provided with blowdown valves.

B. Dielectric fittings such as couplings or flanges shall be installed to isolate pipes of non-ferrous metal where connection is made to ferrous metal. Isolation shall be accomplished by use of a brass converter fitting of threaded brass or bronze couplings (not unions), or flanged joints with gaskets and bolt bushings. Materials shall withstand pressure and temperature as required. Valves of the same materials may also be used.

C. Drains shall be accessible and shall consist of 3/4" ball valves with hose thread adapters, cap and chain unless indicated otherwise.

D. Escutcheons shall be the split pattern chromium plated bronze or steel. Special height escutcheons shall be provided where extended sleeves are used. Escutcheons shall be sized to cover the entire opening.

E. Water seals (Trap) shall be provided on condensate drain from each air handling unit. Seal shall be of sufficient depth to prevent blowout or siphoning of water and shall be configured as indicated on the Drawings.

F. Pipe sleeves shall be installed as outlined in SECTION 23 00 10 HVAC GENERAL REQUIREMENTS.

2.05 PUMPS [S] [O/M]

A. General: Pumps shall operate at not over 1750 rpm and shall be suitable for pumping 210°F water. Pump shop drawings shall include pump curves with operating head, pumping quantity, and motor horsepower clearly marked. Pump impeller shall be no larger than 80% of the range between minimum impeller and maximum impeller size for the model selected. Pump motor and couplings shall be suitable for operation with variable frequency drive (VFD) where indicated. Pumps located outdoors shall be provided with TEFC motor.

B. Base Mounted Units shall be Bell & Gossett Series 1510 two bearing, end suction split case, enclosed impeller, non-overloading, centrifugal type. Casing and bearing housings shall be cast iron with grease fitting. Shaft seal shall be mechanical type. Impeller, impeller guide rings, and shaft sleeve shall be bronze or stainless steel. Shaft shall be steel, turned and ground. Pump and motor bearings shall be sleeve, roller or ball type. Pump shall be direct connected through a flexible coupling to a general-purpose type electric motor. Pump and motor shall be mounted on a common cast iron or steel base. Each pump shall be furnished complete with suction diffuser constructed of cast iron with steel inlet vanes, start-up strainer, normal service strainer, and adjustable support leg. Each pump shall be set firmly and bolted and grouted in place.

C. Line Mounted Units shall be Bell & Gossett complete with alloy steel shaft, bronze sleeve bearings, shaft seal, flexible shaft coupling, rubber mounted motor, closed impeller and each shall be serviceable without removing from the line.

2.06 HVAC WATER TREATMENT

A. Chemical feeder [S] shall consist of a one-shot feeder and a one year supply of chemicals. The feeder shall have a steel body of two-gallon capacity, with holes at top and bottom sides tapped for 3/4" pipe thread, and 3/4" pipe thread drain. The bypass feeder shall be rated at 300 psi at 200°F. The tank shall have a wide mouth, 3-1/2" opening so that chemical addition can be performed without the need of a funnel. The bypass feeder shall have a continuous threaded closure requiring 2-1/2 turns to close and seal. The cap shall be constructed of cast iron with an epoxy-coated underside to prevent corrosion and shall use a square ring gasket seal. The ring gasket shall not be glued or restrained from movement. The bypass feeder shall be provided with legs to elevate the feeder off the floor. The legs shall have holes to allow anchor bolt mounting to the floor.

B. The Contractor shall contact the Owner's Water Treatment Consultant for closed loop systems and condenser water systems. All chemical treatment required for startup of all systems shall be provided by the Contractor.

PART 3 - EXECUTION

3.01 PIPING INSTALLATION:

A. General: Sleeves and sealant shall be provided where pipes pass through floors, partitions or walls as outlined in Section 23 00 10, HVAC GENERAL REQUIREMENTS. Pipe shall be cut accurately to measurements established at the job site and worked into place without springing or forcing, properly clearing all windows, doors and other openings. Pipe in finished areas shall be concealed. Excessive cutting or other weakening of the building structure to facilitate piping installation will not be permitted. Each end of each piece of pipe shall be reamed. Pipe shall be installed to permit free expansion and contraction without damage to joints or hangers. Changes in direction shall be made with fittings. Bushings and all thread nipples will not be allowed.

B. All piping shall be installed with sufficient pitch to insure adequate drainage and all high points in water lines shall be provided with manual-air vents, all low points with drains. Cooling coil condensate drain lines shall slope 1/8" per foot in direction of flow. Pipe extending through the roof shall be properly flashed.

C. Bull head tee piping connections shall not be used in supply or return arrangements.

D. Piping connections to equipment shall be provided with unions or flanges. Banked water coils shall be piped in reverse return arrangement with a balancing cock in the return leg of each coil. Boilers shall not be connected into the piping systems until they have been thoroughly cleaned internally in accordance with the manufacturer's instructions and not until they can be fired under a fairly continuous load. Connections shall not be made to any equipment until the piping systems have been cleaned completely and are free of all dirt.

E. A suction diffuser shall be provided at the suction connection to each base mounted pump; maximum water pressure drop shall not exceed 2.5 feet w.g. at full pump flow. Suction diffusers shall have start-up screen.

F. Open ends of pipe lines or equipment shall be properly capped or plugged during installation to keep dirt or foreign material out of the system.

G. Escutcheons shall be provided where exposed pipes pass through finished walls or floors.

H. Miscellaneous piping terminating at floor drains or in the air shall be resiliently anchored to protect against fatigue or damage incurred as a result of vibration or abuse.

I. A hose bib for draining the condenser water system shall be provided downstream of the condenser water pump triple duty valve. The hose bib shall be located at the lowest point within the mechanical room. Provide other drain valves as necessary to allow complete drainage of the condenser water piping.

J. Joints:

1. Copper tubing shall be cut square, ends reamed and all filings and dust wiped from interior of pipe. Joints shall be soldered with solder drawn through the full fitting length. Excess solder shall be wiped from joint before solder hardens. Solder shall be 95/5 composition – 50/50 will not be allowed. All solder joints shall have piping surfaces sanded or brushed. Self-cleaning solder flux as a substitute for sanding or brushing is not acceptable. In lieu of soldered fittings, ProPress (no substitute) fittings may be used for copper pipe 2" and smaller.

2. Threaded joints shall be made with tapered threads properly cut. Joints shall be made tight with a stiff mixture of litharge and glycerin or other approved thread joint compound applied with a brush to the male threads only. Not more than three threads shall show after the joint is made up. The use of thread protectors for pipe couplings is not acceptable. Expanding self-hardening pipe dope ("expando") shall not be used.

3. Welded Joints:

a. Welded joints shall be fusion-welded by qualified welders in accordance with American National Standard B31.1.06, Chapter 5, unless otherwise required. Changes in direction of piping shall be made with welding fittings only. Mitering or notching pipe to form elbows and tees or other similar type construction will not be permitted. The contractor shall wire brush and paint welded pipe welds before insulation is applied. (Saddle type welding outlets may be used for equipment take-off's from the mains.)

b. All pipe welding shall be done only by competent and experienced welders. High test welding rods suitable for the material to be welded are to be used throughout. All welds shall be built up to a thickness of 1 ½ times pipe wall thickness. All tees, branches, reducers or specialties that may be required in welded piping shall be carefully laid out by welders, using templates, and the joints shall have carefully matched intersections

and shall be properly spaced. Finished pass on all welds shall be a smooth continuous weld cap. Multiple “stringers” on horizontal welds will not be acceptable.

c. During welding, all piping shall be securely clamped in place so that true alignment is held throughout the welding process. Where there is apt to be distortion, proper allowance shall be made so that the sections to be joined will be in proper alignment after the weld is completed. Care shall be exercised to prevent the occurrence of protruded metal into the pipe. All welds shall be of sound metal, free from laps, cold shuts, gas pockets, oxide inclusions and similar defects.

d. Adequate protection blankets, screens, etc. shall be provided during cutting and welding to protect existing adjacent surfaces.

4. Flanges and unions shall be faced true and made square and tight. Unions shall be 125 psi service, bronze seat type. Flanges shall be ASA Standard 125 psi service with red rubber gaskets. Unions or flange joints shall be provided on each side of each valve 2-1/2” or larger and in each line immediately preceding the connection to each major piece of equipment such as a pump, cooling tower, boiler, chiller, heating coil, cooling coil and other similar items.

3.02 REFRIGERANT PIPING:

A. All refrigerant piping shall be sized, installed, and routed in accordance with the refrigeration equipment manufacturer’s recommendations.

B. All piping joints and the inside of all piping shall be clean. Burnish all mating surfaces until all dirt, oxide, or other debris is removed. Using no flux, braze all joints using hard solder equal to Stay-Bright for pipe 2 inches and below or Stay-Silver for pipe larger than 2 inches. Remove all internal components from refrigerant accessories which may be subject to heat damage prior to brazing.

C. Before charging, refrigerant lines shall be thoroughly cleaned and purged. Refrigerant lines shall be pulled down to a vacuum of 500 microns and then pressure tested according to the manufacturer’s instructions before charging with refrigerant.

D. All filters from filter dryers shall be replaced after 48 hours of system operation and prior to final acceptance.

E. Refrigerant circuit access ports located outdoors shall be fitted with locking-type tamper resistant caps or shall be otherwise secured to prevent unauthorized access.

3.03 RELIEF VENTS:

A. All natural gas vents and refrigerant relief devices shall be independently and directly piped to the outside in accordance with the local Building Code, the International Fuel Gas Code and ANSI/ASHRAE Standard 15a. Refrigerant relief devices shall include chiller rupture disks and purge piping.

3.04 CONTROL ACCESSORIES:

A. Control valves, pipe wells and pressure tappings shall be furnished under Section 23 09 00 and installed as work of this Section.

3.05 PUMPS:

A. Contractor shall verify that final installed pump-motor shaft alignment is within the acceptable tolerances as specified by the pump manufacturer. Alignment shall be verified at both hot and cold operating temperatures and after all piping has been connected.

3.06 TEMPORARY SYSTEMS FILTRATION

A. Complete temporary closed loop water filtration of chilled water and heating water systems prior to the beginning of the construction process and upon completion of all piping systems.

B. The filter system shall be installed in a side stream method to the hydronic loops to allow the removal of suspended solids down to 0.45 micron nominal. The filters shall be fully automated to perform continuous filtration and backwash cycles based on pressure differential and/or time. Filtration shall be provided until total suspended solids are below 0.5 ppm (mg/liter). Final filtering shall occur subsequent to system cleaning and flushing.

C. Water Analysis: Filter supplier shall conduct analyses for each filter to include an initial water sample from the water circulating loop. Additional water samples will be taken at 30 day intervals until test data shows suspended solids below the aforementioned threshold. All samples shall be taken at the filter inlet. Before filter is disconnected, contractor shall forward a copy of all documented results to the engineer for final review.

3.07 TESTING:

A. Chilled Water and Heating Water, Condenser Water and Steam Supply and Condensate Return Piping:

1. Piping shall be tested and results approved by the Architect/Engineer prior to application of insulation.

2. Piping system shall be capped and subjected to a static water pressure of 50 psig above operating pressure (minimum 125 psig), and pressure maintained for four (4) hours with no leaks or loss in pressure. Testing with air is prohibited.

3. Test source of pressure shall be isolated from the system before conducting pressure tests.

3.08 SYSTEM STARTUP:

A. When chilled and heating water systems have been tested and made tight, flush all dirt, trash, and extraneous material with cleaner as recommended by equipment manufacturers, the Owners Water Treatment Consultant, and in accordance with Sections 23 80 00 and 23 05 93. The cleaning chemicals used shall be provided by the Contractor. The Contractor shall notify the Owner's Water Treatment Consultant 30 days prior to the boil-out/cleaning of the system.

B. The chemicals to be used by the Contractor for the specified initial treatment shall be furnished by Contractor. The Owner's Water Treatment Consultant shall be provided the opportunity to supervise the cleaning of equipment and the initial chemical fill for placing the equipment in normal service.

C. Chemical formulation shall be compatible with system materials, shall conform to DEQ regulations and shall not exceed DEQ or local effluent limits.

D. After cleaning and chemically treating the HVAC systems, the Contractor shall furnish the Owner, in writing, the following information:

1. Date of initial treatment.

2. Type of chemicals used for treatment.

3. Estimated date that further treatment or testing will be required.

E. Where any portion of the cooling tower is constructed of galvanized steel, passivation shall be provided. In addition to the chemical treatment specified herein, the condenser water treatment system shall be operated under proper conditions to passivate all galvanized surfaces to prevent white rust formation. The passivation process shall be provided in accordance with the cooling tower manufacturer's written recommendations. The conditioning period shall be a minimum of six weeks maintaining the following water chemistry parameters at all times: pH level between 7.0 and 8.0; Conductivity<2,400; Calcium Hardness>50 ppm; Chlorides<250 ppm; Sulfates<250 ppm; Alkalinity<300 ppm; Chlorine<0.5 ppm.

END OF SECTION

SECTION 23 30 00

HVAC AIR DISTRIBUTION

PART 1 - GENERAL

1.01 SUMMARY

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

B. Work Included:

1. HVAC Ductwork
2. Air Duct Accessories
3. HVAC Fans
4. Special Exhaust Systems
5. Air Terminal Units
6. Air Outlets and Inlets
7. Ventilation Hoods

C. Related Sections:

1. Section 01 91 13 -- General Commissioning Requirements
2. Section 23 00 10 – HVAC General Requirements
3. Section 23 05 00 – Common Work Results for HVAC
4. Section 23 05 48 – Vibration and Seismic Controls for HVAC Equipment and Piping
5. Section 23 05 53 – Identification for HVAC Piping and Equipment
6. Section 23 07 00 – HVAC Insulation
7. Section 23 05 93 – Testing, Adjusting, and Balancing for HVAC
8. Section 23 09 00 – Instrumentation and Control for HVAC
9. Section 23 70 00 – Central HVAC Equipment
10. Section 23 80 00 – Decentralized HVAC Equipment

1.02 REFERENCES:

A. General: The following standards or codes form a part of this specification to the extent indicated by the reference thereto.

B. Air Movement and Comfort Association (AMCA):

Bulletin 210, Standard Test Code for Air Moving Devices

Standard 511, Air Performance and Water Penetration

C. American Society for Testing and Materials (ASTM):

ASTM A 525 General Requirements for Steel Sheet, Zinc Coated (Galvanized) By the Hot-Dip Process

ASTM A 527 Steel Sheet, Zinc Coated (Galvanized) By the Hot-Dip Process, Lock-Forming Quality

ASTM E 84 Standard Test Method for Surface Burning Characteristics of Building Materials

ASTM C 411 Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation

D. Underwriters Laboratories, Inc. (UL)

Standard 723 Tests for Surface Burning Characteristics of Building Materials

E. Sheet Metal and Air Conditioning Contractors' Association (SMACNA)

Duct Construction Standards (Latest Edition)

HVAC Air Duct Leakage Test Manual (Latest Edition)

F. National Fire Protection Association (NFPA):

1. Standard 90A – Standard for the Installation of Air Conditioning and Ventilating Systems

2. Standard 90B – Standard for the installation of Warm Air Heating and Air Conditioning Systems

3. Standard 96 – Standard for the Installation of Equipment for the Removal of Smoke and Grease – Laden Vapors from Commercial Cooking Equipment

4. Standard 255 – Method of Test of Surface Burning Characteristics of Building Materials

G. California Department of Health Services

Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers

1.03 DEFINITIONS:

A. Duct Sizes: Sizes shown on Drawings are actual sheet metal dimensions. For acoustically lined ducts, sizes indicated are actual sheet metal sizes allowing for 1" thick acoustic lining. For double wall ductwork, sizes indicated are inside dimensions.

B. Low Pressure Ductwork: Static pressure rating less than 2" w.g. and velocities less than 2000 fpm.

C. Medium Pressure Ductwork: Static pressure rating less than 6" w.g. and velocities greater than 2000 fpm and all ductwork upstream of VAV boxes.

D. High Pressure Ductwork: Static pressure rating over 6" w.g. and velocities greater than 2000 fpm.

1.04 COMMISSIONING OF HVAC SYSTEMS:

A. The Contractor shall provide contact information to the Commissioning Agent indicated in Division 1 for all major items of Equipment.

B. Provide additional submittal copy of major equipment for Commissioning Agent specified in Division 1.

1.05 SUBMITTALS:

A. Submit shop drawings, product data and samples in accordance with Division 1 and Section 23 00 10.

B. Shop drawings, diagrams, catalog data and such other data necessary to fully describe and substantiate compliance with these specifications shall be submitted for all equipment and materials marked with notation set forth in Section 23 00 10.

C. Operation and maintenance data shall be submitted in accordance with Division1, for all items of equipment and materials marked with notation set forth in Section 23 01 00.

D. All fans for use with Variable Frequency Drives (VFD) shall have critical speed and multiples of critical speed indicated on each submittal.

1.06 SPARE PARTS

A. Each fan powered terminal box and make-up air fan shall be provided with 3 sets of filters. At end of construction each unit shall be provided with a clean filter and one set shall be turned over to the Owner as spares.

B. Each belt driven piece of equipment shall be provided with one spare set of belts to be turned over to the Owner at the end of construction.

PART 2 - PRODUCTS

2.01 HVAC DUCTWORK

A. Materials:

1. Sheet Metal Ducts: Trademarked galvanized steel, lock forming quality, having zinc coating of 0.90 ounces per square foot for each side (G90, ASTM A653 and A653M).

2. All ductwork without external insulation, exposed to view in finished, non-utility spaces shall have paint-grip or galvaneal coating to accept field painting.

3. Fasteners: Use rivets and bolts throughout; sheet metal screws may be used on low pressure ducts.

4. Sealants: United McGill “United Duct Sealer” or equal. Water and fire resistant when dry, compatible with mating materials. Where sealants are used on exposed ductwork, composition shall be designed to prevent bleed-through of finish paint, or sealant shall be pre-painted with a coating impervious to bleed-through. For field applications within the weatherproofing system, all adhesives and sealants shall comply with the requirements of the California Health Services Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers.

5. All duct and accessory materials shall have a composite flame spread rating not exceeding 25, and a smoke developed rating not exceeding 50 as tested under procedure ASTM E-84-75, NFPA 255 and UL 723. Duct coverings and linings shall not flame, glow, smolder or smoke when tested in accordance with ASTM C411.

B. Fabrication:

1. All ductwork shall conform accurately to the dimensions indicated on plans and shall be fabricated and installed in accordance with ASHRAE Guide and Data Books and SMACNA Duct Construction Standards, except that sheet metal gauges and zinc coating shall not be lighter than specified under this Section.

2. All rectangular sheet metal ducts over 18” wide shall be cross-broken for rigidity.

3. Reinforcing angles, stiffeners and tie-rods for all sheet metal ducts shall be provided where required to prevent sagging, buckling, and vibration in accordance with the latest SMACNA Duct Construction Standards Publication. Reinforcing for flat oval duct shall be provided as specified for rectangular duct in accordance with the latest SMACNA Duct Construction Standards Publication.

4. Lap metal ducts in direction of air flow. Hammer down edges and slips to leave smooth interior surface.

5. Where square elbows are indicated on the Drawings, curved elbows may be used provided the centerline radius is not less than 1-1/2 times the width of duct and as space allows.

6. Provide turning vanes in all square elbows. Provide air foil type turning vanes on all ducts more than 24" wide. Mitered round elbows (2-piece) shall not be used unless specifically indicated. Mitered round elbows shall have airfoil turning vanes.

7. Transitions shall be made with a slope ratio of 4:1, except at equipment divergence and convergence shall not exceed a slope ratio of 3:1.

8. All duct joints and seams shall be mechanically tight, and sealed with sealant or gaskets to provide a substantially airtight system.

9. All duct liners shall be installed using fasteners in strict accordance with SMACNA Duct Construction Standards. Fastener pins shall be clinched pin type or welded pin type. The use of adhesive type pins is not acceptable. All liners shall have transverse edges coated with adhesive, all corners lapped and butted or folded.

10. Duct liners at fan discharges shall be lapped on outside of fan discharge flange or shall have metal nosing on leading edge. Fastening pin length shall be equal to liner thickness.

11. Provide easements where low pressure ductwork conflicts with piping and structure. Where easement exceeds 10% duct area, split into two ducts maintaining original duct area.

12. Plenums and Casings (Site Fabricated Units) [S]: Construct of galvanized steel panels joined by standing seams on outside of casing. Rivet or bolt all seams and joints on approximately 6" centers and seal with sealant. Reinforce with steel angles and provide diagonal bracing. Access doors shall be 36" x 18" with frame welded to plenum, three brass hinges and three brass tension fasteners operable from either side of door.

13. Ductwork associated with clothes dryer exhaust shall have smooth interior finish with joints running in the direction of airflow. Ductwork associated with commercial clothes dryer shall be installed with a minimum 6 inches to combustible materials.

C. Low Pressure Ducts:

1. Sheet Metal Gauges:

a. Rectangular Ducts:

Max. Dimen., In.	Min. Gauge
Up to 30	24
31 to 54	22
55 to 84	20
85 and Over	18

b. Round Ducts:

Duct Diameter, In.	Min. Gauge
Up to 22	24
23 to 36	22
37 to 50	20
51 to 60	18

61 to 84	16

D. Medium Pressure Ducts:

1. Sheet Metal Gauges:

a. Rectangular Ducts:

Max. Dimen., In.	Min. Gauge
Up to 18	22
19 to 48	20
49 to 72	18
73 to 96	16
97 to 144	14

b. Round Ducts (Factory Made With Spiral Lock Seams equal to United McGill):

Duct Diameter, In.	Min. Gauge
Up to 26	24
28 to 36	22
38 to 50	20
51 to 60	18
61 and Over	16

c. Flat-Oval Ducts (Factory Made With Spiral Lock Seams equal to United McGill):

Max. Width, In.	Min. Gauge
9 to 24	24
25 to 48	22
49 to 70	20
71 and Over	18

2. Fittings shall be minimum 20 gauge on flat oval, but not less than 2 gauges heavier than ductwork in which it is installed on round and flat oval. Fittings for duct sizes 5" round and below may be minimum 24 gauge.

3. All take-offs shall be full body pre-manufactured 45° conical lateral type or alternate pre-manufactured fitting with equivalent loss coefficient. The use of field-installed or factory lateral taps or manifolds is not acceptable.

4. All elbows shall have centerline radius (R = 1.5 D), and shall be stamped or pressed smooth radius or minimum five gore type. Adjustable gore type fittings are not acceptable.

Flexible Ducts [S]: Flexible Ducts shall be Flexmaster Type 1M or Thermaflex type M-KE. Duct shall incorporate acoustic rated CPE or PE inner liner, 1" thick fiberglass insulation, and reinforced metalized vapor barrier. Maximum C factor shall be 0.24 btu/hr/sq.ft./°F at 75°F mean temperature. Duct shall have a working pressure of not less than 6 inches w.g. for positive pressure and 1 inch w.g. for negative pressure and suitable for velocities up to 4000 fpm. Vapor transmission shall be less than 0.05 Perm when tested in accordance with ASTM E96, Procedure A. The entire assembly shall be rated and marked as UL 181 Class 1. Flame Spread Rating shall not exceed 25 and Smoke Developed Rating shall not exceed 50 when

tested in accordance with ASTM E-84-75, NFPA 255, and UL 723. Minimum duct insertion loss at 2500 fpm for a 10-foot length of straight duct shall be as listed below when tested in accordance with ADC FD-72 R1:

Duct Insertion Loss, dB

Octave Band	2	3	4	5	6
Frequency, Hz	125	250	500	1000	2000
6 inch duct	7	19	34	37	38
8 inch duct	8	13	29	35	36
12 inch duct	20	26	27	33	26

E. Special Ducts:

1. All kitchen exhaust ducts carrying grease laden air (and all supply ducts located within 18" of a type I exhaust hood) shall be provided as indicated below:

   a. Where fire-rated enclosures are required: Grease ducts shall be factory fabricated, double wall, insulated grease duct [S] as manufactured by Metal-Fab, Metalbestos, or Hart & Cooley. Duct shall be suitable for 0" clearance to combustibles. Duct shall consist of minimum 0.035" thick stainless steel inner wall, minimum 0.024" aluminized steel outer wall, and high temperature ceramic insulation. Duct shall be classified under UL 1978 and UL 2221 and shall comply with NFPA-96. Duct system shall be one or two hour rated as required by VUSBC. Grease duct system shall include all supports, fittings, roof penetrations, expansion joints, etc. as necessary for a full and proper installation. Grease duct shall be installed in strict accordance with manufacturer's instructions. Shop drawing shall include a sketch showing the assembly of all sections.

   b. Where fire-rated enclosures are not required: Grease duct shall be field fabricated ductwork constructed from 16 gauge black sheet steel with all joints, seams and penetrations welded liquidtight. Mechanical fasteners shall not be used for assembly or support where such fasteners could penetrate the duct walls. Ducts shall run continuous from the hood connection to the exhaust fan connection a minimum of 40 inches above the roof. Ductwork shall be tested prior to installing any coverings. Two layers of fire wrap [S] shall be applied to the outside of the ducts. Fire wrap shall be Firemaster FastWrap XL as manufactured by Morgan Thermal Ceramics or equivalent by 3M or Unifrax. Fire wrap shall be 1-½ inches thick and shall be listed and labeled by UL in accordance with ASTM E 2336 for zero clearance to combustibles. Listed and labeled liquidtight access doors shall be provided by the fire wrap manufacturer and installed in the side of each horizontal section of duct for cleaning purposes. Access doors shall be a minimum of 12 inches and as otherwise outlined in the applicable code. Access door spacing shall not exceed 20 feet. Prior to Substantial Completion, the Contractor shall provide a letter from the fire wrap manufacturer stating that the fire wrap and grease duct access doors have been installed in accordance with manufacturer's installation instructions and that installation complies with the UL listing.

2. Watertight ducts shall be fabricated from copper sheets with soldered seams and joints or stainless steel sheets with brazed seams and joints. Thickness of material and fabrication shall be as required for low pressure systems except that thickness of material shall be suitable for soldering, brazing or welding without deformation or burning of the metal. All joints shall be watertight and low points shall be provided with drain tubes. Provide waterstops with drain tubes where indicated on plans.

3. All exposed round and flat oval ductwork and concealed premanufactured ductwork indicated to be lined shall be double-walled internally insulated duct with perforated internal liner, 1" acoustic insulation and paint grip or galvaneal coating on exterior. Provide all fittings and adapters to match lined duct. Insulation shall have K factor of 0.27 btu/hr./sq.ft./in./°F at 75°F mean temperature and minimum noise attenuation of 1.54 dB/ft. at a center frequency of 1000 Hz and 2000 fpm in 24" diameter duct. Ductwork shall be United McGill Acousti-K27 or approved equal. Joint mastic shall be totally concealed within fitting couplings.

4. Provide a 4-inch diameter galvanized steel exhaust duct for all residential clothes dryers. Duct shall discharge outside the building and terminate with a weatherproof wall cap. Connection at wall shall be a recessed noncombustible metal wall box or wall receptacle. Coordinate exact location of wall box with dryer provided for flush installation of dryer to wall. Coordinate location with Owner where dryer is not in Contract. Wall box shall have paintable surface, shall have hidden nailing flanges, contain gas line connection when gas dryer is provided.

2.02 AIR DUCT ACCESSORIES

A. Access Doors:

1. Doors for low pressure rectangular ductwork shall be galvanized steel, 20 gauge rigid type, 12" X 16" minimum size unless noted otherwise, except where size of duct will not accommodate this size, they shall be as large as possible. Door shall have gasket, two hinges, and two compression latches with outside and inside handles. Provide insulated doors where installed in insulated ductwork.

2. Doors for round or flat-oval low, medium or high pressure ductwork shall be a complete factory mounted, duct section/access door assembly constructed of minimum 20 gauge galvanized steel. Access door shall match within two inches the diameter of duct and shall be complete with gasket, insulated door with handle, compression clips and chain retainer.

B. Fire dampers [S] shall be provided in accordance with the National Fire Protection Association Standard No. 90A. Dampers shall be UL 555 approved (for dynamic air systems), factory fabricated and assembled, and shall consist of 24 gauge, or heavier, interlocking curtain or rotating damper blades, fusible link and linkage, and 22 gauge, or heavier, galvanized steel frame. Dampers shall be tested for closure under airflow conditions and shall be labeled for maximum airflow and direction of flow. Where fire dampers are located in walls behind sidewall grilles, the fire damper shall be designed and UL listed for flush installation of the grille. Where fire dampers are located in watertight ductwork, fire dampers shall be

constructed of 304 stainless steel; all duct/sleeve connections shall be sealed watertight with sealant in accordance with the terms of the UL Listing. Entire unit shall be securely anchored in structure where opening is made. Free area of fire damper for medium/high velocity ducts shall equal the cross section area of duct in which installed. Free area of fire damper for conventional velocity ducts shall be not less than 75% of the cross section area of duct in which installed. Dynamic fire dampers shall be rated for velocities up to 2000 fpm and pressures up to 4.0 in. wg. Fire dampers shall be furnished to the job site with instructions detailing UL approved installation method.

C. Dampers:

1. General:

a. Fabricate of galvanized steel.

b. Where manual dampers occur behind or above finished portions of hard ceilings or walls, a Zipset Remote Balancing System shall be provided.

1) System shall include an RP series remote panel with the number of connectors as required. Panels shall be located in Mechanical Rooms only, coordinate exact locations with all applicable trades. Patch panels shall be labeled as to the location of each damper. Where air devices are located less than 10'-0" AFF, feed through option may be utilized at the discretion of the Contractor. THERE SHALL BE NO ACCESS HOLES, PLATES, ETC. in the ceilings. All actuator connections shall either be feed-thru or remote panel type.

2) Actuators shall be Model ZSA-1, 9-12V Actuator. They shall operate over a temperature range of 30-125°F and shall be rated for a maximum torque of 30 in-lbs. Actuators shall be UL94-5VA rated for plenum-rated ceilings.

3) System shall come complete with an HHC-1 controller, or HHC-1R controller at the Contractors discretion. Controller shall be hand held and 9V battery powered and shall be turned over to the Owner upon completion of the testing and balancing.

c. Where dampers are located in accessible spaces, operators shall be locking type quadrant operators. Quadrant operators shall be installed on 1-1/2" high 4 bend galvanized steel bracket so that duct insulation may be extended and sealed under the quadrant operator.

d. End of damper rod on each damper shall be grooved to show damper position.

2. Manual Volume Dampers shall be opposed blade multi-louver construction 16 gauge minimum with molded synthetic or stainless steel bearings, galvanized channel iron frame and maximum blade width of 8 inches. Axles shall be positively locked into blades to prevent slippage or loosening. Damper blades shall be interlocking type with linkage and control shaft.

D. Rectangular branch take-off connections from mains shall be made using 45 degree entry fittings per SMACNA 1995 figure 2-6. Grille and register connections to mains shall be made using 45 degree entry fittings where space allows. Where diffuser, register or grille is located too close to the main, air deflectors shall be used. Air deflectors shall be factory fabricated. Adjustable deflectors shall be complete with worm gear operator when behind grilles, an extension rod and concealed regulator when above plaster ceilings, or self-locking lever type regulator when accessible.

E. Instrument Test Holes: Holes, with patches, in ducts and plenums shall be provided where directed or necessary for using pitot tubes for taking air measurements for balancing the air systems. At locations where ducts or plenums are insulated and on all medium and high pressure ductwork die cast collars with threaded neoprene caps shall be provided.

F. Apparatus Connections: At points where sheet metal connections are made to fans or where ducts of dissimilar metal are connected, provide a flexible connection of neoprene coated canvas of sufficient length to eliminate transmission of vibration. Flexible connections shall be securely fastened and air tight.

G. Duct Sleeves: All ducts shall have sleeved openings 1" larger than the overall duct dimensions framed in place when the wall is constructed and 1/4" larger when floors are poured. Space between duct or duct insulation and sleeve shall be tightly filled with mineral fiber rope insulation and sealed. All duct penetrations through corridor walls, floors not requiring fire dampers and walls indicated to be smoke partitions shall be sealed with U.L. approved firestopping sealant. In fire partitions or floors requiring fire dampers, the duct sleeve shall be sized to match the fire damper frame with all voids packed tight with mineral fiber rope. All penetrations through draftstop partitions shall be sealed to maintain the integrity of the partition. Flanges, constructed of 20 gauge galvanized sheet metal, not less than 3" wide, shall be installed at each opening in finished areas.

H. Prefabricated curbs shall be provided where ductwork above roof penetrates roof surface, sized to match ductwork and duct supports. Curbs shall be insulated type, 12 inches high complete with mounting flange and integral cant strip where acceptable to roofing manufacturer. Outer shell shall be mitered and welded continuously to form a rigid leakproof shell; inner shell shall be solid metal similarly constructed. Wood nailing strips shall be bolted to top of curb shell to provide means for securing flashing material to the curb. Curb shall be constructed of galvanized steel. Ductwork and insulation cover shall be counterflashed to the curb. Curb sidewalls shall be fully insulated to minimum R-5. Top of curb shall be gasketed for airtight fit of rooftop unit.

I. All wire mesh, woven metal fabric, bird screens, and similar items shall be constructed from corrosion resistant, galvanized steel or aluminum.

J. Acoustic Lining: See Section 23 07 00.

2.03 HVAC FANS [S] [O/M]

A. Roof fans and sidewall fans shall be equal to Greenheck of model indicated, roof or sidewall vent type, power exhaust fans having backward curved aluminum or steel blade centrifugal fan, directly or belt connected as indicated to motor in fully enclosed air cooled motor compartment, outside of exhaust air stream. Fan and motor housing shall be aluminum. Provide electronically commutated motors (ECM) for all fans unless otherwise noted. ECM motor shall be suitable for connection to DDC system specified in 23 09 00 where required. All ECM motors shall be complete with means to adjust the speed of the fan either through the DDC system or at the fan. All ECM motors shall be speed controllable down to 20% of full speed (80% turndown). ECM motor shall be a minimum of 85% efficient at all speeds. Each fan shall be complete with bird screen and motor (gravity) operated dampers. Each fan shall be tested and rated in accordance with AMCA Standard #210. Each fan motor shall be factory wired to a terminal strip mounted in a junction box attached inside the motor housing. A weather resistant switch or disconnect, with thermal overload, shall be provided in wiring between the terminal strip and motor connection.

B. In-Line fans shall be Greenheck straight through blower complete with backward curved non-overloading steel or aluminum blades, motor mounted out of the airstream, square steel enclosure, rubber in shear vibration isolators and disconnect switch with thermal overload wired to motor. Unit shall be suitable for mounting at any angle. Bearings shall be pre-lubricated and sealed at the factory. Power unit shall be accessible without disconnecting ductwork. Motor operated dampers shall be provided where indicated for 120 V, two-position service. Verify duct size at installation location.

C. Kitchen hood exhaust fan shall be upblast type of spun aluminum construction with backward inclined or airfoil blades, containing a built-in grease trough with grease collection pan, and having a motor compartment completely isolated from airstream. A weather resistant switch or disconnect with thermal overload shall be provided in wiring between the terminal strip and motor connection. Fan shall be U.L. 705 and U.L. 762 listed for grease removal and shall have a non-sparking wheel. Fan shall be hinged at or above the curb to allow inspection and cleaning of the inside of the fan and ductwork. Provide safety cable as required by the weight of the equipment.

D. All motor operated dampers shall be Class 1A with maximum leakage rate of 4 cfm/ft2 at 1.0 inch water gauge when tested in accordance with AMCA 500D.

E. Prefabricated curbs shall be insulated type, 12-14 inches high complete with mounting flange, integral cant strip and rack or flange to support dampers. Outer shell shall be mitered and welded continuously to form a rigid leakproof shell, inner shell shall be solid metal similarly constructed. Wood nailing strips shall be bolted to top of curb shell to provide means for securing flashing material to the curb. Curb shall be constructed of (aluminum) (galvanized steel). Curb sidewalls shall be fully insulated to minimum R-5. Top of curb shall be gasketed for airtight fit of rooftop unit.

F. See PART 1 for spare parts requirements.

2.04 AIR TERMINAL UNITS [S] [O/M]

A. Variable Air Volume Heating Boxes

1. General: Variable volume heating boxes shall be Trane hot water heating units complete with insulated casing, damper and damper seat, pressure independent type with heating coil.

2. Casing shall be minimum 24 gauge welded steel construction. Casing shall be internally insulated acoustically and thermally with not less than 1/2 inch, 1.5 lb. density fiberglass complying with FPA-90A and UL 181. Unit inlet shall contain a factory mounted damper or air valve for controls indicated.

3. Air Volume shall be controlled by single blade 16 gauge steel damper and 20 gauge seat, with integral actuator factory installed. Integral flow taps and calibration chart shall be provided on each unit. Leakage rate shall not exceed 4 percent at 3.0 inches wg. Unit shall be equipped with pressure compensating control with volume regulator for pressure-independent operation.

4. Heating Coil shall be hot water flanged type and shall be as specified in Section 23 80 00. Coil shall be mounted at the unit discharge as indicated.

5. Controls shall be factory mounted and shall be furnished under Section 23 09 00, complete with fused power disconnect.

B. Fan Powered Variable Air Volume Heating Boxes

1. General: Fan powered variable volume boxes shall be UL labeled units as manufactured by Trane. Units shall be single duct, parallel fan type, pressure independent, variable volume units operating in conjunction with a hot water coil and unit mounted fan. All units shall have electronically commutated motors (ECM).

2. Casing shall be minimum 24 gauge welded steel construction. Casing shall be internally acoustically and thermally with not less than 1/2 inch 1.5 lb. density fiberglass complying with NFPA-90A and UL 181. Casing shall be sized for and shall include volume controller, fan and filter with slide-in filter track.

3. Fans shall be complete with direct connect motor and rubber-in-shear isolator and shall be furnished with control relay for start-stop from the control system. Motors shall have internal overload protection. Motor shall be provided with variable speed switch with positive off.

4. Air Volume for primary air shall be controlled by single blade 16 gauge damper and 20 gauge seat, with integral factory installed actuator. Unit shall be complete with integral flow taps and calibration chart for each unit. Unit shall be equipped with pressure compensating control with volume regulator for pressure-independent operation.

5. Coil shall be hot water as specified in Section 23 80 00. Coil shall be mounted at the unit discharge to heat both primary and secondary air. Where unit mounted coil exceeds

maximum allowed air pressure drop, duct mounted coil that satisfies the constraints shall be provided downstream of box discharge.

6. Controls shall be factory mounted and shall be furnished under Section 23 09 00, complete with fused power disconnect.

7. See PART 1 for spare parts requirements.

2.05 AIR OUTLETS AND INLETS [S]:

A. Acceptable Manufacturers:

1. Standard Products: Price, Metal Industries, Krueger, Tuttle and Bailey, and Titus.

B. General:

1. All devices shall be commercial grade and shall be constructed of steel or aluminum as indicated on the drawings.

2. Manufacturer shall certify cataloged performance and ensure correct application of each air device to provide air pattern, velocity, pressure drop and sound characteristics NC suitable for space installed. Shop drawings shall include air quantity, size, pressure drop, throw ft, and sound level NC.

3. All devices located in ceilings shall have white baked enamel finish. Devices at other locations shall have prime finish suitable for painting or anodized aluminum unless noted otherwise.

4. Maximum air outlet noise level shall not exceed NC35.

5. Provide sponge rubber seal around edges of all supply registers and grilles.

C. Diffusers:

1. Square ceiling diffusers shall be welded steel or aluminum as indicated on the drawings, removable core, louver face, complete with equalizing grid, volume control unit and adjustable vanes for down-discharge pattern.

2. Strip diffusers shall be extruded aluminum adjustable pattern, recessed type complete with volume control, mounting frames, mounting yokes, mounting strips and accessories.

D. Registers and Grilles:

1. Return and exhaust registers shall be aluminum, unless noted otherwise, complete with 45 degree fixed airfoil vanes at not more than 1/2 inch centers. Provide 1 or 1-1/4 inch margin, 1/8 inch beveled frame with concealed screw holes. Damper shall be opposed blade face operated type with removable key. Units on watertight ducts shall be all

polished stainless steel or aluminum with baked enamel finish, including damper, linkage, core and frame.

2. Bottom registers shall be heavy duty steel to withstand abuse. Fixed horizontal vanes shall be minimum 14 gauge spaced on maximum 1/2" centers, and set at 38°. Vanes shall be set in heavy steel support bars at maximum 8 inch centers. Provide 1-1/4 inch margin steel frame and countersunk or concealed screw holes. Damper shall be opposed blade face operated type with removable key.

3. Supply Registers:

   a. Sidewall supply registers shall be aluminum complete with removable, reversible double deflection core and fixed horizontal or longitudinal deflecting vanes at not more than 1/3 inch centers. Provide 1 or 1-1/4 inch margin frame 1/8 inch beveled frame or 3/16 to 1/4 inch curved frame with concealed screw holes. Damper shall be opposed blade face operated type with removable key. Units shall be provided with core removal tools which shall be turned over to the Owner. Front row of deflection blades shall be horizontal.

   b. Ceiling supply registers shall be one, two, three or four way deflection as indicated on plans and shall have adjustable curved blades to discharge air along ceiling, 1-1/4" inch margin frame with countersunk screw holes and opposed blade face operated damper with removable key.

4. Grilles shall be as specified for registers except without opposed blade dampers.

2.06 VENTILATION HOODS [S] [O/M]:

A. Kitchen Hood Exhaust System

1. Exhaust fan shall be upblast type of spun aluminum construction with backward inclined or airfoil blades, containing a built-in grease trough with grease collection pan, and having a motor compartment completely isolated from airstream. Fan shall be U.L. 705 and U.L. 762 listed for grease removal and shall have a non-sparking wheel.

2. Exhaust hood shall be UL listed with a supply fire damper and shall meet all requirements of NFPA #96, UL and applicable building codes and shall be constructed of 18 gauge stainless steel with all seams and joints having a liquid tight external weld. The stainless steel shall have a180 grit finish and all joints shall be ground smooth and polished. The hood shall have a stainless steel filter housing, complete with UL listed extractors the full length of the housing and sized for the air quantity indicated. This housing shall terminate at the bottom with a pitched drip tray full length of the hood. The tray shall be easily removable for cleaning. The area of the hood below the filter housing shall have an enclosed chase for the fire protection system. Vapor-proof lights shall be installed on three to four foot centers completely wired and ready for an external power source. Hoods shall be mounted at 80" above floor and a minimum of 2'-0" above the cooking surface, or as indicated by the terms of the hood's UL listing. Stainless steel filler skirts matching the

hood shall be provided between the hood and ceiling where ceilings are higher than top of hood. Filler skirts shall be fully welded with flanged edges, bolted to hood.

3. Controls shall be a complete factory-furnished package including fuses, interlocks, switches, safety devices and all wiring required to interlock the exhaust fan and canopy mounted control station. A heat sensor with control relay shall be provided to energize the system upon detection of heat under the hood.

4. See PART 1 for spare parts requirements.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Duct clearance and lengths shall be established from measurements taken at the job site before any ducts are fabricated.

B. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pitot tube openings where required for testing and balancing of system. Where exhaust ducts are installed within a chase or shaft, pitot tube shall extend to the outside of the chase or shaft and be capped.

C. Locate ducts with sufficient space around equipment to allow normal passage, and operating and maintenance activity.

D. Locate all ductwork to align with the ceiling grid where connections are to be made to Diffusers, Registers and Grilles. Field verify exact grid location before installing ductwork.

E. Locate all Diffusers, Registers and Grilles as indicated on plans and in accordance with the Reflected Ceiling Plans, if provided.

F. Provide low loss factory fabricated fittings for all round take-off connections to low velocity rectangular ducts.

G. All Flex duct shall be properly supported to prevent any short radius bends or kinks. Connections to diffusers shall be made using long radius bends or elbows with turning vanes to ensure that airflow is distributed evenly across the neck of the diffuser. Conditions that create higher airflows in one quadrant of diffuser throw are not acceptable. Maximum flex duct runout length shall be 5 feet. Flex duct shall not penetrate wall construction of any type.

H. Install duct accessory items in accordance with manufacturers printed instructions.

I. Install volume, smoke and fire dampers where shown on plans.

J. Manual volume dampers shall be installed at all branch connections, divided flow branches, and end-of-run diffuser/register connections for low pressure supply, return, and exhaust duct systems. Manual volume dampers shall be installed within 3 feet of the main duct.

K. Provide access doors at all automatic dampers, fire/smoke dampers, duct heaters, duct mounted coils, thermostats and at all other points requiring inspection or servicing. Duct access doors for fire and smoke dampers shall be permanently labeled with minimum 1/2 inch high letters reading FIRE DAMPER or SMOKE DAMPER. Labeling shall be as specified for equipment nameplates under Section 23 05 53.

L. Fire dampers shall be UL listed for the type assembly in which they are installed.

M. All grease exhaust ductwork shall be sloped downward to the hood or an approved receptacle at not less than 1/4 inch per foot.

N. Where clothes dryer exhaust duct is installed concealed within the building construction, a label shall be provided indicating the equivalent length of the exhaust duct. The label shall be located within six feet of the duct connection. Where dryer exhaust duct is concealed within walls or behind hard ceilings, shield plates shall be installed between the duct and the finished face of the framing members to prevent damage from nails or screws. Coordinate dryer wall box with baseboard molding and masonry coursing as applicable.

O. All watertight ductwork shall be sloped downward to the air inlet or to a waterstop with drain tube. Slope shall be not less than 1/4 inch per foot.

P. Connection of horizontal ducts to rooftop exhaust fans shall be made using radiused elbows or mitered elbows with turning vanes. Duct transitions shall be as hereinbefore specified.

Q. Ductwork installed or stored on site shall be protected such that open ends are covered to prevent construction dust and debris and other foreign matter from being introduced into the duct systems. If at any time during construction, dust or debris is discovered within the duct systems or ducts openings are observed to be unprotected, the Contractor will be responsible for properly cleaning all duct systems in accordance with NADCA procedures for the respective type of ductwork.

R. Grille, Register and Diffuser Installation:

1. Where grilles are installed at walls or ceilings, the duct shall be fastened securely to the masonry or panel at each side of the opening and the grille shall be securely fastened snug against the masonry or panel.

2. If flanged grille frames are used on exposed ducts, runout shall be same size as outside dimension of flange and full depth of register assembly.

3. Unless otherwise indicated in the Contract Documents, sidewall grilles and registers to be installed high shall be installed within 6 inches of the ceiling or nearest overhead projection. Unless otherwise indicated in the Contract Documents, sidewall registers and or grilles to be installed low shall be installed within 6 inches of the floor, but shall be coordinated with cove or base molding. Sidewall registers shall also be coordinated with the block coursing where applicable.

4. Ceiling diffusers shall be installed in and coordinated with the ceiling tile or other ceiling units. Diffusers, Registers and Grilles shall be centered in each ceiling unit, unless shown otherwise. Mounting frames shall be installed as required to support diffusers, registers and grilles. Grilles, registers and diffusers shall not be supported from the ceiling system, conduit, piping or unrelated ductwork.

S. Patching: Where existing control, monitoring or other penetrating devices are removed from ductwork, the opening shall be patched to match thickness, type and finish of existing ductwork, and sealed airtight.

3.02 DUCT CLEANING:

A. Clean all new supply and return duct systems 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 duct as recommended by duct manufacturer. Comply with paragraph "Air Duct Accessories" in this Section for access panels and doors.

2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.

3. Remove and reinstall ceiling to gain access during the cleaning process.

C. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.

2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

D. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).

2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.

3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.

4. Coils and related components.

5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.

6. Supply-air ducts, dampers, actuators, and turning vanes.

7. Dedicated exhaust and ventilation components and makeup air systems.

E. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.

2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.

3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of ducts or duct accessories.

4. Clean fibrous-glass duct with HEPA vacuuming equipment; do not permit duct to get wet. Replace fibrous-glass duct that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.

5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.

6. Provide drainage and cleanup for wash-down procedures.

7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

F. Source-Removal Cleaning Methods: The HVAC system shall be cleaned using source-removal mechanical cleaning methods designed to extract contaminants from within the HVAC system and to safely remove these contaminants from the facility. No cleaning method, or combination of methods, shall be used that could potentially damage components of the HVAC system or negatively alter the integrity of the system.

1. Use continuously operating vacuum-collection devices to keep each section being cleaned under negative pressure.

2. Cleaning methods that require mechanical agitation devices to dislodge debris that is adhered to interior surfaces of HVAC system components shall be equipped to safely remove these devices. Cleaning methods shall not damage the integrity of HVAC system components or damage porous surface materials such as duct and plenum liners.

G. Cleaning Mineral-Fiber Insulation Components:

1. Fibrous-glass thermal or acoustical insulation elements present in equipment or ductwork shall be thoroughly cleaned with HEPA vacuuming equipment while the HVAC system is under constant negative pressure and shall not be permitted to get wet according to NADCA ACR 2006.

2. Cleaning methods used shall not cause damage to fibrous-glass components and will render the system capable of passing the HVAC System Cleanliness Tests (see NADCA ACR 2006).

3. Fibrous materials that become wet shall be discarded and replaced.

H. Duct System Cleanliness Tests:

1. Visually inspect duct system to ensure that no visible contaminants are present.

2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."

3. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

4. Duct system will be considered defective if it does not pass tests and inspections.

5. Prepare and submit test and inspection reports.

3.03 DUCT SCHEDULE:

A. All ductwork shall be fabricated, installed, sealed, and tested in accordance with the schedule below. All testing shall be in accordance with the latest edition of the SMACNA HVAC Air Duct Leakage Test Manual.

1. Testing shall be conducted and the results approved by the Architect/Engineer prior to the application of insulation.

2. The Architect/Engineer shall be notified one week prior to conducting the test. Unless specifically waived, the Engineer and Owner reserve the right to witness the test. Final, signed and dated test results shall be documented as outlined in SMACNA HVAC Air Duct Leakage Test Manual and submitted to the Architect/Engineer.

B. Supply Ductwork

1. Medium pressure (to include all ductwork upstream of VAV boxes):

a. Pressure Class: Positive 6” w.g.

b. Seal Class: A

c. Leakage Class for Round Duct: 3

d. Leakage Class for Rectangular Duct: 6

e. Testing Requirement: 100%

2. Low pressure duct downstream of VAV boxes:

a. Pressure Class: Positive 2” w.g.

b. Seal Class: A

c. Leakage Class for Round Duct: 12

d. Leakage Class for Rectangular Duct: 12

e. Testing Requirement: 25%

3. Low pressure duct connected to air handling units, energy recovery units, and rooftop air conditioning units/heat pumps in excess of 5 tons:

a. Pressure Class: Positive 3” w.g.

b. Seal Class: A

c. Leakage Class for Round Duct: 6

d. Leakage Class for Rectangular Duct: 6

e. Testing Requirement: 25%

4. Low pressure duct connected to cabinet unit heaters, fan coil units, and heat pumps - 5 tons or less:

a. Pressure Class: Positive 2” w.g.

b. Seal Class: A

c. Leakage Class for Round Duct: 12

d. Leakage Class for Rectangular Duct: 12

e. Testing Requirement: N/A

5. Ductwork connected to equipment not listed above:

a. Pressure Class: Positive 2” w.g.

b. Seal Class: A

c. Leakage Class for Round Duct: 12

d. Leakage Class for Rectangular Duct: 12

e. Testing Requirement: N/A

C. Return Ductwork:

1. Ductwork located outdoors:

a. Pressure Class: Negative 2" w.g.

b. Seal Class: A

c. Leakage Class for Round Duct: 6

d. Leakage Class for Rectangular Duct: 6

e. Testing Requirement: 100%

2. Ductwork located in unconditioned spaces or fully ducted systems located above ceiling:

a. Pressure Class: Negative 2" w.g.

b. Seal Class: A

c. Leakage Class for Round Duct: 12

d. Leakage Class for Rectangular Duct: 12

e. Testing Requirement: 10%

3. Ductwork exposed in conditioned spaces or installed in ceiling return plenums:

a. Pressure Class: Negative 2" w.g.

b. Seal Class: A

c. Leakage Class for Round Duct: 24

d. Leakage Class for Rectangular Duct: 24

e. Testing Requirement: N/A

4. Ductwork connected to cabinet unit heaters, fan coil units, or heat pumps – 5 tons or less:

a. Pressure Class: Negative 2" w.g.

b. Seal Class: A

c. Leakage Class for Round Duct: 12

d. Leakage Class for Rectangular Duct: 12

e. Testing Requirement: N/A

5. Ductwork connected to equipment not listed above:

a. Pressure Class: Negative 2” w.g.

b. Seal Class: A

c. Leakage Class for Round Duct: 12

d. Leakage Class for Rectangular Duct: 12

e. Testing Requirement: N/A

D. Exhaust Ductwork:

1. Negative pressure general exhaust:

a. Pressure Class: Negative 2” w.g.

b. Seal Class: A

c. Leakage Class for Round Duct: 12

d. Leakage Class for Rectangular Duct: 12

e. Testing Requirement: N/A

2. Positive pressure general exhaust:

a. Pressure Class: Positive 2” w.g.

b. Seal Class: A

c. Leakage Class for Round Duct: 12

d. Leakage Class for Rectangular Duct: 12

e. Testing Requirement: 10%

3. Watertight and dishwasher hood exhaust:

a. Pressure Class: Negative 2” w.g.

b. Seal Class: Welded

c. Leakage Class for Round Duct: 3

d. Leakage Class for Rectangular Duct: 3

e. Testing Requirement: N/A

4. Grease Duct:

a. Pressure Class: Negative 2" w.g.

b. Seal Class: Welded

c. Leakage Class for Round Duct: 3

d. Leakage Class for Rectangular Duct: 3

e. Testing Requirement: 100% Light test (or other test approved by the Code Official in accordance with local and state codes).

3.04 FANS:

A. Coordinate roof opening and locations with structural system.

3.05 FAN POWERED BOXES AND VARIABLE VOLUME HEATING BOXES:

A. Coordinate unit location with lights, piping, ductwork and structural system. Units to be located to allow proper clearances for access and allow installation of ceilings at proper height.

B. Fan powered VAV boxes shall be hung from the structure using threaded rods and neoprene washers.

C. Units shall be located within two feet of the ceiling vertically to allow for proper maintenance.

D. Units shall be installed with a minimum uninterrupted straight duct run equal to two times the duct diameter immediately upstream.

E. Where filters are located within ductwork and where ductwork connects to fan powered VAV box inlets, filters shall be housed in factory-fabricated filter casings with channel rails to hold filter, gasketed access door, continuous piano hinge, cam latches, and duct closure on the opposite end.

END OF SECTION

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SECTION 23 50 00

CENTRAL HEATING EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY:

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

B. Work Included:

1. Breechings, Chimneys and Stacks

2. Heating Boilers

C. Related Sections:

1. Division 01 -- Commissioning

2. Section 23 00 10 – HVAC General Requirements

3. Section 23 05 00 – Common Work Results for HVAC

4. Section 23 05 48 – Vibration and Seismic Controls for HVAC Equipment and Piping

5. Section 23 05 53 – Identification for HVAC Piping and Equipment

6. Section 23 05 93 – Testing, Adjusting, and Balancing for HVAC

7. Section 23 07 00 – HVAC Insulation

8. Section 23 09 00 – Instrumentation and Control for HVAC

9. Section 23 20 00 – HVAC Piping and Pumps

10. Section 23 70 00 – Central HVAC Equipment

11. Section 23 80 00 – Decentralized HVAC Equipment

1.02 REFERENCES:

A. General: The following standards or codes form a part of this specification to the extent indicated by the reference thereto.

B. Air Moving and Conditioning Association, Inc. (AMCA):

Bulletin 210 Standard Test Code for Air Moving Devices

C. American Society of Mechanical Engineers (ASME):

ASME-95 Boiler and Pressure Vessel Code

D. American National Standards Institute (ANSI):

Standard B31.1 Code for Pressure Piping

E. National Fire Protection Association (NFPA):

Standard 30 Flammable and Combustible Liquids Code

F. National Electrical Manufacturers Association (NEMA)

G. Sheet Metal and Air Conditioning Contractors' Association (SMACNA)

Duct Construction Standards (Latest Edition)

H. International Fuel Gas Code

I. Underwriters Laboratories, Inc. (UL)

1.03 EQUIPMENT LABEL:

A. All mechanical equipment and appliances shall be listed and labeled by a nationally recognized testing and inspection agency approved by the authority having jurisdiction. All equipment and appliances shall be installed in accordance with the conditions of the listing. Manufacturer's installation instructions shall be available at the job site at the time of inspection.

1.04 INSPECTION CERTIFICATES:

A. All boilers and pressure vessels shall be inspected and have a certificate of inspection issued by the Virginia Department of Labor and Industry.

1.05 COMMISSIONING OF HVAC SYSTEMS:

A. The Contractor shall provide contact information to the Commissioning Agent indicated in Division 1 for all major items of Equipment.

B. Provide additional submittal copy of major equipment for Commissioning Agent specified in Division 1.

1.06 SUBMITTALS:

A. Submit shop drawings, product data and samples in accordance with Division 1 and Section 23 00 10.

B. Shop drawings, diagrams, catalog data and such other data necessary to fully describe and substantiate compliance with these specifications shall be submitted for all equipment and materials marked with notation set forth in Section 23 00 10.

C. Operation and maintenance data shall be submitted in accordance with Division1, for all items of equipment and materials marked with notation set forth in Section 23 01 00.

PART 2 - PRODUCTS

2.01 PACKAGED CONDENSING GAS-FIRED HOT WATER BOILER [S][O/M]:

A. General: Packaged gas-fired boilers shall be Fulton Endura Plus or equal, condensing type, complete with boiler fittings and automatic controls and designed for use with natural gas. The boiler with all wiring shall be completely factory assembled as a self-contained unit. Boiler design and construction shall be in accordance with Section IV of the ASME Code for hot water heating boilers with maximum water working pressure of 160 psi.

B. The boiler shall have no minimum return water temperature requirements. The boiler shall be a firetube design. The furnace location shall be such that all furnace components are within water-backed areas. Adequate openings shall be provided for access to the water side of the boiler. Temperature and pressure gauge shall be provided with the boiler.

C. Heat Exchanger: The boiler shall be a single-pass firetube design, such that all combustion chamber components are within water-backed areas. The heat exchanger furnace, tubesheets, and firetubes shall be constructed of duplex alloy stainless steel.

D. A zero flow or low flow condition shall not cause any harm to the pressure vessel or heat exchanger of the boiler. Flow switches, dedicated circulator pumps, or primary/secondary piping arrangements shall not be required to protect the heat exchanger or pressure vessel from thermal shock or other system related considerations. Boilers requiring the use of flow switches or primary/secondary piping arrangements are unacceptable.

E. The boiler shall vent using sealed combustion.

1. The flue (exhaust) stack shall be AL 29-4C or equivalent material UL-1738/C-UL S636 approved for Category IV condensing, positive pressure applications, or Polypropylene.

2. The air intake piping shall be Schedule 40 PVC or equivalent.

3. The boiler shall be capable of operating with an exhaust draft not exceeding -0.04” W.C. and a combined air intake and exhaust venting pressure drop not exceeding +1.50” W.C.

4. The boiler vent shop drawing shall be reviewed and approved by an authorized representative of the boiler manufacturer prior to submittal for review by the Architect/Engineer.

F. The boiler shall have a pre-mix combustion system, capable of operating at 4" W.C. incoming gas pressure while simultaneously achieving emissions performance, full modulation/turndown, and full rated input capacity.

G. The exhaust manifold shall be constructed of stainless steel, with a collection area for the ultimate disposal of flue gas condensate.

H. Blower shall be variable speed, non sparking, hardened aluminum impeller centrifugal fan to operate during each burner firing sequence and to pre-purge and post-purge the combustion chamber. Motor shall be brushless DC variable speed motor with hall effect sensor feedback; internal electronic commutation controller with built in speed control and protection features; long life, sealed, ball bearing with high temperature grease. Variable speed blower shall have PWM signal input with tachometer output.

I. The boiler control panel shall be constructed in a UL 508A approved panel shop.

J. Ignition shall be via direct spark or hot surface igniter. A UV scanner shall be utilized to ensure precise communication of flame status back to the flame programmer. Flame rods are not acceptable. Where hot surface igniters are provided, the Manufacturer shall include a minimum of one (1) spare for each boiler provided.

K. The boiler shall be capable of a minimum 15:1 firing rate turndown ratio. The boiler shall operate at no greater O2% than 8.0% over the entire turndown range in order to maximize seasonal efficiency. Boilers exceeding 8.0% O2 at any operating conditions will not be accepted.

L. The boiler shall maintain <20ppm NOx at all operating conditions.

M. Controls

1. The boiler electrical control panel shall include the following devices and features:

   a. 7" color touch screen control display factory mounted on the front cabinet panel door.

      1) The control display shall serve as a user interface for programming parameters, boiler control and monitoring; and shall feature a screen saver, screen disable for cleaning, contrast control, volume control for alarm features, boiler status, configuration, history and diagnostics.

   b. The boiler control panel shall be constructed in a UL 508 approved panel shop.

   c. 24 VAC control transformer.

   d. Control relay for 120 VAC motorized isolation valve control.

e. The flame safeguard control on the boiler shall be integrated with temperature control and lead/lag sequencing modular boiler plant functionality.

f. All controls are to be cabinet, vessel or panel mounted and so located on the boiler as to provide ease of servicing the boiler without disturbing the controls. All controls shall be mounted and wired according to UL requirements.

2. Boiler Operating Controls and Features:

a. Proportional Integral Derivative (PID) temperature load control capability for up to two loops, central heat and domestic hot water.

b. Operating temperature limit for automatic start and stop.

c. Flue gas exhaust temperature monitoring.

d. Return water temperature monitoring.

e. Time of day display.

f. Customizable boiler name display.

g. Alarm history for 15 most recent alarms including equipment status at time of lockout.

h. Password protection options.

3. Lead/Lag Control of Modular (Multiple) Boiler Plants: Lead/Lag capabilities shall be integral to the boiler controller for up to 10 boilers installed in the same hydronic loop and shall not require an external panel.

a. The boiler manufacturer shall provide a supply water header temperature sensor.

b. Lead/lag operation shall not require a master boiler or external control panel. Field wired sensors or communication may be connected to any boiler in the lead/lag sequence.

c. The boilers shall communicate with each other via a private Ethernet/IP addressed network.

1) Field wiring between boilers shall be shielded Cat5e or Cat6 Ethernet cable.

2) In the event a communication cable becomes damaged or interrupted, communication shall be lost with only one boiler and not the entire lead/lag operation. Daisy chain style wiring lacks this redundancy and shall not be accepted.

4. Sequence of Operation:

a. Upon loop temperature dropping below start point, the lead boiler shall be enabled at low fire and shall modulate according to the heating demand.

b. As lag boiler stages are enabled according to heating demand, burners shall return to low fire. Boilers shall modulate in parallel as a cohesive unit according to heating demand.

c. When all boilers are active they shall be released to modulate in parallel up to full fire according to the heating demand.

d. As heating demand decreases, the sequence shall operate in reverse.

e. Rotation of the lead and subsequent lag boilers shall be automatic.

f. Provide hot water reset based on outdoor air temperature.

g. Boiler isolation valves shall be opened and closed based on boiler operation.

5. Building Automation System Interface: Hardware and software to enable building automation system (BAS) to monitor, control, and display boiler status and alarms.

a. Hardwired Contacts:

1) Monitoring: Boiler Status, Burner Demand, General Alarm, Firing Rate.

2) Control with Factory Installed Jumper: Safety Interlock for External Device, Remote Boiler Enable, Remote Lead/Lag Enable, Emergency Stop (E-Stop)

3) Remote Setpoint Signal: 4-20 mA.

b. Communication Protocol: A communication interface with BAS shall enable BAS operator to remotely enable and monitor the boiler plant from an operator workstation.

1) The boilers will communicate with each other and the Building Automation System via a daisy chain addressed Modbus network. Field wiring between nodes shall be twisted pair low voltage with shielded ground.

2) A BACnet MSTP and IP protocol communication gateway shall be provided for each boiler. The BACnet gateway shall be field installed on all boilers. Communication only through the master boiler is unacceptable, communication must be maintained in the event of a master boiler power failure. A communication point mapping list shall be provided.

N. Burner selection:

1. The burner shall be a premix low emission design with abuilt-in flame arrestor functionality.

O. Boiler safety controls shall include:

1. Operating Temperature Limit for automatic start and stop.

2. High Limit: A single UL 353 temperature probe shall function as a dual-element outlet temperature sensor and shall comply with CSD-1 CW-400 requirements for 2 independent temperature control devices.

   a. High limit sensor shall be NTC resistive 10KOhm +/- 1% at 77°F. Sensor shall have brass material bulb with 1.181 +/- 0.015" insertion and 0.370 +/- 0.005" bulb diameter.

   b. Manual reset stops burner if operating conditions rise above maximum boiler design temperature.

P. Low Water Safety Relay monitoring a probe in the boiler pressure vessel.

   1. Air Safety Switch to prevent operation unless sufficient combustion air is proven.

   2. Flame detector to prove combustion.

   3. High condensate probe to prevent operation in the event of a blocked condensate drain.

   4. Blocked exhaust monitor to prevent operation in the event of a blocked condensate drain.

Q. All controls are to be burner or panel mounted and so located on the boiler as to provide ease of servicing the boiler without disturbing the controls. All controls shall be mounted and wired according to UL requirements. Electrical power supplied shall be 120/60/1.

R. Main Fuel Train Components

   1. A factory mounted main fuel train shall be supplied. The fuel train shall be fully assembled, wired, and installed on the boiler and shall comply with CSD-1 code. The fuel train components shall be enclosed within the boiler cabinet.

   2. A lock up regulator upstream of the fuel train shall be furnished by the boiler manufacturer as a standard component integral to the boiler cabinet. Factory test fire of the boiler with the provided lock up regulator is required.

   3. Standard CSD-1 fuel train shall comply with IRI, which has been replaced by GE GAP.

S. Boiler Fittings & Trim

   1. The boiler shall be supplied with an ASME Section IV safety relief valve. The safety relief valve size shall be in accordance with ASME code requirements.

   2. The boiler shall be supplied with a combination temperature and pressure gauge to be mounted on the water outlet piping of the boiler.

   3. A condensate drain connection shall be available on the boiler, allowing flue gas condensate to freely drain out of the exhaust manifold of the boiler. A condensate drain trap assembly shall accompany the boiler system, with pH neutralization accommodations available upon request.

a. Condensate drain piping must be galvanized or stainless steel. Copper, carbon steel, iron, PVC, CPVC, or polypropylene pipe materials are not accepted.

4. The water supply and return connections on the boiler shall be 4" diameter NPT threaded. The water connections shall not be designed to support any external structural load from the piping system.

5. The boiler shall come with lifting eyes and fork truck accessibility for rigging.

6. Instructions for installation, operation and maintenance of the boiler shall be contained in a manual provided with each boiler.

7. A wiring diagram corresponding to the boiler configuration shall be included with each boiler.

8. Each boiler shall be installed and operated in a functioning hydronic system, inclusive of venting, as part of the manufacturing process. A factory test fire report corresponding to the boiler configuration shall be included with each boiler.

T. Emissions

1. When operating on Natural Gas, the boiler shall have CO emissions less than 50 ppm corrected to 3% O2 and NOx emissions less than 20 ppm corrected to 3% O2, over the entire turndown range.

U. Warranty

1. The boiler manufacturer will repair or replace any part of the boiler that is found to be defective in workmanship or material within eighteen (18) months of shipment from the factory or twelve (12) months from start-up, whichever comes first.

2. The boiler's pressure vessel is warranted against failure due to thermal shock, flue gas condensate corrosion, and/or defective material or workmanship for a period of ten (10) years, non-prorated, from the date of shipment from the factory provided the boiler is installed, controlled, operated and maintained in accordance with the Installation, Operation and Maintenance Manual.

3. Warranty Period for the Burner: The boiler manufacturer shall warranty the burner against defective material or workmanship for a period of five (5) years, non-prorated.

4. Waterside corrosion or scaling is not covered. The manufacturer will repair, replace, exchange or credit at their option, FOB factory, the pressure vessel as defined above, provided this equipment has been installed, operated and maintained by the buyer in accordance with the Installation, Operation and Maintenance Manual.

PART 3 - EXECUTION

3.01 GENERAL:

A. All equipment and materials, specified herein or shown on the drawings shall be installed complete, coordinated with all other work, tested and made tight and put into safe controlled operation to perform its intended function as a part of this project.

B. All rooftop equipment shall be secured to the roof framing structure.

C. Boiler and water heater vents shall be installed in accordance with the manufacturers written instructions.

D. Boiler and water heater vents shall be installed with the outlet a minimum of 3 feet above the point of roof penetration and 2’-0” higher than any roof structure within 10’-0” of the roof penetration.

3.02 UNIT HEATERS:

A. Coordinate all heater locations with all lights, piping, ductwork and structural systems.

END OF SECTION

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SECTION 23 60 00

CENTRAL COOLING EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Related Documents: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specifications, apply to this Section.

B. Work Included:

1. Water Cooled Rotary Chiller

2. Cooling Tower

3. Tower Winterizing Accessories

C. Related Sections:

1. Division 01 -- Commissioning

2. Section 23 00 10 – HVAC General Requirements

3. Section 23 05 00 – Common Work Results for HVAC

4. Section 23 05 48 – Vibration and Seismic Controls for HVAC Piping and Equipment

5. Section 23 05 53 – Identification for HVAC Piping and Equipment

6. Section 23 05 93 – Testing, Adjusting, and Balancing for HVAC

7. Section 23 09 00 – Instrumentation and Control for HVAC

8. Section 23 20 00 – HVAC Piping and Pumps

9. Section 23 70 00 – Central HVAC Equipment

10. Section 23 80 00 – Decentralized HVAC Equipment

1.02 REFERENCES

A. General: The following standards or codes form a part of this specification to the extent indicated by the reference thereto.

B. Air Conditioning and Refrigeration Institute (ARI):

1. Guideline T – Thermal Performance for Cool Storage Equipment

2. Standard 550/590 – Standard for Water Chilling Packages Using the Vapor Compression Cycle

C. American Society of Mechanical Engineers (ASME):

ASME 95 – Boiler and Pressure Vessel Code

D. American National Standards Institute (ANSI):

Standard B31.1 – Code for Pressure Piping

E. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE):

Safety Code for Mechanical Refrigeration

F. Cooling Tower Institute (CTI):

Certification Standard STD-201

G. National Electric Manufacturers Association (NEMA)

H. Underwriters Laboratories, Inc. (UL)

1.03 COMMISSIONING OF HVAC SYSTEMS:

A. The Contractor shall provide contact information to the Commissioning Agent indicated in Division 1 for all major items of Equipment.

B. Provide additional submittal copy of major equipment for Commissioning Agent specified in Division 1.

1.04 SUBMITTALS

A. Submit shop drawings and product data in accordance with Division 1 and Section 23 00 10.

B. Shop drawings, diagrams, catalog data and such other data necessary to fully describe and substantiate compliance with these specifications shall be submitted for all equipment and materials marked with notation set forth in Section 23 00 10.

C. Operation and maintenance data shall be submitted in accordance with Division 1, for all items of equipment and materials marked with notation set forth in Section 23 01 00.

1.05 QUALITY ASSURANCE

A. All mechanical equipment and appliances shall be listed and labeled by a nationally recognized testing and inspection agency approved by the authority having jurisdiction. All equipment and appliances shall be installed in accordance with the conditions of the listing. Manufacturer's installation instructions shall be available at the job site at the time of inspection.

B. All pressure vessels shall be inspected and have a certificate of inspection issued by the Virginia Department of Labor and Industry.

C. Factory Startup: The chiller manufacturer shall provide a factory-trained representative to supervise refrigerant charging, controls setup, machine startup, and testing under actual load conditions. The representative shall also instruct operating personnel as to the proper care and operation of the chiller(s).

D. Testing: The chiller system shall be tested as a whole for safe, controlled operation by the manufacturer's representative. A letter, on manufacturer's letterhead, attesting to the successful test shall be submitted to the Engineer before requesting final acceptance of the system.

1.06 WARRANTY

A. Warranty shall be in accordance with Division 01 and Section 23 05 00.

B. Chiller manufacturer shall provide an additional four (4) year motor-compressor warranty for a total motor-compressor warranty of five (5) years.

C. Cooling tower manufacturer shall provide an additional four (4) year warranty on fans, fan shafts, bearings and fan motors for a total warranty of five (5) years.

1.07 EXTRA MATERIALS

A. Each belt driven piece of equipment shall be provided with one spare set of belts to be turned over to the Owner at the end of construction.

PART 2 - PRODUCTS

2.01 WATER COOLED ROTARY CHILLER [S] [O/M]:

A. General: The unit shall be a complete water cooled, water chilling plant complete with rotary screw compressors, evaporator, water-cooled condenser, starter, and control cabinet all mounted on a continuous structural base. The unit shall be semi-hermetic type using an environmentally acceptable refrigerant such as HFC-134a or HFC-410A.

B. Compressor shall be semi-hermetic rotary screw type, direct drive, with capacity control slide valve. Motor shall be squirrel cage induction type, hermetically sealed and suction gas cooled. Unit shall be complete with oil filtration and oil separator furnished and installed separate from the compressor.

C. Condenser shall be of the shell and tube construction. Marine type water boxes or flanged ells shall be provided to enable the tubes to be cleaned without disturbing the water piping. Tubes, tube sheets and tube support plates shall be constructed and tested in accordance with Section VIII of the ASME Boiler and Pressure Vessel Code for the working pressure produced by the refrigerant used and the water system installed. Tubes shall be fabricated from seamless copper tubing with integral fins and shall be individually replaceable and rolled or brazed into copper or steel tube sheets. Performance shall be based on a maximum allowable water velocity not to exceed 10 fps and a scale factor of 0.0001.

D. Evaporator shall be direct expansion type, multi-pass, tube-in-shell design with internally finned copper tubes roller expanded into steel tube sheets. Evaporator shall be stamped in accordance with ASME Boiler and Pressure Vessel Code and fitted with sight glass and relief valve in accordance with ASHRAE Standard 15. Evaporator shall be provided with automatic refrigerant control, automatic oil return and solenoid valve for each circuit. Evaporator shall be thermally insulated to prevent sweating when operating at ambient air dew point up to 70°F. Evaporator capacity shall be based on 0.0001 fouling factor.

E. Controls and Control Panel: Each water chilling unit shall be provided with controls of the microprocessor type properly coordinated with the BAS. All display points shall be analog type and shall also be communicated to the BAS as analog (actual) values unless indicated otherwise. The unit shall be provided with a display panel as well as communicate with the BAS to provide as a minimum the following:

1. Displays:

    a. Entering Chilled Water Temperature

    b. Leaving Chilled Water Temperature

    c. Entering Condenser Water Temperature

    d. Leaving Condenser Water Temperature

    e. Oil Sump Temperature

    f. Oil Differential Pressure

    g. Total Run Hours

    h. Percent Motor Rated Load Amps

    i. Condensing Temperature (Refrigerant)

    j. Condensing Pressure (Refrigerant)

k. Evaporator Temperature (Refrigerant)

l. Evaporator Pressure (Refrigerant)

m. Starter Fault (Binary Point)

n. Chilled Water Flow (Binary Point)

o. Condenser Water Flow (Binary Point)

p. Motor Overload (Binary Point)

2. Safeties and Protection: The chiller microprocessor shall independently control any abnormal condition of the above listed displays to unload or shutdown the compressor dependent on effects of condition. Any unscheduled shutdown or unloading for safety or protection shall be displayed on the unit control panel along with description of condition requiring the unloading and/or shutdown. The information displayed at the unit controller shall also be communicated to the BAS to initiate an alarm and description at the head-end computer. Safety and protection shall include, as a minimum, the following:

   a. Low Refrigerant Temperature Cut-Out

   b. High Pressure Cut-Out

   c. Low Oil Pressure Cut-Out

   d. Chilled Water Flow

   e. Condenser Water Flow

   f. Chilled Water Low Temperature

   g. Motor High Temperature

   h. Motor Overload

   i. Electrical Phase Loss/Reversal

3. Temperature adjustment and current demand controls shall be provided on the control console at the unit and through the BAS.

F. Electric motor shall be high efficiency constant speed, squirrel cage induction, hermetically sealed type, wound and provided with electrical connections for star delta or delta-delta starting on electric current characteristics shown.

G. Motor control center, NEMA Class II, Type C in NEMA I enclosure, completely factory wired and chiller mounted, shall be provided by the Chiller Manufacturer for the compressor, including protective devices, control transformer, magnetic starters and controls. The compressor motor starter shall be fusible star delta closed transition or delta-delta type matched

with the motor complete with integral power factor correction capacitors for 90% minimum power factor. Capacitors shall be cycled with compressor motor by means of fusible magnetic contactor. Each starter and contactor shall be provided with rejection type fuse clips, 120 volt control power transformer, pilot light, H-O-A switch and necessary auxiliary contacts. Provide individual rejection type Class R Fusetron fuses, or accepted equal, for all motors, controls, capacitors, heaters and related systems. Provide a main disconnect switch with external operator to disconnect all power and control circuits within enclosure.

H. Refrigerant and Oil: The manufacturer shall provide a complete charge of refrigerant and oil for field installation.

I. Tools: The manufacturer shall provide sufficient special tools as recommended for field maintenance of the system. Tools shall be contained in a tool box labeled "FOR CHILLER MAINTENANCE".

J. Factory Supervision: The services of a factory trained representative shall be provided for five working days. The representative shall advise on or accomplish the following:

1. Testing hermetic water chilling unit under pressure for leaks; evacuation and dehydration of machine to 35 degrees wet bulb or an absolute pressure of not over 0.204 inches of mercury.

2. Charging the machine with refrigerant.

3. Starting the machine and instructing operating personnel as to its proper care and operation.

4. Testing machine under actual load conditions and attesting in writing that successful automatic operation is achieved and the required capacity is produced.

K. Warranty: The unit manufacturer shall provide an additional four (4) year motor-compressor warranty for a total motor-compressor warranty of five (5) years.

2.02 COOLING TOWER [S] [O/M]:

A. General: Cooling Tower shall be Evapco or Baltimore Aircoil Company, factory assembled, forced draft, centrifugal fan type, vertical discharge. Each tower shall be complete with fill, casing, basin, frame, louvers, inlet screens, float valve assembly, fans, drain and overflow. Tower shall be structurally designed to withstand a 30 psf wind load. All joints shall be watertight and arranged to shed water inward. Removable panel shall be provided to all parts for service and maintenance. All bolts, nuts and washers shall be galvanized steel. All steel shall be protected with minimum G-235 galvanizing. Cooling Tower performance shall be certified in accordance with CTI STD-201.

B. Casing shall be galvanized steel and withstand wind loads of 30 psf. The fan deck and hot water basin covers shall be designed for 50 psf live load and 200 lb. concentrated live load.

C. Air inlet screens shall be galvanized steel, FRP or PVC.

D. Cold Water Basin shall be of one piece welded design with heavy gauge stainless steel floor and sides up to the overflow level. Basin shall be self-cleaning and complete with depressed center section, cleanout and drain fitting, side outlet sump with suction screen and anti-cavitation device and electric water level control with electric solenoid valve. The basin shall be designed to support the tower when resting on only two grillage beams. The basin shall be provided with side or bottom piping connections as required for piping arrangement indicated.

E. Distribution Basins shall be furnished complete with internal distribution piping for single point piping connection. The internal piping system shall provide equal flow to the distribution basins. Hot water distribution shall be of the open basin gravity type with plastic diffusing type metering orifices. Basins shall be provided with covers.

F. Fill and Drift Eliminator Material shall be non-corrosive, non-combustible and non-ferrous. Fill shall consist of vertical thermoformed sheets of 15 mil thick polyvinyl chloride (PVC) plastic with louvers formed as part of the fill. Drift eliminators shall be triple-pass PVC. Drift loss shall be limited to 0.01% water circulated at design flow rate.

G. Fans shall be centrifugal type. Motor shall be flange mounted and totally enclosed. Fans shaft shall be stainless steel External oil lines (and dip stick) shall be provided. The fan-drive assembly shall be protected from excessive vibration through a factory mounted vibration cut-out switch in a NEMA 4X enclosure.

H. Basin Heater shall be pre-wired packaged type with stainless steel element, safety float switch with stainless steel float, thermostat bulb and a galvanized NEMA 3 enclosure containing a circuit breaker, magnetic contactor, temperature switch and auxiliary contact.

I. Access Doors shall be not less than 24” wide and 30” high and shall be provided on both end walls for access to the eliminator and plenum section. Fan guard shall be provided over each fan cylinder.

J. Variable Frequency Drive:

1. A complete variable frequency drive system (VFD) shall be provided as specified hereinbefore.

K. Warranty: The unit manufacturer shall provide an additional four (4) year warranty on fans, fan shafts, bearings and fan motors for a total warranty of five (5) years.

L. Structural Supports or Dunnage shall be provided in addition to that indicated on the contract documents as necessary to support the tower in accordance with the recommendations of the manufacturer.

M. Ladder and Hand Rail shall be provided for access and safety on top of tower.

N. Where access to cold water basin exceeds 30 inches above the roof surface or surrounding grade, an OSHA approved service platform shall be provided. Platform shall include handrails and ladder to roof or grade.

O. See PART 1 for spare parts requirements.

2.03 COOLING TOWER WINTERIZING ACCESSORIES [S] [O/M]:

A. Pipe Heat Trace [S] shall be Chromalox, UL Listed, RAPID-TRACE, Type SRL self-regulating heating cable. Buss wires shall be 16 AWG copper. Heating matrix shall be semi-conductive polymer for self regulation. Jacket shall be water and chemical resistant, flame-retardant thermoplastic rubber with protective tinned-copper braid. Provide all accessories required for a safe watertight installation. Heat Trace shall protect piping indicated to -10°F. Heat trace shall meet all requirements of NEC-1999.

B. Low Water Cut-Off shall be float type. Install in cooling tower basin at suitable height to de-energize basin heater if water level is less than 2" above top of heater.

C. Water Level Controller shall be Magnetrol mercury displacer type liquid level switch with flanged mounting. Switch enclosure shall be NEMA-4 with epoxy painted cover and porcelain displacers. Suspension cable and all mounting components shall be stainless steel. Switch rating shall be minimum 10 amps at 120V AC. Units shall be suitable for maximum pressure of 175 psi at 100°F. Mount unit in stilling pipe as indicated on the Drawings.

PART 3 - EXECUTION

3.01 GENERAL:

A. All equipment and materials, specified herein or shown on the drawings shall be installed complete, coordinated with all other work, tested and made tight and put into safe controlled operation to perform its intended function as a part of this project.

B. All rooftop equipment shall be secured to the roof framing structure.

3.02 COOLING TOWERS:

A. Cooling towers shall be installed to be level within the tolerances allowable as published by the manufacturer.

B. No piping shall be supported by the cooling tower. Provide pipe supports as necessary. Service clearance areas shall not be impeded by piping.

END OF SECTION

SECTION 23 70 00

CENTRAL HVAC EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY:

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

B. Work Included:

1. Central Station Air Handlers

C. Related Sections:

1. Division 01 -- Commissioning
2. Section 23 00 10 – HVAC General Requirements
3. Section 23 05 00 – Common Work Results for HVAC
4. Section 23 05 48 – Vibration and Seismic Controls for HVAC Piping and Equipment
5. Section 23 05 53 – Identification for HVAC Piping and Equipment
6. Section 23 05 63 – Anti-Microbial Coatings for HVAC Ducts and Equipment
7. Section 23 05 93 – Testing, Adjusting, and Balancing for HVAC
8. Section 23 09 00 – Instrumentation and Control for HVAC
9. Section 23 20 00 – HVAC Piping and Pumps
10. Section 23 30 00 – HVAC Air Distribution
11. Section 23 50 00 – Central Heating Equipment
12. Section 23 60 00 – Central Cooling Equipment

1.02 REFERENCES:

A. General: The following standards or codes form a part of this specification to the extent indicated by the reference thereto.

B. Air Moving and Conditioning Association, Inc. (AMCA):

Bulletin 210 Standard Test Code for Air Moving Devices

C. Air Conditioning and Refrigeration Institute (ARI):

Guideline T Thermal Performance for Cool Storage Equipment

Standard 210 Standard for Unitary Air Conditioning Equipment

Standard 410 Standard for Forced Circulation Air Cooling and Heating Coils

Standard 430 Standard for Central Station Air Handling Units

D. American National Standards Institute (ANSI):

Standard B31.1 Code for Pressure Piping

E. American Society of Heating, Refrigeration and Air Conditioning Engineers (ANSI/ASHRAE):

Standard 15 Safety Code for Mechanical Refrigeration

F. National Fire Protection Association (NFPA):

Standard 30 Flammable and Combustible Liquids Code

Standard 90A Air Conditioning and Ventilating Systems of other than Residence Type

G. National Electrical Manufacturers Association (NEMA)

H. Sheet Metal and Air Conditioning Contractors' Association (SMACNA)

Duct Construction Standards (Latest Edition)

I. International Fuel Gas Code (IFGC)

J. International Energy Conservation Code (IECC)

K. Underwriters Laboratories, Inc. (UL)

1.03 EQUIPMENT LABEL:

A. All mechanical equipment and appliances shall be listed and labeled by a nationally recognized testing and inspection agency approved by the authority having jurisdiction. All equipment and appliances shall be installed in accordance with the conditions of the listing. Manufacturer's installation instructions shall be available at the job site at the time of inspection.

1.04 COMMISSIONING OF HVAC SYSTEMS:

A. The Contractor shall provide contact information to the Commissioning Agent indicated in Division 1 for all major items of Equipment.

B. Provide additional submittal copy of major equipment for Commissioning Agent specified in Division 1.

1.05 SUBMITTALS:

A. Submit shop drawings, product data and samples in accordance with Division 1 and Section 23 00 10.

B. Shop drawings, diagrams, catalog data and such other data necessary to fully describe and substantiate compliance with these specifications shall be submitted for all equipment and materials marked with notation set forth in Section 23 00 10.

C. Operation and maintenance data shall be submitted in accordance with Division1, for all items of equipment and materials marked with notation set forth in Section 23 01 00.

D. All fans for use with Variable Frequency Drives (VFD) shall have critical speed and multiples of critical speed indicated on each submittal.

1.06 SPARE PARTS:

A. Each cooling or heating unit shall be provided with 3 sets of filters. At end of construction each unit shall be provided with a clean filter and one set shall be turned over to the Owner as spares.

B. Each belt driven piece of equipment shall be provided with one spare set of belts to be turned over to the Owner at the end of construction.

PART 2 - PRODUCTS

2.01 INDOOR VAV HYDRONIC AIR HANDLERS [S] [O/M]:

A. Indoor air handling units shall be equal to Trane factory fabricated units furnished complete with all components as specified herein and as required by application and model number indicated on drawings. Units shall be single-zone draw through type complete with air-tight insulated and gasketed casing, supply and relief fans, motors, belt guards (as applicable), drain pan, cooling coils, heating coils, energy recovery wheel section, internal bypass section, energy recovery wheel bypass sections for economizer, filter section, mixing box, and internal spring type vibration isolators. Each unit shall have physical dimensions suitable for allotted space and allow complete removal of filters, coils, drain pans and accessories without having to dismantle the unit, adjacent equipment or building components. Unit mounted and wired

variable frequency drives (VFD) as specified hereinafter shall be provided for the supply and relief fans.

B. Casings for all sections of the unit shall be double wall galvanized steel construction with removable panels or access doors as required for each individual section of the unit. Casing shall be completely insulated internally with a minimum two-inch thick, one and one-half pound density fiberglass insulation.

C. Supply and relief fans shall be double width double inlet centrifugal type with galvanized steel housing. Fan wheel shall be air foil type mounted on solid steel fan shaft supported by grease lubricated ball bearing with average minimum life of 200,000 hours. Bearings shall be provided with lubrication facilities located outside of the unit enclosure. Fan shall be provided with unit mounted motor and drive. Drives shall be designed for 150% of the connected motor capacity and sheaves shall be adjustable to provide at least 20% speed variation. Sheaves shall be selected to drive the fan at a speed which will produce the specified capacity when set at its approximate midpoint. Fan shall be statically and dynamically balanced at the factory after unit has been assembled. Fan shall be certified in accordance with ARI 430.

1. Fan, motor and drives shall be internally mounted on a common steel base. Flexible canvas connection shall be installed between fan discharge and unit casing discharge to ensure isolation. Internal spring isolators with thrust restraints shall be factory installed with minimum two inch deflection.

2. Fan casing shall be provided with hinged, gasketed and insulated access door with quick opening latches. Access door shall be located on drive side of fan housing. Location of access shall be coordinated with drawings to assure adequate clearances and service capabilities.

D. Energy Wheel Section (where indicated)

1. The air handling unit shall have a total energy wheel. The energy wheel shall be an integral part of the air handling unit. The relief air portion of the energy wheel shall have an internal bypass damper.

2. The air handling unit shall be certified by ARI to contain a rotary energy recovery wheel that is ARI 1060 certified. The air handling unit nameplate shall bear the ARI 1060 certification label. Performance characteristics of the energy wheel shall be provided as defined by ARI 1060. The energy wheel shall be a total energy wheel. The total net effectiveness of the recovery device shall not be less than 70 percent when the specified ventilation flow rate equals the exhaust flow rate. Wheel face velocity shall not exceed 900 fpm and pressure drops shall be less than 1.25 in w.g. The energy recovery cassette shall be an Underwriters Laboratories (UL) Recognized Component certified for mechanical, electrical, and fire safety in accordance with UL Standard 1812.

3. The energy recovery wheel modules shall be housed in the same casing as specified above. The energy recovery component shall incorporate a rotary wheel in an insulated cassette frame complete with seals, drive motor, and drive. The energy recovery wheel shall incorporate a desiccant that shall not plug the aperture. Coated segments shall be washable

using standard detergent or alkaline-based coil cleaners. The desiccant shall not dissolve in the presence of water or high humidity. The rim shall be continuous rolled stainless steel to form an even concentric circle to prevent leakage around the rim. All diameter and perimeter seals shall be provided as part of the cassette assembly. Perimeter seals shall be self-adjusting; diameter seals shall be adjustable. Seals shall be factory set. Wheel bearings shall be permanently sealed and lubricated and have a minimum L-10 life of 400,000 hours.

4. The wheel drive motor shall be provided, mounted in the cassette frame and supplied with a connector for field service. The wheel drive motor shall be thermally protected and UL Component Recognized. Drive belts shall require no belt tensioners. The wheel drive motor shall be no greater than 0.5 hp.

5. Energy recovery media for wheels larger than 25 inches in diameter shall be provided in the form of removable segments.

6. Access doors shall be provided to allow for the removal of wheel segments. Access shall be provided for motor, bearing and belt removal.

7. Control of the energy wheel shall be incorporated into the air handler control system and shall be as described in Section 23 09 00. The energy recovery device shall be designed with variable effectiveness control. The air handler manufacturer shall provide an internal by pass dampers for this control. The wheel's variable effectiveness control shall have the ability to modulate the wheel's total energy recovery effectiveness to 40 percent of the initial total recovery capacity.

8. Provide replaceable filters at each outside air intake opening. Maximum velocity across the filters shall be 350 fpm.

E. Coils:

1. Heating coils shall be steam coils as specified in Section 23 80 00.

2. Cooling coils shall be water coils as specified in Section 23 80 00.

3. All coils shall be installed within casing sections. Coil casings shall completely enclose all coil items including headers and return bends. Casing shall provide a minimum of six inches between coils to allow for field mounting of sensors or instrumentation. Casing shall provide removable access panels for removal of coils without disassembling remainder of unit. Condensate drain pans are required for all cooling coils. Stacked cooling coils shall be provided with intermediate drain pans internally piped to main drain pan. Coil drain pans shall be insulated to prevent sweating under all conditions. Drain pan shall be provided with mastic coating to prevent corrosion. Drain pan shall slope to drain all moisture collected from the coil. Drain piping connections shall be provided at the lowest point of the drain pan.

F. Internal bypass section and economizer energy recovery wheel bypass sections shall be factory fabricated internal bypass type complete with galvanized steel dampers, and linkage. Casing

shall be as specified hereinbefore with removable access panels of adequate size for inspection and service of dampers and mechanisms. Dampers shall be low leakage type with maximum leakage not to exceed 3 cfm per square foot at one inch water gage. Internal bypass damper arrangement shall provide proper mixing of outside air in separate section and return air while having capability of modulating either air stream.

G. Combination filter mixing box section shall be factory fabricated of same construction and of physical size to match unit casing as previously specified. Section shall include angular filter holding racks, outside air and return air dampers. Section shall be complete with hinged access doors located on both sides to facilitate filter media installation and replacement. Section shall be provided with block-off panels and means of sealing around filter media to prevent the bypass of unfiltered air. Filter face velocity shall not exceed 350 feet per minute. Fiberglass filters shall be pleated media, UL Class 2 listed and labeled, two inches thick, MERV-8 efficiency. Dampers for outside air and return air shall be full size of unit openings and shall be low leakage type with maximum leakage rate not to exceed 3 cfm per square foot at one inch water gauge. Damper arrangement shall provide proper mixing of outside air and return air while having capability of modulating either air stream.

H. Heating and cooling coils shall be water coils as specified in Section 23 80 00.

I. Condensing (outdoor) unit (AHU-2A only) shall be complete with compressor-motor unit, condenser coil, welded-wire or stamped sheet metal condenser coil guards, condenser fans, motor starters, controls and piping enclosed in a sheet steel enclosure recommended for outside installation. Condenser fans shall be vertical or horizontal discharge as shown. Intake and discharge openings shall be provided with welded-wire or stamped sheet metal coil guards. Condensing unit controls shall provide automatic capacity modulation and condenser and evaporator pressure control for operation down to 0°F outside air temperature. Crankcase heater shall be provided in compressor body.

1. Refrigerant piping and specialties are specified in Section 23 20 00.

2. Controls for safe automatic controlled operation of each system (including hot gas bypass) shall be provided. Operation shall be as specified in Section 23 09 00. Provide thermostat to limit cooling coil discharge air to 45°F or above by cycling the compressor(s).

3. Refrigerant: Each system shall be cleaned, purged and completely charged with refrigerant and oil, and guaranteed to be free of leakage for one year.

4. Warranty: Motor-compressor shall be guaranteed for five (5) years.

J. All VAV units shall be provided with an internal and integral airflow monitoring station for measuring minimum outside airflow. Accuracy shall be + 5% with an operating temperature range of –20°F to 120°F. Airflow monitoring station shall be compatible with the Building Automation System specified in 23 09 00. The airflow signal shall be an industry standard 0-10 vdc, 2-10 vdc, or 4-20 mA for analog input to the Building Automation System.

K. Performance Test: Each system shall be tested and checked out for safe controlled operation. One week before final inspection, a letter in three copies from the certified representative shall be submitted to the Engineer certifying that each system is performing safely and satisfactorily.

L. See PART 1 for spare parts requirements.

2.02 ROOFTOP AIR HANDLERS [S] [O/M]:

A. General: Rooftop air handling units shall be Trane or Daikin factory fabricated units furnished complete with all components as specified herein and as required by application and model number indicated on drawings. Units shall be single-zone draw through type complete with air-tight and weather-tight insulated and gasketed casing, fans, motors, adjustable, belt guards (as applicable), drain pan, cooling coils, heating coils, filter section, mixing box, and internal spring type vibration isolators. Each unit shall have physical dimensions suitable for allotted space and allow complete removal of filters, coils, drain pans and accessories without having to dismantle the unit, adjacent equipment or building components. Rooftop units shall be sized to allow piping to enter the unit within the curb and to allow valves and accessories within the unit casing. Where units are indicated to be variable air volume, unit mounted and wired variable frequency drive (VFD) as specified hereinafter) shall be provided for the supply and return/exhaust fans.

B. Casings for all sections shall be double wall galvanized steel construction with hinged, gasketed access doors as required for each individual section of the unit. Casing shall be completely insulated internally with a minimum two-inch thick, one and one-half pound density fiberglass insulation.

Provide separate access section between coils for inspection and maintenance. Length of the access section shall be proportional to the width of the unit to allow access to all areas of the coil.

C. Supply and return fan shall be centrifugal type with galvanized steel housing. Fan wheel shall be mounted on solid steel fan shaft supported by grease lubricated ball bearing with average minimum life of 200,000 hours. Bearings shall be provided with lubrication facilities located outside of the unit enclosure. Fan shall be provided with unit mounted motor and drive. Drives shall be designed for 150% of the connected motor capacity and sheaves shall be adjustable to provide at least 20% speed variation. Sheaves shall be selected to drive the fan at a speed which will produce the specified capacity when set at its approximate midpoint. Fan shall be statically and dynamically balanced at the factory after unit has been assembled. Fan shall be certified in accordance with ARI 430.

1. Fan, motor and drives shall be internally mounted on a common steel base. Flexible canvas connection shall be installed between fan discharge and unit casing discharge to ensure isolation. Internal spring isolators with thrust restraints shall be factory installed with minimum two inch deflection.

2. Fan casing shall be provided with hinged, gasketed and insulated access door with quick opening latches. Access door shall be located on drive side of fan housing. Location of

access shall be coordinated with drawings to assure adequate clearances and service capabilities.

D. Energy Wheel Section (where indicated)

1. The air handling unit shall have a total energy wheel. The energy wheel shall be an integral part of the air handling unit. The relief air portion of the energy wheel shall have an internal bypass damper.

2. The air handling unit shall be certified by ARI to contain a rotary energy recovery wheel that is ARI 1060 certified. The air handling unit nameplate shall bear the ARI 1060 certification label. Performance characteristics of the energy wheel shall be provided as defined by ARI 1060. The energy wheel shall be a total energy wheel. The total net effectiveness of the recovery device shall not be less than 70 percent when the specified ventilation flow rate equals the exhaust flow rate. Wheel face velocity shall not exceed 900 fpm and pressure drops shall be less than 1.25 in w.g. The energy recovery cassette shall be an Underwriters Laboratories (UL) Recognized Component certified for mechanical, electrical, and fire safety in accordance with UL Standard 1812.

3. The energy recovery wheel modules shall be housed in the same casing as specified above. The energy recovery component shall incorporate a rotary wheel in an insulated cassette frame complete with seals, drive motor, and drive. The energy recovery wheel shall incorporate a desiccant that shall not plug the aperture. Coated segments shall be washable using standard detergent or alkaline-based coil cleaners. The desiccant shall not dissolve in the presence of water or high humidity. The rim shall be continuous rolled stainless steel to form an even concentric circle to prevent leakage around the rim. All diameter and perimeter seals shall be provided as part of the cassette assembly. Perimeter seals shall be self-adjusting; diameter seals shall be adjustable. Seals shall be factory set. Wheel bearings shall be permanently sealed and lubricated and have a minimum L-10 life of 400,000 hours.

4. The wheel drive motor shall be provided, mounted in the cassette frame and supplied with a connector for field service. The wheel drive motor shall be thermally protected and UL Component Recognized. Drive belts shall require no belt tensioners. The wheel drive motor shall be no greater than 0.5 hp.

5. Energy recovery media for wheels larger than 25 inches in diameter shall be provided in the form of removable segments.

6. Access doors shall be provided to allow for the removal of wheel segments. Access shall be provided for motor, bearing and belt removal.

7. Control of the energy wheel shall be incorporated into the air handler control system and shall be as described in Section 23 09 00. The energy recovery device shall be designed with variable effectiveness control. The air handler manufacturer shall provide an internal by pass dampers for this control. The wheel's variable effectiveness control shall have the ability to modulate the wheel's total energy recovery effectiveness to 40 percent of the initial total recovery capacity.

8. Provide replaceable filters at each outside air intake opening. Maximum velocity across the filters shall be 350 fpm.

E. Coils:

1. Heating coils shall be steam coils as specified in Section 23 80 00.

2. Cooling coils shall be water coils as specified in Section 23 80 00.

3. All coils shall be installed within casing sections. Coil casings shall completely enclose all coil items including headers and return bends. Casing shall provide a minimum of six inches between coils to allow for field mounting of sensors or instrumentation. Casing shall provide removable access panels for removal of coils without disassembling remainder of unit. Condensate drain pans are required for all cooling coils. Stacked cooling coils shall be provided with intermediate drain pans internally piped to main drain pan. Coil drain pans shall be insulated to prevent sweating under all conditions. Drain pan shall be provided with mastic coating to prevent corrosion. Drain pan shall slope to drain all moisture collected from the coil. Drain piping connections shall be provided at the lowest point of the drain pan.

F. Combination filter mixing box section shall be factory fabricated of same construction and of physical size to match unit casing as previously specified. Section shall include angular filter holding racks, outside air and return air dampers. Section shall be complete with hinged access doors located on both sides to facilitate filter media installation and replacement. Section shall be provided with block-off panels and means of sealing around filter media to prevent the bypass of unfiltered air. Filter face velocity shall not exceed 350 feet per minute. Dampers for outside air and return air shall be full size of unit openings and shall be low leakage type with maximum leakage rate not to exceed 3 cfm per square foot at one inch water gauge. Damper arrangement shall provide proper mixing of outside air and return air while having capability of modulating either air stream.

G. Filter section shall be angular type factory fabricated, of same construction and of physical size to match unit casing as previously specified. Filter section shall be complete with filter guides, holding frames and block-off sections as required for filter application. Section shall be complete with hinged access doors on each side to facilitate filter media installation and replacement. Provide, integral with filter frame, means of sealing filter installations to prevent bypass of unfiltered air. Filter face velocity shall not exceed 500 feet per minute.

1. Fiberglass filters shall be pleated media, UL Class 2 listed and labeled, two inches thick of the efficiency indicated on the Drawings at the airflows indicated for each unit. Filters media shall have a rigid frame around entire perimeter and rigid support grille on entering and leaving faces to adequately support the filter media.

H. Mixing box section shall be factory fabricated complete with outside air, return air dampers and linkage. Casing shall be as specified hereinbefore with removable access panels of adequate size for inspection and service of dampers and mechanisms. Dampers shall be low leakage type with maximum leakage not to exceed 3 cfm per square foot at one inch water gauge.

Mixing section and dampers shall be fabricated to provide mixing of the two air streams within the section prior to entering the remainder of the unit.

I. Economizer section shall be factory fabricated complete with outside air, return air and exhaust air dampers and linkage. Casing shall be as specified hereinbefore with removable, hinged, access panels of adequate size for inspection and service of dampers and mechanisms. Dampers shall be low leakage type with maximum leakage not to exceed 3 cfm per square foot at one inch water gauge. Mixing section and dampers shall be fabricated to provide mixing of the two air streams within the section prior to entering the remainder of the unit.

J. Outdoor air dampers shall be provided for 100% outdoor air units. Casing shall be as specified hereinbefore with removable, hinged, access panels of adequate size for inspection and service of dampers and mechanisms. Dampers shall be low leakage type with maximum leakage not to exceed 3 cfm per square foot at one inch water gauge.) (Casing shall be provided with a 100% outdoor air hood to prevent entry of moisture and rain into the rooftop unit.

K. All VAV units shall be provided with an internal and integral airflow monitoring station for measuring minimum outside airflow. Accuracy shall be $\pm$ 5% with an operating temperature range of –20°F to 120°F. Airflow monitoring station shall be compatible with the Building Automation System specified in 23 09 00. The airflow signal shall be an industry standard 0-10 vdc, 2-10 vdc, or 4-20 mA for analog input to the Building Automation System.

L. All duct openings in unit floor over 12 inches wide shall have personnel-load-rated safety grates.

M. Rooftop units shall be provided with factory fabricated curb, 12” – 14” high. The roof curb shall be pitched to match the pitch of the roof such that the top of the curb is level without the use of shims or other similar type devices. Curb sidewalls shall be fully insulated to minimum R-5. Top of curb shall be gasketed for airtight fit of rooftop unit.

N. Performance Test: Each system shall be tested and checked out for safe controlled operation. One week before final inspection, a letter in three copies from the certified representative shall be submitted to the Engineer certifying that each system is performing safely and satisfactorily.

O. See PART 1 for spare parts requirements.

PART 3 - EXECUTION

3.01 GENERAL:

A. All equipment and materials, specified herein or shown on the drawings shall be installed complete, coordinated with all other work, tested and made tight and put into safe controlled operation to perform its intended function as a part of this project.

B. All rooftop equipment shall be secured to the roof framing structure.

3.02 ROOFTOP AIR HANDLING AND AIR CONDITIONING UNITS:

A. Coordinate all openings and location with structural systems.

B. Contractor's attention is directed to Section 23 05 48 Vibration and Seismic Controls for HVAC Piping and Equipment for requirements.

C. Install and connect unit in accordance with manufacturer's recommendations and contract drawing details. Should conflicts in the two occur notify the Architect/Engineer.

D. Coordinate all control items with Section 23 09 00 Instrumentation and Control for HVAC.

END OF SECTION

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SECTION 23 80 00

DECENTRALIZED HVAC EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY:

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

B. Work Included:

1. Ductless Split System Air Conditioners
2. Heating and Cooling Coils
3. Hot Water Baseboard Heaters
4. Electric Wall Heaters
5. Unit Heaters
6. Miscellaneous Appurtenances

C. Related Sections:

1. Division 01 -- Commissioning
2. Section 23 00 10 – HVAC General Requirements
3. Section 23 05 00 – Common Work Results for HVAC
4. Section 23 05 48 – Vibration and Seismic Controls for HVAC Piping and Equipment
5. Section 23 05 53 – Identification for HVAC Piping and Equipment
6. Section 23 05 93 – Testing, Adjusting, and Balancing for HVAC
7. Section 23 09 00 – Instrumentation and Control for HVAC
8. Section 23 20 00 – HVAC Piping and Pumps
9. Section 23 30 00 – HVAC Air Distribution
10. Section 23 50 00 – Central Heating Equipment
11. Section 23 60 00 – Central Cooling Equipment

1.02 REFERENCES:

A. General: The following standards or codes form a part of this specification to the extent indicated by the reference thereto.

B. Air Moving and Conditioning Association, Inc. (AMCA):

Bulletin 210	Standard Test Code for Air Moving Devices

C. Air Conditioning and Refrigeration Institute (ARI):

Standard 210	Standard for Unitary Air Conditioning Equipment
Standard 240	Standard for Unitary Heat Pump
Standard 310	Standard for Packaged Terminal Air Conditioners
Standard 410	Standard for Forced Circulation Air Cooling and Heating Coils
Standard 440	Standard for Room Fan Coil Air Conditioners

D. American National Standards Institute (ANSI):

Standard B31.1	Code for Pressure Piping

E. American Society of Heating, Refrigeration and Air Conditioning Engineers (ANSI/ASHRAE):

Standard 15	Safety Code for Mechanical Refrigeration

F. National Fire Protection Association (NFPA):

Standard 90A	Air Conditioning and Ventilating Systems of other than Residence Type

G. National Electrical Manufacturers Association (NEMA)

H. Sheet Metal and Air Conditioning Contractors' Association (SMACNA)

Duct Construction Standards (Latest Edition)

I. Underwriters Laboratories, Inc. (UL)

1.03 EQUIPMENT LABEL:

A. All mechanical equipment and appliances shall be listed and labeled by a nationally recognized testing and inspection agency approved by the authority having jurisdiction. All equipment and appliances shall be installed in accordance with the conditions of the listing. Manufacturer's installation instructions shall be available at the job site at the time of inspection.

1.04 COMMISSIONING OF HVAC SYSTEMS:

A. The Contractor shall provide contact information to the Commissioning Agent indicated in Division 1 for all major items of Equipment.

B. Provide additional submittal copy of major equipment for Commissioning Agent specified in Division 1.

1.05 SUBMITTALS:

A. Submit shop drawings, product data and samples in accordance with Division 1 and Section 23 00 10.

B. Shop drawings, diagrams, catalog data and such other data necessary to fully describe and substantiate compliance with these specifications shall be submitted for all equipment and materials marked with notation set forth in Section 23 00 10.

C. Operation and maintenance data shall be submitted in accordance with Division1, for all items of equipment and materials marked with notation set forth in Section 23 01 00.

1.06 SPARE PARTS:

A. Each cooling or heating unit shall be provided with 3 sets of filters. At end of construction each unit shall be provided with a clean filter and one set shall be turned over to the Owner as spares.

B. Each belt driven piece of equipment shall be provided with one spare set of belts to be turned over to the Owner at the end of construction.

PART 2 - PRODUCTS

2.01 DUCTLESS SPLIT SYSTEM AIR CONDITIONERS [S] [O/M]:

A. General: Equipment specified under this heading shall be manufactured by Mitsubishi, Daikin, Sanyo, or equal. Each system shall consist of condensing unit, air unit, refrigerant piping and system controls. Each system shall conform with the applicable ARI standards.

B. Condensing (outdoor) unit shall be complete with compressor-motor unit, condenser coil, welded-wire or stamped sheet metal condenser coil guards, condenser fans, motor starters, controls and piping enclosed in a sheet steel enclosure recommended for outside installation. Condenser fans shall be vertical or horizontal discharge. Intake and discharge opening shall be safely guarded. Condensing unit controls and accessories shall provide automatic capacity modulation and condenser and evaporator pressure control for operation down to 0°F outside air temperature. Crankcase heater shall be provided. Unit shall be supported in accordance with manufacturer’s installation instruction.

C. Fan coil unit (indoor) shall be a wall mounted configuration complete with cooling coil. Fan motor and drive, filters, controls, refrigerant piping, insulated enclosure and guide vanes on air discharge. Cooling Coils shall be non-ferrous direct expansion type. Filters shall be manufacturer provided, permanent, washable filter which is user accessible. Provide capillary tube and sight glass for each cooling coil circuit.

D. Condensate pump shall be, in addition to manufacturer supplied unit, Sauermann Model # Si-3200. Pump shall be rated for minimum 3.3 GPH; 3.3 feet suction head; and 10 feet discharge head. Unit shall be provided with condensate drain pan safety switch to de-energize the unit upon accumulation of water in the drain pan.

E. Refrigerant piping and specialties shall be as specified in Section 23 20 00.

F. Controls for safe automatic controlled operation of the system (including low ambient controller, winter start control, evaporator freeze thermostat, crankcase heater, cycle protector, thermostatic expansion valve kit) shall be from wall mounted controller. All accessory controls shall be installed in accordance with manufacturer's recommendation.

G. Refrigerant: The piping system shall be completely charged with refrigerant and oil, and guaranteed to be free of leakages for one year.

H. Performance Test: The system shall be tested with a thoroughly cleaned filter and checked out for safe controlled operation. One week before final inspection, a letter in three copies from the certified representative shall be submitted to the Engineer certifying that the system is performing safely and satisfactorily.

I. Warranty: Motor-compressor shall be guaranteed for five (5) years.

J. See PART 1 for spare parts requirements.

K. Set rooftop condensing unit on roof mounted equipment supports. Supports shall be factory fabricated equipment mounting pedestals sized for the weight of the equipment indicated. Pedestals shall be minimum 12 inches high, complete with equipment rail, slide channel "U" shaped mounting brackets, 18 gauge threaded galvanized rods, lateral spacer bracket and galvanized slide assembly. Supports shall be located to adequately support duct with no more than 4 feet of duct unsupported.

L. Indoor unit shall be mounted maximum 6" below the ceiling.

2.02 HEATING AND COOLING COILS [S]:

A. General: This specification applies to all coils whether remote mounted, mounted in factory fabricated air handling units or mounted in site-built units and shall be used as a guideline to establish the minimum requirements unless definitely specified otherwise for the particular case involved.

B. Steam coils shall be constructed of cast semi-steel, seamless work hardened copper, or welded steel headers, red brass or copper tubes and aluminum fins mechanically bonded. Tubes shall

be rolled and brushed or welded into headers. Tubes shall be 5/8 inch or 1 inch diameter, staggered, full circulating, and completely drainable. Tube wall shall be minimum 0.020 inch thickness. Fins shall be minimum .0075 inch thickness. Coil support frame shall be heavy gauge galvanized steel with heavy gauge flanges and support plates. Fin tube and header section shall float with the casing to allow free expansion of tubing. Coils shall be factory tested and suitable for 200 psi working pressure. Coils shall be full tube face, steam distributing tube type with orificed distributing tubes installed concentric inside of condenser tubes.

C. Water coils shall be full tube face, fin and tube type constructed of seamless copper tubes and aluminum fins mechanically bonded to tubes. Coil support frame shall be heavy gauge galvanized steel with heavy gauge flanges and support plates. Tubes shall be 1/2 inch or 5/8 inch diameter, staggered, full circulating, and completely drainable. Tube wall shall nominally be minimum 0.020 inch thickness (and minimum 0.014 inch thickness for fan coil and VAV unit coils). Fins shall be minimum .0075 inch thickness. Coils shall be factory tested and suitable for 150 psi working pressure. Mount coils for counter flow service. Where coils are furnished in sections, the return connection to each section shall be provided with a balancing cock. Cooling coil ratings shall be certified in accordance with ARI Standard #410. Maximum cooling coil face velocity shall not exceed 550 feet per minute. Fin spacing shall be such that there are a maximum of 12 fins per inch.

D. Direct expansion (DX) refrigerant evaporator coils shall be full tube face, fin and tube type constructed of seamless copper tubes and aluminum fins mechanically bonded to tubes. Coil support frame shall be heavy gauge galvanized steel with heavy gauge flanges and support plates. Tubes shall be 1/2 inch or 5/8 inch diameter. Tube wall shall be minimum 0.020 inch thickness. Fins shall be minimum .0075 inch thickness. Tubes shall be staggered and circuited with equalizing distributing tubes to match the number of compressor refrigerant circuits provided. Coil circuiting shall be full face interlaced type where required for optimum capacity reduction. Units shall be provided with brass liquid distributors for each circuit. Coils shall be factory proof tested at 450 psig and leak tested at 300 psig, cleaned, dehydrated and sealed with dry nitrogen charge. Coils shall be coordinated with the manufacturer of the condensing unit for capacities indicated. Cooling coil ratings shall be certified in accordance with ARI Standard #410. Maximum cooling coil face velocity shall not exceed 550 feet per minute.

E. Heating and cooling coils in the same unit shall be provided as separate coils with independent fin sheets to allow preheat, dehumidification, and individual removal of each coil.

2.03 HOT WATER BASEBOARD HEATERS [S]:

A. Convectors shall be equal to Vulcan complete with a back panel, front enclosure, heating elements, hangers, and accessories as required for complete installation.

Heating element shall be constructed of aluminum fins mechanically bonded to seamless copper tubing, type as indicated. Elements shall be designed and tested for safe operation at 100 psi hot water.

B. Element support shall attach to the back panel, be vertically adjustable for pitch, provide for free longitudinal movement for expansion and contraction, and shall support and bear on the tube, not the fins.

C. Enclosure shall be of style indicated. Front panel shall consist of a three-sided, 16 gauge steel cabinet with die formed inlet air openings, and a continuous bar type discharge grille. Back panel shall be 20 gauge steel, the full height of the enclosure, and shall be pre-punched for fastening to the wall and attaching element hangers. Enclosures, sleeves, end caps and accessories shall be provided as required for finished installation. Color will be selected by the architect.

D. Control section shall be provided where required for controls or accessories, matching the enclosure design, and shall be a 12" removable section equipped with a key operated, cam locking device and a stop.

E. Dampers shall be provided where indicated.

F. Submittal data for convectors shall include drawings showing elevation of each convector to indicate how convector enclosures are coordinated with the building factors.

2.04 ELECTRIC WALL HEATERS [S] [O/M]:

A. Wall heaters shall be Markel Commercial down-flow model complete with enclosure, front panel, aluminum or corrosion resistant steel sheathed heating element, thermal limit switch, fan and fan motor and built-in disconnect switch and thermostat. All controls shall be concealed. Each unit shall be recessed type unless shown otherwise. Mount units nominal 12" above floor (except in toilets mount units nominal 6" below ceiling.)

2.05 UNIT HEATERS [S] [O/M]:

A. Electric unit heaters shall be Markel heavy duty unit heater complete with UL approved steel finned tubular electric heating element, thermal limit switch, direct connected motor and propeller fan, decorative steel enclosure, individually adjustable louvers, suspension hanger accessories, built-in non-fused disconnect switch, wall thermostat and contactor. Unit heater fan and heating element shall be factory wired.

B. See PART 1 for spare parts requirements.

2.06 MISCELLANEOUS APPURTENANCES [S] [O/M]:

A. Flow switch shall be mounted in chilled water line at the chiller and shall be McDonnel FS-4 with paddle size appropriate for line in which installed.

B. Miscellaneous electric appurtenances such as transformers, solenoid valves, electric relays, selector switches, on-off switches, pilot lights and other similar items required by the electric

sequence control diagrams and not shown to be provided by the Electrical Contractor shall be provided as part of the Mechanical Contract.

1. On-Off switches shall be toggle type, 20 amp. contract rating complete with engraved cover plate where required.

2. Relays shall be G.E., Square D, or Cutler-Hammer 20 amp rating with sufficient contacts for the sequence indicated.

3. Unit heater thermostats for space mounting shall be Johnson Controls T26, line voltage type with SP-ST switching action rated 6 amp. full load and 36 amp. locked rotor at 120 volts.

4. Exhaust fan thermostats shall be Johnson Controls T22 with auto-off fan switch. The thermostat shall be rated for 6 amps. at 120 volts.

5. Firestats shall be UL approved, Johnson Controls A25 manual reset type with an adjustable temperature setting. Set at 125°F.

6. Thermostat guards shall be rectangular wire and all required accessories for wall mounting. Guards shall have ample openings to allow fast sensing of room air conditions. Guards and baseplate shall be selected and sized to suit type of thermostat and mounting where installed.

C. Pipe Heat Trace [S] shall be Chromalox, UL Listed, RAPID-TRACE, Type SRL self-regulating heating cable. Buss wires shall be 16 AWG copper. Heating matrix shall be semi-conductive polymer for self regulation. Jacket shall be water and chemical resistant, flame-retardant thermoplastic rubber with protective tinned-copper braid. Provide all accessories required for a safe watertight installation. Heat Trace shall protect piping indicated to -10°F.

D. Blowdown separator [S] [O/M] shall be Johnston Boiler Company, or accepted equal, complete with after cooler, drain and vent fittings and ASME stamped for 150 psi service.

E. Equipment rails for rooftop condensing units shall be Roof Products and Systems (RPS), Model ER-4 or equal. Equipment rails shall be fabricated of 18 gauge galvanized steel with built-in cant, monolithic construction with integral base plate and continuous mitered and welded corner seams, with factory installed wood 2x4 nailer. Each equipment rail shall include a matching 18 gauge galvanized steel counterflashing cap with integral drip edge, all corners mitered and welded, and screws for attachment. Equipment Rails over 3 feet long shall incorporate 14 gauge internal gusset reinforcing. Rail height shall be 9”-16”.

F. Dampers and Damper Motors:

1. Automatic control dampers shall be opposed blade construction for modulating service and parallel blade construction for two-position service. Dampers shall be of the multi-louver construction with brass bearings, channel iron frame and maximum width of 10”. Damper blades shall be interlocking felt edged and air tight.

2. Damper motors shall be provided for all automatic dampers and shall be sufficient capacity to operate the connected damper. Damper motor shall be electric type.

PART 3 - EXECUTION

3.01 GENERAL:

A. All equipment and materials, specified herein or shown on the drawings shall be installed complete, coordinated with all other work, tested and made tight and put into safe controlled operation to perform its intended function as a part of this project.

B. All rooftop equipment shall be secured to the roof framing structure.

3.02 ROOFTOP CONDENSING UNITS:

A. Rooftop condensing units shall be installed on factory fabricated equipment rails as hereinbefore specified.

3.03 UNIT HEATERS:

A. Coordinate all heater locations with all lights, piping, ductwork and structural systems.

END OF SECTION