

PROJECT MANUAL – VOLUME 2A

Mechanical Specifications

Issued for Construction

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PART 1 GENERAL

1.1 SCOPE OF WORK

- .1 It is intended for the Division 20, 21, 22, 23 scope of work to include complete and functional systems - including all required materials, labor, equipment, and services necessary to achieve the desired final product. It is further intended for the Division 20 scope of work to include coordination with Divisions 21 and 22 and Division 23 for complete Fire Protection, Plumbing and HVAC systems.

1.2 COORDINATION OF DIVISIONS 20, 21, 22 AND 23

- .1 Divisions 20, 21, 22 and 23 are used to communicate the requirements for the total Fire Protection, Plumbing and HVAC scope of work. It is intended for these four Divisions to serve as a single document, communicating the combined Mechanical scope of work, inclusive of Fire Protection, Plumbing and HVAC.

1.3 GENERAL REFERENCES

- .1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 specification sections, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.
- .2 Division 00 and Division 01 of these specifications shall govern Mechanical work, including Bidding Requirements, Conditions of the Contract, and Supplementary Conditions. It is the Mechanical Contractor's responsibility to be aware of all information and requirements included in these locations, and to include those requirements as part of the Mechanical scope of work.
- .3 This section applies to all Division 20, 21, 22, 23 work. The Division 20, 21, 22, 23 Contractor shall ensure that all Division 20, 21, 22, 23 work described throughout other specification sections and on the drawings is in accordance with this section.
- .4 It shall be understood by the Contractor that Divisions 20, 21, 22 and 23 information is intended to serve as a single document, and each section of these specifications directly or indirectly relates to all other sections. As such, each section does not attempt to identify every other Division 20, 21, 22 and/or 23 section that is related. Significant references to information outside of Division 20, 21, 22 and 23 are, however, occasionally provided for informational purposes. This information is provided to assist in coordination, but the lack of a reference to another portion of the Contract Documents does not relieve the Contractor of the responsibility for coordination with other sections of Divisions 20, 21, 22 and 23 and all other trades.

1.4 RELATED REQUIREMENTS

- .1 References to other Divisions and Sections of these specifications are occasionally provided to assist in coordination. These references are not intended to be comprehensive. It is the responsibility of the Contractor to coordinate between specification Sections and Divisions, and ensure any coordination with other Sections or Divisions necessary for compliance is executed.

1.5 REFERENCE STANDARDS

- .1 References to industry standards, testing procedures, etc. are noted in individual sections of these specifications. The requirements and standards from the referenced documents shall be considered part of the requirements of these specifications.

1.6 APPLICABLE CODES AND STANDARDS

- .1 Division 20, 21, 23, 23 work shall be performed in accordance with applicable codes and standards as adopted by the authorities having jurisdiction including amendments.

Following is a listing of major codes and standards, the requirements of which shall be considered part of the scope of this project. This list should not be considered comprehensive, and codes or standards not included in this list should not be excluded from the scope of the project.

- .1 Americans with Disabilities Act (ADA)
- .2 Applicable State and Local Codes and Ordinances
- .3 National Electrical Code
- .4 International Building Code
- .5 International Fire Code
- .6 International Mechanical Code
- .7 Uniform Plumbing Code

1.7 ABBREVIATIONS AND ACRONYMS

- .1 The following are industry abbreviations used in these specifications:
 - .1 ABS: Acrylonitrile-butadiene-styrene plastic
 - .2 AHJ: Authority Having Jurisdiction
 - .3 ASJ: All-service jacket
 - .4 BAS: Building automation system
 - .5 BR: Butyl rubber; Buna-N: Nitrile rubber
 - .6 CPVC: Chlorinated polyvinyl chloride plastic
 - .7 CR: Chlorosulfonated polyethylene synthetic rubber
 - .8 CSM: Chlorosulfonyl-polyethylene rubber
 - .9 CWP: Cold working pressure
 - .10 DDC: Direct digital control
 - .11 DOP: Dioctyl phthalate or bis-(2-ethylhexyl) phthalate
 - .12 EMCS: Energy Management and Control System
 - .13 EMS: Energy Management System consisting of BAS (typically with a PC and support software), DDC controllers, and networking software/hardware/wiring.
 - .14 EPDM: Ethylene-propylene-diene terpolymer rubber
 - .15 FOG: Fats, oils, and greases
 - .16 FRP: Fiberglass-reinforced plastic
 - .17 FSK: Foil, scrim, kraft paper
 - .18 FSP: Foil, scrim, polyethylene
 - .19 HDPE: High-density polyethylene plastic
 - .20 HEPA: High-efficiency particulate air
 - .21 I/O: Input/output
 - .22 LLDPE: Linear, low-density polyethylene plastic
 - .23 MS/TP: Master slave/token passing
 - .24 MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc
 - .25 NBR: Acrylonitrile-butadiene rubber
 - .26 NC: Noise criteria; NR: Natural rubber
 - .27 NUSIG: National Uniform Seismic Installation Guidelines
 - .28 PE: Polyethylene plastic
 - .29 PEX: Crosslinked polyethylene plastic
 - .30 PC: Personal computer

- .31 PID: Proportional plus integral plus derivative
- .32 PMMA: Polymethyl methacrylate (acrylic) plastic
- .33 PP: Polypropylene plastic
- .34 PTFE: Polytetrafluoroethylene plastic
- .35 PUR: Polyurethane plastic
- .36 PVC: Polyvinyl chloride plastic
- .37 PVDC: Polyvinylidene chloride
- .38 RC: Room criteria
- .39 RTD: Resistance temperature detector
- .40 SSL: Self-sealing lap
- .41 SWP: Steam working pressure
- .42 TFE: Tetrafluoroethylene plastic
- .43 TPE: Thermoplastic elastomer
- .44 ULPA: Ultra low penetration air

1.8 DEFINITIONS

- .1 The following definitions shall apply to the use of these words when used in Division 20, 21, 22, 23. These definitions are not intended to define use of these words outside of Division 20, 21, 22, 23.
- .2 Acceptance: The Owner's assumption of ownership of the Mechanical systems.
- .3 Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- .4 Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.
- .5 Contractor (The Contractor, This Contractor, Division 20, 21, 22, 23 Contractor, etc.): The contractor responsible for the Division 20, 21, 22, 23 scope of work.
- .6 Date of Acceptance: The official date when Acceptance occurs. This will coincide with the granting of Substantial Completion unless noted otherwise by the Owner's Representative. It shall not be assumed that the Date of Acceptance has deviated from Substantial Completion unless written documentation is provided by the Owner's Representative indicating differently.
- .7 Electrical: Shall be considered interchangeable with "Division 26".
- .8 Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- .9 Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- .10 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, crawlspace, and tunnels.
- .11 Mechanical: Shall be considered interchangeable with "Division 20, 21, 22, 23".
- .12 Owner's Representative: The primary consultant or their designated representative, as outlined in the General Conditions.
- .13 Provide: Furnish and install.

1.9 SUBMITTALS

- .1 General

- .1 The Contractor is responsible for identifying all required submittals throughout these specifications, and following the required procedures for each type of submittal.
- .2 Action Submittals
 - .1 Submittal information shall be provided and approved on all materials and equipment prior to ordering.
 - .2 Materials or equipment that are procured, and work that is executed, without completing Action Submittal review shall be at the Contractor's risk.
 - .3 Review will be for general conformance only and shall not relieve the Contractor for any deviations from the requirements of the documents unless clear written reference is made by the Contractor in the submittal to proposed deviations.
 - .1 Exceptions: Fire protection and EMCS submittals can be provided separately. At the discretion of the Owner's Representative, partial submittals may be provided. If allowed, provide a table indicating submittal status with each submittal, and provide an initial submittal with all required tabs and space for all current and future submittals.
 - .4 Provide one file per division containing one bookmarked PDF file with each bookmark corresponding to each Specification Section. Arrange bookmarks in ascending order of Specification Section number. Individual submittals sent piecemeal will be returned without review or comment. At Contractor's option, four separate submittals may be provided consisting of long lead items, underground/site work, building work, and building automation system. Deviations will be returned without review.
 - .5 All submittals must be provided as clearly marked and highlighted to identify which subsection of the specifications is being submitted. Submittals must clearly cross out or remove items in the submittal that do not apply to the project.
 - .6 Provide product submittals and shop drawings in native/searchable PDF format, submitted via email. Scanned copies are not acceptable.
 - .7 Provide indication of which options and accessories are to be included.
 - .8 Include all scheduled information for equipment listed in schedules on the drawings.
 - .9 Efficiency Standards
 - .1 Units requiring more than a 5% increase in power input beyond the scheduled equipment to meet design capacities will not be considered equal.
 - .2 Units requiring more than a 15% increase in fan brake horsepower over the scheduled equipment to meet the design flow and external static pressure requirements will not be considered equal and will not be accepted.
- .3 Informational Submittals
 - .1 Submit Informational Submittals for documentation purposes.
- .4 Operation and Maintenance Materials
 - .1 Provide operation and maintenance data for individual equipment after initial submittals have been reviewed.
 - .2 Operation and Maintenance Manuals shall be provided in three post binders capable of having materials added or removed. Standard clasp-type binders are not acceptable. Binders with overlapping, telescoping posts shall be used.
 - .3 Provide a title page at the beginning of the manual with the project title, date, Architect, Engineer, and Contractor. Also provide a master index. The title page and index shall be provided at the beginning of each volume when multiple volumes are required.
 - .4 Organize the manual into five divisions: Contacts, Equipment, Maintenance Schedule and Extra Materials, Energy Management and Controls System, Warranties and Certifications.

- .1 Contacts division: Division shall consist of name, address, and phone number of the following parties: Architect, Mechanical Engineer, Electrical Engineer, General Contractor, Mechanical Contractor, Plumbing Contractor, Sheet Metal Contractor, EMCS Contractor, Electrical Contractor and major equipment suppliers.
- .2 Equipment division: Provide a separate section for each section of the specifications. Each section shall include, at a minimum, the following for each item of Division 20, 21, 22, 23 equipment.
 - .1 Performance curves or tables showing the specified operating points and the operating points after final testing and balancing
 - .2 Manufacturer's maintenance instructions: Instructions shall include name of vendor, installation instructions, parts numbers and lists, operating instructions for equipment, maintenance and lubrication instructions, troubleshooting guides, and overhaul specifications for major equipment.
 - .3 Wiring diagrams
 - .4 Step-by-step procedures for putting each piece of mechanical equipment into operation
 - .5 Refer to individual specification sections for additional information required to be incorporated into the Operation and Maintenance Manual.
- .3 Maintenance Summary and Extra Materials division: Division shall include two sections.
 - .1 The first section shall consist of a preventative maintenance schedule summary table (or list). The table shall be organized by specification section and include equipment name and designation as it appears on the equipment schedule, equipment location, and type and frequency of preventative maintenance requirements (including lubrication).
 - .2 The second section shall consist of a list of extra materials furnished under this contract. The list shall be organized by specification section and include equipment name and designation as it appears on the equipment schedule, extra material(s) furnished, and verification by an owner's representative that material(s) have been provided. List shall be similar to that included at the end of this section.
- .4 Energy Management and Controls System division: Division shall be as specified in 230900.
- .5 Warranties and Certificates division: Division shall include
 - .1 Test and balance reports
 - .2 Test records of piping, tanks, ductwork, etc
 - .3 Signed checklist of Instruction Period
 - .4 Certificate from Health Department indicating acceptance of domestic water quality
 - .5 Copies of specific product Warranties
 - .6 Copies of certified factory start-up reports
 - .7 Valve tag identification schedules
 - .8 Fire sprinkler system certification
- .5 Prior to binding, submit one copy of Operation and Maintenance Manual to Owner's Representative for review. After this review and final approval of the manuals, prepare two (2) copies of approved manuals for use during the instruction period. Following instruction period, turn over both copies to the Owner.
- .6 Manuals may be compiled in multiple volumes if necessary for ease of use.

.5 Record Documents

- .1 Maintain a set of Contract Documents dedicated for record drawings. These documents shall incorporate all clarifications and changes provided by the Owner's Representative, as well as field changes made by the Contractor. All markings shall be neat and legible. Turn over documents to the Owner's Representative at the completion of the project.
- .2 Submit record documents that include accurate dimensioned record drawings of all underground work, above ground piping, and ductwork systems. Record documents shall be submitted in electronic format.

1.10 WARRANTIES

.1 General Warranty Requirements

- .1 The warranty period shall begin at the date of Substantial Completion.
- .2 If temporary use of equipment and/or systems is allowed prior to substantial completion, that shall not initiate the warranty period unless specifically noted otherwise. The warranty period shall be extended for equipment and systems as required to comply with the project warranty requirements.
- .3 Provide software and firmware updates for all equipment and systems that become available during the warranty period.
- .4 Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

.2 Special Warranty Requirements

- .1 Warranty requirements included in individual specification sections are supplemental to the general warranty requirements for the project. All requirements are intended to be additive, and in no way to lessen general project warranty requirements. If general project warranty requirements are more stringent than requirements listed in an individual section, the more stringent requirement shall take precedence.
- .2 Documentation shall be provided for required additional warranties, and included in Operation and Maintenance Materials.

1.11 QUALITY ASSURANCE

.1 Material and Equipment Qualifications

- .1 Provide materials and equipment that are standard products of manufacturers regularly engaged in the manufacture of such products, which are of a similar material, design and workmanship. Standard products shall have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year use shall include applications of equipment and materials under similar circumstances and of similar size. The product shall have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2 year period.
- .2 Alternative Qualifications: Products having less than a two-year field service record will be acceptable if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturer's factory or laboratory tests, can be shown.

.2 Service Support: The equipment items shall be supported by service organizations. When requested to gain approval, submit a certified list of qualified permanent service organizations for support of the equipment which includes their addresses and qualifications. These service organizations shall be reasonably convenient to the equipment installation and able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

.3 Manufacturer's Nameplate: Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

- .4 UL Listings: All equipment shall be provided with a UL or approved equivalent label when labeling is available for that type of equipment.
- .5 Fuel-fired equipment shall be labeled by the appropriate nationally recognized label for the fuel type (i.e. AGA).
- .6 All control panels shall be UL listed (or equivalent approved label).
- .7 Pressure vessels shall be provided in accordance with applicable pressure vessel ordinances.
- .8 All Mechanical equipment shall have an AIC rating of 100,000 or otherwise specified on electrical one-line diagrams fault current for each piece of equipment.

1.12 PRE-INSTALLATION TESTING

- .1 Perform all required testing prior to installation of the affected systems and equipment.
- .2 Provide all required documentation of pre-installation testing.
- .3 When review and acceptance of pre-installation testing and documentation is required, any affected work performed without required acceptance shall be at the Contractor's risk.

1.13 MOCK-UPS AND SAMPLES

- .1 Provide all required mock-ups and samples prior to proceeding with affected work.
- .2 Provide all required documentation.
- .3 When review and acceptance of mock-ups and samples is required, any affected work performed without required acceptance shall be at the Contractor's risk.

1.14 COORDINATION

- .1 Contractor shall prepare above ceiling coordination drawings for efficient installation of different components and coordination for installation of products and materials fabricated by each trade.
 - .1 Content: Project-specific information, drawn accurately to scale, 1/4 inch per foot (1/8 inch per foot) . Do not base Coordination Drawings on reproductions of the Contract Documents or standard printed data. Include the following information, as applicable:
 - .1 Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
 - .2 Indicate required installation sequences.
 - .3 Indicate dimensions shown on the Contract Drawings and make specific note of dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Architect for resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.
 - .2 Sheet Size: 24 by 36 inches.
 - .3 Number of Copies: Electronic submissions are preferred. Where not feasible, provide the following.
 - .1 Submit two opaque copies of each submittal. Architect will return one copy.
 - .2 Submit five copies where Coordination Drawings are required for operation and maintenance manuals. Architect will retain two copies; remainder will be returned. Mark up and retain one returned copy as a Project Record Drawing.
 - .4 Refer to individual Sections for Coordination Drawing requirements for Work in those Sections.

1.15 DELIVERY, STORAGE AND HANDLING

- .1 Follow manufacturer's directions in delivery, storage, protection, and installation of equipment and materials.

- .2 Promptly notify Owner's Representative in writing of conflicts between requirements of Contract Documents and Manufacturer's directions and obtain written instructions from Owner's Representative before proceeding with work. The Contractor shall bear expenses arising from correcting deficiencies of work that do not comply with manufacturer's directions or such written instructions from Owner's Representative.
- .3 Handle, store, and protect equipment and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer. Replace damaged or defective items.
- .4 Store ductwork in a clean, dry location. If the location of storage cannot be protected from moisture, keep ductwork above grade level to protect from standing water.

1.16 EXTRA MATERIALS

- .1 Refer to individual specification sections for specific requirements of extra materials to be furnished under this contract.
- .2 Provide summarized list of extra materials that have been furnished. List shall include verification by Owner's Representative that parts have been furnished. Incorporate into O&M Manual. Extra materials list shall be similar to that provided at the end of this section.

1.17 PERMITS AND FEES

- .1 All permits and inspections required to complete the Division 20, 21, 22, 23 scope of work shall be included in the prices of the respective divisions' bid prices. All certifications provided as part of the permit and inspection process shall be provided to the Owner as part of the Mechanical scope of work as specified in these documents.
- .2 All fees required by utility providers shall be included in the 20, 21, 22, 23 bid price, including water, gas, sanitary sewer, and storm sewer connections. This shall include all charges to the project by these agencies, including but not limited to general fees, equipment charges (meters, vaults, etc.), tap fees, and utility main installation charges.

1.18 ALTERNATES

- .1 Alternate pricing shall reflect a complete and working mechanical system, with specific features and/or portions of the systems designated as base bid or alternate as described.

1.19 SCOPE AND APPROPRIATE USE OF BID DOCUMENTS

- .1 These specifications and accompanying drawings are intended to communicate the design concept for this project and outline the scope of work. They should not be viewed as a comprehensive document that details every specific task, item, or piece of equipment required to complete the project. It is understood that industry knowledge and experience is required to establish an accurate and complete scope of work from these documents, and it is assumed that the Division 20, 21, 22, 23 Contractors possess that knowledge and experience. Work not specifically noted in these specifications or the accompanying drawings, but which is required to complete the project, shall be included by the Division 20, 21, 22, 23 Contractors as part of their scope of work.
- .2 These specifications and the accompanying drawings are intended to supplement each other. Information included in either one shall be incorporated into the project as if included in both. In the event of any conflicts, the most stringent requirements shall be considered the governing scope of work until and unless clarification can be obtained by the Contractor.
- .3 In the event of dimensional discrepancies between Division 20, 21, 22, 23 documents and other disciplines, Architectural and Structural documents take precedence over Division 20, 21, 22, 23. Refer to this information for sufficient understanding to the extent that it impacts the Division 23 scope of work.
- .4 Drawings are intended to indicate the general arrangement of piping, ductwork, equipment and other components of Division 20, 21, 22, 23 systems. They shall be followed as closely

as possible, but shall be considered diagrammatic in nature. They are not intended to show every component, fitting, offset, etc. Components, fittings, offsets, etc. as required to meet the intent of the documents and to achieve coordination with other trades shall be included in the Division 20, 21, 22, 23 scope of work. Note that more detailed information about routing may be provided for certain areas of the project where special constraints exist. It is the intent of this detailed information to better communicate the constraints, but these drawings and details shall still be considered diagrammatic in nature as outlined above.

1.20 ROUTING AND LOCATIONS

- .1 It is the Contractor's responsibility to coordinate equipment locations and system routing with available space and with all other trades.
- .2 It is the Contractor's responsibility to coordinate and verify the exact locations and routing of equipment and systems prior to fabrication and installation. If discrepancies become apparent as part of the verification process, the Contractor shall ask for written clarification/direction. Alteration, removal and/or replacement of work already installed as a result of failure to verify and/or coordinate locations and routing prior to fabrication and/or installation shall be at the Contractor's expense.
- .3 Locations of equipment shown on the drawings are approximate unless specifically dimensioned.
- .4 All ductwork, piping, tubing, conduit, etc. shall be concealed within building construction unless noted otherwise. Mechanical rooms are considered to be within building construction for the purposes of this requirement.
- .5 Existing utilities, piping, and ductwork have been indicated as closely as possible. The Contractor can assume that points of connection to existing utilities have been shown within 10 feet (3 meters) of the actual location. When actual points of connection are more than 10 feet (3 meters) from the location shown on the drawings, the Contractor shall notify the Owner's Representative prior to commencing this portion of the work.
- .6 The Contractor is responsible for any remedial work required from failure to locate and preserve underground utilities. This shall include all work necessary to repair any damaged utilities to their original condition.

1.21 SCHEDULING

- .1 It is understood that while drawings are to be followed as closely as circumstances permit, the Contractor shall be responsible for installation of systems according to the true intent and meaning of Contract Documents. Anything not clear or in conflict will be explained by making application to Owner's Representative. The Contractor shall familiarize himself with his scope of work as well as the required coordination with other trades and the scheduling of other trades sufficiently to address coordination issues in a timely manner such that they do not result in remedial work for other trades.
- .2 Should conditions arise where certain changes would be advisable, secure approval from Owner's Representative for those changes before proceeding with work. Proceeding without written approval is at the Contractor's risk and at the Contractor's expense.
- .3 The contractor shall coordinate with the work of various trades when installing interrelated work. Before installation of mechanical items, proper provisions shall be made to avoid interferences. Changes required in work specified in Division 20, 21, 22, 23 caused by neglect to do so shall be made at no cost to Owner.
- .4 Inserts and supports required by Division 20, 21, 22, 23 shall be furnished and installed unless otherwise noted. Furnish sleeves, inserts, supports, and equipment that are an integral part of other Divisions of the Work to those involved in sufficient time to be built into construction as the Work proceeds. Locate these items and see that they are properly installed. Expense resulting from improper location or installation of items above shall be borne under Division 20, 21, 22, 23.

1.22 CUTTING AND PATCHING

- .1 The Division 20, 21, 22, 23 Contractor shall be responsible for all cutting and patching required to complete the Division 20, 21, 22, 23 scope of work.
- .2 All patching shall be performed such that it matches existing finishes.
- .3 The Contractor shall not cut any structural members without first getting approval from the Owner's Representative to do so.
- .4 All cutting and patching required to correct defective or otherwise unacceptable work shall be the responsibility of the Division 20, 21, 22, 23 Contractor.

1.23 GUARANTEE

- .1 All Division 20, 21, 22, 23 systems and equipment shall be guaranteed for a minimum period of one year.
- .2 Specific equipment and/or systems requiring warranties beyond one year are indicated in the table at the end of this section.
- .3 The guarantee shall begin at the Date of Acceptance, unless written documentation is provided noting otherwise. When more than one Date of Acceptance is indicated for various portions or specific equipment, the guarantee shall begin at the Date of Acceptance independently for each portion of the system or piece of equipment.
- .4 Permission to use Division 20, 21, 22, 23 systems or equipment for temporary heating or other contractor use prior to the Date of Acceptance, as outlined elsewhere in these specifications, shall not constitute the beginning of the guarantee period. The contractor shall make any necessary arrangements to extend equipment and/or system warranties sufficient to maintain the designated guarantee period from the Date of Acceptance.
 - .1 Exception: When temporary heating and or other system use is requested by the Owner for the Owner's benefit prior to the Date of Acceptance, the guarantee period for the portions of the system or specific equipment requested for use may begin at the time it is put into service. This can only be assumed to have occurred if written documentation is provided indicating such.

1.24 SUBSTITUTIONS

- .1 When multiple manufacturers are listed in these specifications, equipment can be used from those manufacturers providing they can meet the requirements of the specifications and drawings. This shall include meeting capacity requirements, efficiencies, space and weight limitations, electrical provisions, etc. The detailed information in the specifications, scheduled equipment information, additional drawing information and any specific references to a particular manufacturer and/or model of equipment shall be considered the basis of design. Other listed manufacturers, even when listed in these specifications, will only be allowed if they meet or exceed that basis of design.
- .2 Substitutions involving manufacturers not listed in these specifications will not be allowed without written approval. When written approval is requested, information will be reviewed in preliminary fashion for general conformance only. Any approved manufacturers will still be required to meet the requirements of these specifications and the drawings, and final approval during submittal review will only be granted if the equipment meets or exceeds the requirements of the documents.
- .3 It is the Contractor's responsibility when utilizing approved substituted equipment to ensure the equipment will fit within the constraints of the project as detailed using the basis of design equipment (space, weight, power, etc.). Any required alterations by Division 20, 21, 22, 23 or any other Division of work to accommodate differences between the substituted equipment and the basis of design equipment shall be the responsibility of the Division 20, 21, 22, 23 Contractor, including the cost of design for the required changes.

- .4 If the changes required by substituted equipment cannot be accommodated, the Contractor shall be responsible for replacing the substituted equipment with the basis of design equipment.
- .5 Proposed substituted equipment will not be considered equal if it requires an increase of more than 5% in power usage at design conditions.

1.25 PAYMENT REQUESTS

- .1 Submittals and operation and maintenance data must be received and approved before payment requests will be considered for materials and equipment.
- .2 BMS submittals must be received before payment requests will be reviewed for this portion of the work. Only payment requests for programming and submittals will be reviewed until submittals are approved.
- .3 Fire sprinkler system submittals, including code-approved shop drawings, must be received before payment requests will be reviewed for this portion of the work. Only payment requests for design and submittals will be reviewed until submittals are approved.

1.26 TEMPORARY HEATING

- .1 Temporary heating shall not be provided by the permanent mechanical system.
 - .1 Exception: The Owner's Representative may choose to allow the Contractor to use the permanent mechanical system. In such cases, the Contractor shall obtain written authorization from the Owner's Representative. In no case shall the permanent system be used until and unless this written authorization is granted.
- .2 If allowed to use the permanent systems for temporary heating, the following constraints shall apply:
 - .1 The contractor shall be responsible for providing a clean system at substantial completion, to include pressure cleaning of coils and vacuum cleaning of ductwork if required to negate the effects of use during construction.
 - .2 Granting the use of equipment and systems for temporary heat will not constitute Acceptance of equipment, and will not start the warranty or guarantee period for the Owner.
 - .3 System guarantee and equipment warranties shall be extended to maintain the guarantee and warranty periods from the Date of Acceptance. Any costs associated with extension of warranties shall be at the Contractor's expense.
 - .4 Filters shall be installed meeting the requirements of these documents. When multiple stages of filtration are provided on a system, filters meeting the requirements of the first stage of filtration shall be provided and maintained during use. A minimum of MERV 13 filtration filters shall be used during this time, even if this requirement is more stringent than the requirements for permanent filtration. New filters shall be provided prior to system balancing.
 - .5 Filter fabric shall be provided at all return grilles, and shall be replaced as appropriate to maintain a clean system.

1.27 VISITING THE PROJECT SITE

- .1 The premises shall be examined and conditions shall be understood which may affect performance of work of this Division before submitting proposals for this work.
- .2 No subsequent allowance for time or money will be considered for any consequence related to failure to examine existing site conditions.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 START UP SERVICE

- .1 Refer to individual sections of these specifications for specific requirements.
- .2 Start-up shall be performed by a certified representative when required. Prior to start-up, certification of representative shall be forwarded to the Engineer for review.
- .3 Schedule start-up with the Owner. Perform operation and maintenance training at the time of start-up for equipment requiring start up service.

3.2 CLEANING

- .1 Leave all equipment and systems in a clean and new condition at the completion of the project. Clean all piping and ductwork exposed in finished spaces. Remove all stickers from equipment in finished spaces (plumbing fixtures, etc.). Repair all scratched and damaged equipment to new condition, to include touch-up painting.

3.3 DEMONSTRATION AND TRAINING

- .1 Provide two training sessions for the Owner. The first training session shall occur prior to substantial completion. The second training session shall occur prior to completion of the warranty period. The content below is required for the first training session. The content for the second training session shall be as requested by the Owner, up to and including all information included in the first training session.
- .2 Operation and maintenance of mechanical systems utilizing Operation and Maintenance Manual. During the training session, each piece of equipment shall be located, and all information included in the O&M manuals shall be demonstrated to the satisfaction of the Owner's Representative.
- .3 Individuals present shall include the mechanical contractors, subcontractors and equipment factory representatives as appropriate. Certified factory representatives shall be present for all equipment requiring certified factory start-up.
- .4 Provide a video tape of the training sessions conducted and furnish copies of the tape to the Owner. Video tapes shall be of sufficient quality to allow training of future employees or refresher training of personnel. Turn over to the Owner in DVD format.
- .5 The two training sessions shall each occur in one consolidated session for all mechanical equipment.
 - .1 Exceptions:
 - .1 Training for equipment requiring certified factory start-up shall be conducted at the time of start-up.
 - .2 Multiple sessions shall be scheduled as required to maintain a maximum allowable duration of any single session of four hours.
 - .3 When separate training sessions are warranted to achieve proper training on all equipment and systems, as determined by the owner's representative, multiple sessions shall be scheduled as required.
 - .4 EMCS system training shall occur independently, and shall be in accordance with the requirements of Section 23 09 00 .
 - .5 Training session shall include all equipment included in the table at the end of this section. A table similar to this one shall be used to verify owner training has been completed on all equipment, and shall be included in the Operation and Maintenance Manual.

3.4 PUNCH LISTS

- .1 Notify the Owner's Representative in writing when the project is ready for punch lists.
- .2 When all punch list items have been addressed, notify the Owner's Representative in writing that the project is ready for a backcheck of completed punch list items. Include a copy of the

original punch list with each completed item initialed and any required notation indicating if something was not completed and why.

- .3 If, at the time of the backcheck, items are found that continue to be in nonconformance with the project documents, these items will be forwarded to the Contractor. Completion of these items shall be required to achieve substantial completion. All site visits required beyond the initial punch list and initial back check visits, including visits required to verify completion of these remaining outstanding items, shall be charged to the Contractor at normal billing rates.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- .1 Access Doors.
- .2 Pipe, Tube and Fittings.
- .3 Joining Materials.
- .4 Transition fittings.
- .5 Dielectric fittings.
- .6 Mechanical sleeve seals.
- .7 Sleeves.
- .8 Stack-Sleeve Fittings
- .9 Sleeve-Seal Systems.
- .10 Sleeve-Seal Fittings.
- .11 Escutcheons.
- .12 Floor Plates.
- .13 Grout.
- .14 Silicone Sealants.
- .15 Piping Systems - Common Requirements
- .16 Piping Joint Construction
- .17 Equipment Insulation - Common Requirements
- .18 Concrete Bases
- .19 Erection of Supports and Anchorages
- .20 Grouting

1.2 GENERAL REFERENCES

- .1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.
- .2 Division 20, including all Common Mechanical Requirements in Section 20 00 00, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.

1.3 RELATED REQUIREMENTS

1.4 SUBMITTALS

- .1 Action Submittals
 - .1 Product Data:
 - .1 Transition fittings.
 - .2 Dielectric fittings.
 - .3 Mechanical sleeve seals.
 - .4 Escutcheons.
 - .5 Coordination drawings.
 - .2 Welding certificates.
 - .3 Shop drawings: Submit for all major equipment including, but not limited to the items listed in Division 20, 21, 22, 23. Submittals shall be provided in electronic format.

- .4 As-built Drawings: Submit as-built drawings that include accurate dimensioned record drawings of all underground work, above ground piping, and ductwork systems. As-built drawings shall be submitted in electronic format.
- .5 Substitutions: The contractors' base bid must be in accordance with the materials or products specified. Any exceptions to this must be approved in writing by the Architect/Engineer, 10 days or more prior to bidding. Voluntary alternates may be submitted for consideration on the proposal, with listed addition or deductions to the base bid, but will not affect the awarding of the contract.
- .6 Coordination Drawings: Contractor shall prepare above ceiling coordination drawings for efficient installation of different components and coordination for installation of products and materials fabricated by each trade.
 - .1 Content: Project-specific information, drawn accurately to scale, 1/4 inch per foot. Do not base Coordination Drawings on reproductions of the Contract Documents or standard printed data. Include the following information, as applicable:
 - .1 Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
 - .2 Indicate required installation sequences.
 - .3 Indicate dimensions shown on the Contract Drawings and make specific note of dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Architect for resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.
 - .2 Sheet Size: 30 by 42 inches
 - .3 Number of Copies: Electronic submissions are preferred. Where not feasible, provide the following.
 - .1 Submit two opaque copies of each submittal. Architect will return one copy.
 - .2 Submit five copies where Coordination Drawings are required for operation and maintenance manuals. Architect will retain two copies; remainder will be returned. Mark up and retain one returned copy as a Project Record Drawing.
 - .4 Refer to individual Sections for Coordination Drawing requirements for Work in those Sections.
- .2 Informational Submittals
 - .1 Field quality control reports.
- .3 Operation and Maintenance Materials
 - .1 Operation and Maintenance Manuals: When the building is substantially complete and before the building is taken over by the Owner for maintenance purposes, the contractor shall provide four sets of complete operation and maintenance manuals. The manual shall consist of an indexed loose-leaf binder containing the equipment data, manufacturer's installation, operating, and maintenance, repair parts manual for each system component, test reports, and as-built temperature control diagrams. Refer to Divisions 20, 21, 22, and 23 for additional submittal requirements. Provide an electronic copy of the operation and maintenance manual in addition to three (3) sets of loose-leaf hard copy binders. Preliminary copy of O&M manuals shall be submitted to commissioning agent for review. Schedule of preliminary submittal will be reviewed with Commissioning Agent at the commissioning kick off meeting.

1.5 COORDINATION

- .1 Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for installations.
- .2 Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- .3 Coordinate requirements for access panels and doors for items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."
- .4 Under provisions of commissioning documentation; testing of mechanical equipment, as well as training of owner's operation and maintenance personnel, shall be required in cooperation with the commissioning agent.
- .5 Refer to the Owner/Utility tie-in schedule.
- .6 Each contractor shall coordinate its construction operations with those of other contractors and entities to ensure efficient and orderly installation of each part of the Work.
- .7 Each contractor shall coordinate its operations with operations, included in different sections, which depend on each other for proper installation, connection, and operation.
 - .1 Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
 - .2 Coordinate installation of different components with other contractors to ensure maximum accessibility for required maintenance, service, and repair.
 - .3 Make adequate provisions to accommodate items scheduled for later installation.
 - .4 Where availability of space is limited, coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair of all components, including mechanical and electrical.
- .8 Contractor shall participate in whole building information modeling coordination process utilizing a three-dimensional software platform compatible with Autodesk® Navisworks®. Contractor shall include all time associated with detailing, coordination meetings, and model generation for the BIM coordination process.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Deliver ductwork, pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent ductwork and pipe end damage and to prevent entrance of dirt, debris, and moisture.
- .2 Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.
- .3 During installation, provide temporary caps of sufficient material to prevent entrance of dirt, debris, and moisture.

PART 2 PRODUCTS

2.1 ACCESS DOORS

- .1 Manufacturers:
 - .1 Larson.
 - .2 Milcor.
 - .3 Nystrom.
- .2 Access doors in walls or ceilings shall be of 24"x24" in size, unless specified otherwise or space restricted.
- .3 Non-labeled door shall be 16-gauge prime painted steel frame; 14-gauge prime painted steel panel; concealed spring type hinges; and flush, screwdriver operated metal cam lock.

- .4 Labeled doors shall be UL listed; 16-gauge, prime painted steel frame; sandwich type with 20-gauge face sheets, flush design with filler panels; continuous hinges with stainless steel pins and flush, self-latching cylinder locks with two keys per lock. Coordinate doors and accessories with Division 08.
- .5 All access doors shall have flush mounted handles.

2.2 PIPE, TUBE AND FITTINGS

- .1 Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

- .1 Refer to individual Division 21, 22, and 23 piping sections for special joining materials not listed below.
- .2 Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - .1 ASME B16.21, nonmetallic, flat, asbestos-free, 1/8 inch (3.2 mm) maximum thickness unless thickness or specific material is indicated.
 - .1 Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - .2 Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
 - .2 AWWA C110/A21.10, rubber, flat face, 1/8 inch (3.2 mm) thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- .3 Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- .4 Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- .5 Solder Filler Metals: {RS#564}, lead-free alloys. Include water-flushable flux according to ASTM B813.
- .6 Brazing Filler Metals: AWS A5.8M/A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8M/A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
- .7 Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- .8 Solvent Cements for Joining Plastic Piping:
 - .1 CPVC Piping: ASTM F493.
 - .2 PVC Piping: ASTM D2564. Include primer according to ASTM F656.
 - .3 PPVC to ABS Piping Transition: ASTM D3138.
 - .4 ABS Piping: ASTM D2235.
- .9 Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

2.4 TRANSITION FITTINGS

- .1 AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
 - .1 Manufacturers:
 - .1 Cascade Waterworks Mfg. Co.
 - .2 Dresser Industries.
 - .3 Ford Meter Box Company.
 - .4 JCM Industries.
 - .5 Smith-Blair.
 - .6 Viking Johnson.

- .2 Underground Piping NPS 1-1/2 (DN 40) and smaller: Manufactured fitting or coupling.
- .3 Underground Piping NPS 2 (DN 50) and larger: AWWA C219, metal sleeve-type coupling.
- .4 Aboveground Pressure Piping: Pipe fitting.
- .2 Plastic-to-Metal Transition Fittings: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
 - .1 Manufacturers:
 - .1 Eslon Thermoplastics.
- .3 Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
 - .1 Manufacturers:
 - .1 Thompson Plastics.
- .4 Plastic-to-Metal Transition Unions: MSS SP-107, CPVC and PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.
 - .1 Manufacturers:
 - .1 Nibco.

2.5 DIELECTRIC FITTINGS

- .1 Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- .2 Insulating Material: Suitable for system fluid, pressure, and temperature.
- .3 Dielectric Unions: Factory-fabricated, union assembly, for 250 psig (1725 kPa) minimum working pressure at 180 deg F (82 deg C).
 - .1 Manufacturers:
 - .1 Capitol Manufacturing Co.
 - .2 Central Plastics Company.
 - .3 Eclipse.
 - .4 Epco Sales.
 - .5 Hart Industries.
 - .6 Watts.
 - .7 Zurn Industries.
- .4 Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150 or 300 psig (1035 or 2070 kPa) minimum working pressure as required to suit system pressures.
 - .1 Manufacturers:
 - .1 Capitol Manufacturing Co.
 - .2 Central Plastics Company.
 - .3 Epco Sales.
 - .4 Watts.
- .5 Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
 - .1 Manufacturers:
 - .1 Advance Products & Systems.
 - .2 Calpico.

- .3 Central Plastics Company.
 - .4 Pipeline Seal and Insulator.
 - .2 Separate companion flanges and steel bolts and nuts shall have 150 or 300 psig (1035 or 2070 kPa) minimum working pressure where required to suit system pressures.
- .6 Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300 psig (2070 kPa) minimum working pressure at 225 deg F (107 deg C).
 - .1 Manufacturers:
 - .1 Calpico.
 - .2 Lochinvar.
- .7 Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300 psig (2070 kPa) minimum working pressure at 225 deg F (107 deg C).
 - .1 Manufacturers
 - .1 Perfection Corp.
 - .2 Precision Plumbing Products.
 - .3 Sioux Chief Manufacturing Co.
 - .4 Victaulic Company.

2.6 MECHANICAL SLEEVE SEALS

- .1 Manufacturers:
 - .1 Advance Products & Systems.
 - .2 Flexicraft Pipesseal.
 - .3 Calpico.
 - .4 Metraflex.
 - .5 Pipeline Seal and Insulator.
- .2 Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
- .3 Pressure Plates: Glass reinforced plastic. Include two for each sealing element.
- .4 Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.7 SLEEVES

- .1 Manufacturers:
 - .1 Advance Products & Systems, Inc.
 - .2 CALPICO, Inc.
 - .3 GPT; an EnPro Industries company.
- .2 Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop collar.
- .3 Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, anti-corrosion coated or zinc coated, with plain ends and integral welded waterstop collar.
- .4 Galvanized-Steel Sheet Sleeves: 0.0239 inch (0.6 mm) minimum thickness; round tube closed with welded longitudinal joint.
- .5 PVC Pipe Sleeves: ASTM D1785, Schedule 40.
- .6 Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

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

2.8 STACK-SLEEVE FITTINGS

- .1 Manufacturers:
 - .1 Smith, Jay R. Mfg. Co.
 - .2 Zurn Specification Drainage Operation.
- .2 Description: Manufactured, Dura-coated or Duco-coated cast-iron sleeve with integral clamping flange for use in waterproof floors and roofs. Include clamping ring, bolts, and nuts for membrane flashing.
 - .1 Underdeck Clamp: Clamping ring with setscrews.

2.9 SLEEVE-SEAL SYSTEMS

- .1 Manufacturers:
 - .1 Advance Products & Systems.
 - .2 Airex Manufacturing.
 - .3 CALPICO.
 - .4 GPT; an EnPro Industries company.
 - .5 Metraflex Company.
 - .6 Proco Products.
- .2 Description:
 - .1 Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
 - .2 Designed to form a hydrostatic seal of 20 psig (137 kPa) minimum.
 - .3 Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size.
 - .4 Pressure Plates: Stainless steel.
 - .5 Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.10 SLEEVE-SEAL FITTINGS

- .1 Manufacturers:
 - .1 Advance Products & Systems, Inc.
 - .2 CALPICO, Inc.
 - .3 GPT; an EnPro Industries company.
 - .4 Metraflex Company (The).
 - .5 Presealed Systems.
 - .6 Proco Products, Inc.
- .2 Description:
 - .1 Manufactured plastic, sleeve-type, waterstop assembly, made for imbedding in concrete slab or wall.
 - .2 Plastic or rubber waterstop collar with center opening to match piping OD.

2.11 ESCUTCHEONS

- .1 Description: Manufactured chrome plated wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

- .2 One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
- .3 One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
- .4 One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.
- .5 Split-Casting Brass Type: With polished, chrome-plated finish and with concealed hinge and setscrew.
- .6 Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed hinge, and spring-clip fasteners.

2.12 FLOOR PLATES

- .1 One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
- .2 Split-Casting Floor Plates: Cast brass with concealed hinge.

2.13 GROUT

- .1 Description: Nonshrink, recommended for interior and exterior sealing openings in nonfire-rated walls or floors.
- .2 Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- .3 Design Mix: 5000 psi (34.5 MPa), 28-day compressive strength.
- .4 Packaging: Premixed and factory packaged.

2.14 SILICONE SEALANTS

- .1 Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant, ASTM C920, Type S, Grade NS, Class 25, use NT.
 - .1 Manufacturers:
 - .1 GE Construction Sealants; Momentive Performance Materials Inc.
 - .2 Pecora Corporation.
 - .3 Permathane®/Acryl-R®; ITW Polymers Sealants North America.
 - .4 Polymeric Systems, Inc.
 - .5 Sherwin-Williams Company (The).
 - .6 The Dow Chemical Company.
 - .2 Sealant shall have a VOC content of 250 g/L or less.
 - .3 Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
 - .4 Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
 - .5 Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

- .2 Silicone, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade P, Class 25, Uses T and NT. Grade P Pourable (self-leveling) formulation is for opening in floors and other horizontal surfaces that are not fire rated.
 - .1 Manufacturers:
 - .1 May National Associates, Inc.; a subsidiary of Sika Corporation.
 - .2 Sealant shall have a VOC content of 250 g/L or less.
 - .3 Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
 - .4 Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
 - .5 Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.
- .3 Silicone Foam: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.
 - .1 Manufacturers:
 - .1 Smooth-On.
 - .2 Sealant shall have a VOC content of 250 g/L or less.
 - .3 Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
 - .4 Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.
 - .5 Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

PART 3 EXECUTION

3.1 INSTALLATION

- .1 Access Doors
 - .1 Access doors shall be provided in all pipe chases, soffits, walls, ceilings, and ductwork to give access to valves, dampers, both sides of booster coils in ductwork or VAV terminals, control devices, etc.

- .2 All access doors shall be within 24 inches (600 mm) of any fire damper.
- .3 Coordinate the exact location with other trades.
- .4 Verify the exact quantity, size and location of the required access panels after the installation of systems and equipment requiring access, and prior to the closure of affected ceilings and building assemblies.
- .2 Equipment Installation - Common Requirements
 - .1 Install equipment to allow maximum possible headroom unless specific mounting heights are indicated or coordination with other services dictates different mounting heights. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated. Install HVAC, Plumbing, and Fire Protection equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations. Install equipment to allow right of way for piping installed at required slope.

3.2 CONNECTIONS

- .1 Piping Connections
 - .1 Make connections according to the following, unless otherwise indicated:
 - .1 Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each control valve and at final connection to each piece of equipment.
 - .2 Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to each control valve and at final connection to each piece of equipment.
 - .3 Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
 - .4 Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.3 PAINTING

- .1 Painting of mechanical systems, equipment, and components is specified in Division 09.
- .2 Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.4 WORK IN EXISTING BUILDINGS

- .1 Access to the existing building will be provided by the owner as required and a project schedule will identify access requirements to occupied buildings. Work shall be completed by the Contractor without interruption once Work has begun to facilitate returning the areas of work back to the Owner as soon as possible.
- .2 Provide adequate protection of all existing and newly installed Work. Contractor shall promptly repair any damage to new or existing Work at Contractor's expense.
- .3 Contractor shall consult with the Owner on methods of performing Work so the Owner's operation is not disrupted more than absolutely necessary. The Owner shall designate when interruption of existing services may occur. Contractor shall leave all services in operation until such time.
- .4 All items and equipment removed as part of the demolition process shall remain property of the owner unless possession rights are waived. Contractor shall meet with Owner prior to start of demolition to determine which items are to be salvaged. Contractor shall remove remaining items from the site.

3.5 PIPING SYSTEMS - COMMON REQUIREMENTS

- .1 Install piping according to the following requirements and Division 21, 22, 23 sections specifying piping systems.
- .2 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.
- .3 Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- .4 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.
- .5 Install piping indicated to be exposed in finished areas as high as possible unless noted otherwise.
- .6 Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- .7 Install piping to permit valve servicing. Valves shall be located not more than 24 inches (600 mm) above the suspended ceiling grid.
- .8 Install piping at indicated slopes.
- .9 Install piping free of sags and bends. Piping shall be installed level and plumb where piping slopes are not required.
- .10 Install fittings for changes in direction and branch connections.
- .11 Install piping to allow application of insulation.
- .12 Select system components with pressure rating equal to or greater than system operating pressure.
- .13 Install escutcheons for penetrations of walls, ceilings, and floors:
 - .1 New Piping:
 - .1 Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - .2 Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
 - .3 Piping in High Humidity Areas: One-piece, cast-brass type with polished chrome-plated finish.
 - .4 Insulated Piping: One-piece, stamped-steel type with spring clips.
 - .5 Bare Piping in Finished Spaces: One-piece, stamped-steel type.
 - .6 Bare Piping in Unfinished Service Spaces and Equipment Rooms: Split-plate, stamped-steel type with concealed hinge and set screw.
 - .7 Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
 - .2 Existing Piping: Use the following:
 - .1 Chrome-Plated Piping: Split-casting, cast-brass type with chrome-plated finish.
 - .2 Piping in High Humidity Areas: Split-casting, cast-brass type with chrome-plated finish.
 - .3 Insulated Piping: Split-plate, stamped-steel type with concealed hinge and spring clips.
 - .4 Bare Piping: Split-plate, stamped-steel type with set screw or spring clips.
- .14 Sleeves are not required for core-drilled holes.
- .15 Permanent sleeves are not required for holes formed by removable PE sleeves.

- .16 Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.
- .17 Install sleeves for pipes passing through footings and foundation walls, masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
 - .1 Cut sleeves to length for mounting flush with both surfaces of walls.
 - .1 Exception: Extend sleeves installed in floors 2 inches (50 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 - .2 Install sleeves in new walls and slabs as new walls and slabs are constructed.
 - .3 Install sleeves that are large enough to provide 1/4 inch (6.4 mm) annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
 - .1 Schedule 40 Black Steel Sleeves: For pipes smaller than NPS 12 penetrating interior walls.
 - .2 5-Inch Wall Black Steel Sleeves: For pipes NPS 12 and larger penetrating interior walls.
 - .3 Schedule 40 Galvanized Steel Sleeves: For pipes smaller than NPS 12 penetrating floors, and roof slabs.
 - .4 5-Inch Wall Galvanized Steel Sleeves: For pipes NPS 12 and larger penetrating floors and roof slabs.
 - .5 Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.
 - .4 Seal sleeves in concrete floors roof slabs and masonry walls with grout.
 - .5 Seal sleeves in plaster/gypsum board partitions with plaster or dry wall compound and caulk with non-hardening silicone sealant to provide airtight installation.
 - .6 Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.
 - .7 Sleeves through floors and walls shall be sized so that the required pipe insulation is continuous through the sleeve.
- .18 Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1 inch (25 mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - .1 Install steel pipe for sleeves smaller than 6 inches (150 mm) in diameter.
 - .2 Install cast-iron "wall pipes" for sleeves 6 inches (150 mm) and larger in diameter.
 - .3 Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- .19 Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1 inch (25 mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - .1 Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve.

Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

- .20 Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.
- .21 Verify final equipment locations for roughing-in.
- .22 Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.
- .23 Contractor shall maintain adequate clearances (per the latest edition of the national electric code) above and around any new electrical panels, equipment, and transformers when routing overhead piping.

3.6 PIPING JOINT CONSTRUCTION

- .1 Join pipe and fittings according to the following requirements and Division 21, 22, and 23 sections specifying piping systems.
- .2 Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- .3 Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- .4 Soldered Joints: Apply ASTM B813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with {RS#564}.
- .5 Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8M/A5.8.
- .6 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.
- .7 Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- .8 Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- .9 Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
- .10 Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
 - .1 CPVC Piping: Join according to ASTM D2846/D2846M Appendix.
 - .2 PVC Pressure Piping: Join schedule number ASTM D1785, PVC pipe and PVC socket fittings according to ASTM D2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D2855.
 - .3 PVC Non-pressure Piping: Join according to ASTM D2855.
 - .4 PVC to ABS Non-pressure Transition Fittings: Join according to ASTM D3138 Appendix.
 - .5 ABS Piping: Join according to ASTM D2235 and ASTM D2661 Appendixes.
- .11 Plastic Pressure Piping Gasketed Joints: Join according to ASTM D3139.
- .12 Plastic Non-pressure Piping Gasketed Joints: Join according to ASTM D3212.

- .13 PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D2657.
 - .1 Plain-End Pipe and Fittings: Use butt fusion.
 - .2 Plain-End Pipe and Socket Fittings: Use socket fusion.
- .14 Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

3.7 CONCRETE BASES

- .1 Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
 - .1 Construct concrete bases not less than 4 inches (100 mm) larger in both directions than supported unit.
 - .2 Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18 inch (450 mm) centers around the full perimeter of the base.
 - .3 Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
 - .4 Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - .5 Install anchor bolts to elevations required for proper attachment to supported equipment.
 - .6 Install anchor bolts according to anchor-bolt manufacturer's written instructions.
 - .7 Use 3000 psi (20.7 MPa), 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section 03 30 00 "Cast-in-Place Concrete."
- .2 Provide concrete bases where specified within individual products' specifications and/or where indicated on the drawings and details.

3.8 ERECTION OF SUPPORTS AND ANCHORAGES

- .1 Metal
 - .1 Refer to Division 05 Section 05 00 00 "Metal Fabrications" for structural steel.
 - .2 Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.
 - .1 Provide all supplementary steel to provide proper drainage for gravity flow systems.
 - .3 Field Welding: Comply with AWS D1.1/D1.1M.
- .2 Wood
 - .1 Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor mechanical materials and equipment.
 - .2 Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
 - .3 Attach to substrates as required to support applied loads.

3.9 GROUTING

- .1 Mix and install grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- .2 Clean surfaces that will come into contact with grout.
- .3 Provide forms as required for placement of grout.

- .4 Avoid air entrapment during placement of grout.
- .5 Place grout, completely filling equipment bases.
- .6 Place grout on concrete bases and provide smooth bearing surface for equipment.
- .7 Place grout around anchors.
- .8 Cure placed grout.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- .1 Expansion Joints.
 - .1 Flexible-Hose Packless Expansion Joints.
 - .2 Metal-Bellows Packless Expansion Joints.
 - .3 Metal, Expansion-Compensator Packless Expansion Joints.
 - .4 Rubber, Expansion-Compensator Packless Expansion Joints.
 - .5 Rubber Packless Expansion Joints.
 - .6 Flexible, Ball-Joint Packed Expansion Joints.
 - .7 Slip-Joint Packed Expansion Joints.
 - .8 Grooved-Joint Expansion Joints.
- .2 Alignment Guides and Anchors.
 - .1 Alignment Guides.
 - .2 Anchor Materials.

1.2 GENERAL REFERENCES

- .1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.
- .2 Division 20, including all Common Mechanical Requirements in Section 20 00 00 200000, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.

1.3 RELATED REQUIREMENTS

1.4 SUBMITTALS

- .1 Action Submittals
 - .1 Product Data:
 - .1 Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot (meter) and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
 - .2 Expansion Joints: Indicate maximum temperature and pressure rating, and maximum expansion compensation.
 - .2 Design Data: Indicate selection calculations.
 - .3 Manufacturer's Instructions: Indicate manufacturer's installation instructions, special procedures, and external controls.
 - .4 Delegated-Design Submittal: For each anchor and alignment guide indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - .1 Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and bends.
 - .2 Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
 - .3 Alignment Guide Details: Detail field assembly and attachment to building structure.

- .4 Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.
- .5 Product Certificates: For each type of pipe expansion joint, signed by product manufacturer.
- .2 Informational Submittals
 - .1 Welding certificates.
- .3 Operation and Maintenance Materials
 - .1 Maintenance Data: Include adjustment instructions.

1.5 QUALITY ASSURANCE

- .1 Welding Qualifications: Qualify procedures and personnel according to the following:
 - .1 Steel Shapes and Plates: AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 - .2 Welding to Piping: ASME BPVC-IX.

1.6 MOCK-UPS AND SAMPLES

- .1 Submit two low pressure compensators 3/4 inch (20 mm) in size.

1.7 EXTRA MATERIALS

- .1 Extra Packing for Packed Expansion Joints: One set for each joint.

PART 2 PRODUCTS

2.1 EXPANSION JOINTS

- .1 Flexible-Hose Packless Expansion Joints:
 - .1 Manufacturers
 - .1 Flex Pression Ltd.
 - .2 Flex-Hose Co.
 - .3 Flexicraft Industries.
 - .4 Mason Industries.
 - .5 Metraflex Company.
 - .6 Unisource Manufacturing.
 - .2 Description: Manufactured assembly with inlet and outlet elbow fittings and two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose.
 - .3 Flexible Hose: Corrugated-metal inner hoses and braided outer sheaths.
 - .4 Expansion Joints for Copper Tubing NPS 2 (DN 50) and Smaller: Copper-alloy fittings with solder-joint end connections.
 - .1 Bronze hoses and single-braid bronze sheaths with 450 psig at 70 deg F (3100 kPa at 21 deg C) and 340 psig at 450 deg F (2340 kPa at 232 deg C) ratings.
 - .2 Bronze hoses and double-braid bronze sheaths with 700 psig at 70 deg F (4830 kPa at 21 deg C) and 500 psig at 450 deg F (3450 kPa at 232 deg C) ratings.
 - .5 Expansion Joints for Copper Tubing NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Copper-alloy fittings with threaded end connections.
 - .1 Stainless-steel hoses and single-braid, stainless-steel sheaths with 300 psig at 70 deg F (2070 kPa at 21 deg C) and 225 psig at 450 deg F (1550 kPa at 232 deg C) ratings.

- .2 Stainless-steel hoses and double-braid, stainless-steel sheaths with 420 psig at 70 deg F (2890 kPa at 21 deg C) and 315 psig at 450 deg F (2170 kPa at 232 deg C) ratings.
- .6 Expansion Joints for Steel Piping NPS 2 (DN 50) and Smaller: Stainless-steel fittings with threaded end connections.
 - .1 Stainless-steel hoses and single-braid, stainless-steel sheaths with 450 psig at 70 deg F (3100 kPa at 21 deg C) and 325 psig at 600 deg F (2250 kPa at 315 deg C) ratings.
 - .2 Stainless-steel hoses and double-braid, stainless-steel sheaths with 700 psig at 70 deg F (4830 kPa at 21 deg C) and 515 psig at 600 deg F (3550 kPa at 315 deg C) ratings.
- .7 Expansion Joints for Steel Piping NPS 2-1/2 to NPS 6 (DN 65 to DN 150): Stainless-steel fittings with flanged end connections.
 - .1 Stainless-steel hoses and single-braid, stainless-steel sheaths with 200 psig at 70 deg F (1380 kPa at 21 deg C) and 145 psig at 600 deg F (1000 kPa at 315 deg C) ratings.
 - .2 Stainless-steel hoses and double-braid, stainless-steel sheaths with 275 psig at 70 deg F (1900 kPa at 21 deg C) and 200 psig at 600 deg F (1380 kPa at 315 deg C) ratings.
- .8 Expansion Joints for Steel Piping NPS 8 to NPS 12 (DN 200 to DN 300): Stainless-steel fittings with flanged end connections.
 - .1 Stainless-steel hoses and single-braid, stainless-steel sheaths with 125 psig at 70 deg F (860 kPa at 21 deg C) and 90 psig at 600 deg F (625 kPa at 315 deg C) ratings.
 - .2 Stainless-steel hoses and double-braid, stainless-steel sheaths with 165 psig at 70 deg F (1130 kPa at 21 deg C) and 120 psig at 600 deg F (830 kPa at 315 deg C) ratings.
- .9 Expansion Joints for Steel Piping NPS 14 (DN 350) and Larger: Carbon-steel fittings with flanged or weld end connections.
 - .1 Stainless-steel hoses and double-braid, stainless-steel sheaths with 165 psig at 70 deg F (1130 kPa at 21 deg C) and 120 psig at 600 deg F (830 kPa at 315 deg C) ratings.
- .2 Metal-Bellows Packless Expansion Joints:
 - .1 Manufacturers
 - .1 Adscos Manufacturing.
 - .2 American BOA.
 - .3 Badger Industries.
 - .4 Expansion Joint Systems.
 - .5 Flex Pression Ltd.
 - .6 Flex-Hose Co.
 - .7 Flex-Weld.
 - .8 Flexicraft Industries.
 - .9 Flo Fab.
 - .10 Hyspan Precision Products.
 - .11 Mason Industries.
 - .12 Metraflex Company.
 - .13 Proco Products.

- .14 Senior Flexonics Pathway.
- .15 Tozen Corporation.
- .16 U.S. Bellows.
- .17 Unaflex.
- .18 Unisource Manufacturing.
- .19 Universal Metal Hose.
- .20 Wahlco Metroflex.
- .2 Standards: ASTM F1120 and EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
- .3 Type: Circular, corrugated bellows with external tie rods.
- .4 Minimum Pressure Rating: 200 psig unless otherwise indicated.
- .5 Configuration: Single- or double-joint with base Single joint, Single joint with base, and double joint with base class(es) unless otherwise indicated.
- .6 Expansion Joints for Copper Tubing: Single or Multi-ply phosphor-bronze bellows, copper pipe ends, and brass shrouds.
 - .1 End Connections for Copper Tubing NPS 2 (DN 50) and Smaller: Solder joint or threaded.
 - .2 End Connections for Copper Tubing NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Solder joint or threaded.
 - .3 End Connections for Copper Tubing NPS 5 (DN 125) and Larger: Flanged.
- .7 Expansion Joints for Steel Piping: Single or Multi-ply stainless-steel bellows, steel pipe ends, and carbon-steel shroud.
 - .1 End Connections for Steel Pipe NPS 2 (DN 50) and Smaller: Threaded.
 - .2 End Connections for Steel Pipe NPS 2-1/2 (DN 65) and Larger: Flanged or Weld.
- .3 Metal, Expansion-Compensator Packless Expansion Joints:
 - .1 Manufacturers
 - .1 Adesco Manufacturing.
 - .2 Flex Pression Ltd.
 - .3 Flex-Weld.
 - .4 Flexicraft Industries.
 - .5 Hyspan Precision Products.
 - .6 Mason Industries.
 - .7 Metraflex Company.
 - .8 Senior Flexonics Pathway.
 - .9 Unaflex.
 - .10 Unisource Manufacturing.
 - .2 Minimum Pressure Rating: 200 psig unless otherwise indicated.
 - .3 Configuration for Copper Tubing: Two-ply, phosphor-bronze bellows with copper pipe ends.
 - .1 End Connections for Copper Tubing NPS 2 (DN 50) and Smaller: Solder joint or threaded.
 - .2 End Connections for Copper Tubing NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Threaded.

- .4 Configuration for Steel Piping: Two-ply, stainless-steel bellows; steel-pipe end connections; and carbon-steel shroud.
 - .1 End Connections for Steel Pipe NPS 2 (DN 50) and Smaller: Threaded.
 - .2 End Connections for Steel Pipe NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged or Weld.
- .4 Rubber, Expansion-Compensator Packless Expansion Joints:
 - .1 Manufacturers:
 - .1 Amber/Booth Company.
 - .2 Flex-Hose Co.
 - .3 Flexicraft Industries.
 - .4 General Rubber Corporation.
 - .5 Mason Industries.
 - .6 Proco Products.
 - .7 Tozen Corporation.
 - .8 Unaflex.
 - .9 Unisource Manufacturing.
 - .2 Material: Twin reinforced-rubber spheres with external restraining cables.
 - .3 Minimum Pressure Rating: 150 psig at 170 deg F (1035 kPa at 77 deg C) unless otherwise indicated.
 - .4 End Connections for NPS 2 (DN 50) and Smaller: Threaded.
- .5 Rubber Packless Expansion Joints:
 - .1 Manufacturers:
 - .1 Amber/Booth Company.
 - .2 Flex-Hose Co.
 - .3 Flex-Weld.
 - .4 Flexicraft Industries.
 - .5 Garlock Sealing Technologies.
 - .6 General Rubber Corporation.
 - .7 Mason Industries.
 - .8 Metraflex Company.
 - .9 Proco Products.
 - .10 Red Valve Company.
 - .11 Tozen Corporation.
 - .12 Unaflex.
 - .13 Unisource Manufacturing.
 - .2 Standards: ASTM F1123 and FSA's "Technical Handbook: Non-Metallic Expansion Joints and Flexible Pipe Connectors."
 - .3 Material: Fabric-reinforced rubber complying with FSA-NMEJ-703.
 - .4 Arch Type: Single or multiple arches with external control rods.
 - .5 Spherical Type: Single or multiple spheres with external control rods.
 - .6 Minimum Pressure Rating for NPS 1-1/2 to NPS 4 (DN 40 to DN 100): 150 psig (1035 kPa) at 220 deg F (104 deg C).
 - .7 Minimum Pressure Rating for NPS 5 and NPS 6 (DN 125 and DN 150): 140 psig (966 kPa) at 200 deg F (93 deg C).

- .8 Minimum Pressure Rating for NPS 8 to NPS 12 (DN 200 to DN 300): 140 psig (966 kPa) at 180 deg F (82 deg C).
- .9 Material for Fluids Containing Acids, Alkalies, or Chemicals: BR.
- .10 Material for Fluids Containing Gas, Hydrocarbons, or Oil: Buna-N.
- .11 Material for Water: BR.
- .12 End Connections: Full-faced, integral steel flanges with steel retaining rings.
- .6 Flexible, Ball-Joint, Packed Expansion Joints:
 - .1 Manufacturers:
 - .1 Advanced Thermal Systems.
 - .2 Hyspan Precision Products.
 - .3 Mason Industries.
 - .2 Standards: ASME BPVC-II, "Materials"; and ASME B31.9, "Building Services Piping," for materials and design of pressure-containing parts and bolting.
 - .3 Material: Carbon-steel assembly with asbestos-free composition packing.
 - .4 Design: For 360-degree rotation and angular deflection.
 - .5 Minimum Pressure Rating: 250 psig at 400 deg F (1725 kPa at 204 deg C).
 - .6 Angular Deflection for NPS 6 (DN 150) and Smaller: 30 degree minimum.
 - .7 Angular Deflection for NPS 8 (DN 200) and Larger: 15 degree minimum.
 - .8 End Connections for NPS 2 (DN 50) and Smaller: Threaded.
 - .9 End Connections for NPS 2-1/2 (DN 65) and Larger: Flanged.
- .7 Slip-Joint Packed Expansion Joints:
 - .1 Manufacturers:
 - .1 Adesco Manufacturing.
 - .2 Advanced Thermal Systems.
 - .3 Hyspan Precision Products.
 - .4 Mason Industries.
 - .2 Standard: ASTM F1007.
 - .3 Material: Carbon steel with asbestos-free PTFE packing.
 - .4 Design: With internal guide and injection device for repacking under pressure. Include asbestos-free PTFE packing, compound limit stops, and drip connection if used for steam piping.
 - .5 Configuration: Single joint, Single joint with base, and double joint with base class(es) unless otherwise indicated.
 - .6 End Connections: Flanged or weld ends to match piping system.
- .8 Grooved-Joint Expansion Joints:
 - .1 Manufacturers
 - .1 Anvil International.
 - .2 Shurjoint Piping Products.
 - .3 Victaulic Company.
 - .2 Description: Factory-assembled expansion joint made of several grooved-end pipe nipples, couplings, and grooved joints.
 - .3 Standard: AWWA C606, for grooved joints.
 - .4 Nipples: Galvanized, ASTM A53/A53M, Schedule 40, Type E or S, steel pipe with grooved ends.

- .5 Couplings: Five, flexible type for steel-pipe dimensions. Include ferrous housing sections, Buna-N gasket suitable for diluted acid, alkaline fluids, and cold and hot water, and bolts and nuts.

2.2 ALIGNMENT GUIDES AND ANCHORS

- .1 Alignment Guides:
 - .1 Manufacturers
 - .1 AdSCO Manufacturing.
 - .2 Advanced Thermal Systems.
 - .3 Flex-Hose Co.
 - .4 Flex-Weld.
 - .5 Flexicraft Industries.
 - .6 Hyspan Precision Products.
 - .7 Mason Industries.
 - .8 Metraflex Company.
 - .9 Senior Flexonics Pathway.
 - .10 U.S. Bellows.
 - .11 Unisource Manufacturing.
 - .2 Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding spider for bolting to pipe.
- .2 Anchor Materials:
 - .1 Steel Shapes and Plates: ASTM A36/A36M.
 - .2 Bolts and Nuts: ASME B18.10 or ASTM A183, steel hex head.
 - .3 Washers: ASTM F844, steel, plain, flat washers.
 - .4 Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.
 - .1 Stud: Threaded, zinc-coated carbon steel.
 - .2 Expansion Plug: Zinc-coated steel.
 - .3 Washer and Nut: Zinc-coated steel.
 - .5 Chemical Fasteners: Insert-type-stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.
 - .1 Bonding Material: ASTM C881/C881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
 - .2 Stud: ASTM A307, zinc-coated carbon steel with continuous thread on stud unless otherwise indicated.
 - .3 Washer and Nut: Zinc-coated steel.
 - .6 Concrete: Portland cement mix, 3000 psi (20.7 MPa) minimum. Comply with requirements in Division 03 Section 03 30 00 "Cast-in-Place Concrete" for formwork, reinforcement, and concrete.
 - .7 Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink, nonmetallic grout; suitable for interior and exterior applications.
 - .1 Properties: Nonstaining, noncorrosive, and nongaseous.
 - .2 Design Mix: 5000 psi (34.5 MPa), 28-day compressive strength.

PART 3 EXECUTION

3.1 INSTALLATION

- .1 Expansion Joints
 - .1 General
 - .1 Install expansion joints of sizes matching sizes of piping in which they are installed.
 - .2 Install packed-type expansion joints with packing suitable for fluid service.
 - .3 Install metal-bellows expansion joints according to EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
 - .2 Install rubber packless expansion joints according to FSA-NMEJ-702.
 - .1 Install grooved-joint expansion joints to grooved-end steel piping.
- .2 Alignment Guides and Anchors
 - .1 Install alignment guides to guide expansion and to avoid end-loading and torsional stress.
 - .2 Install two one guide(s) on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.
 - .3 Attach guides to pipe and secure guides to building structure.
 - .4 Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
 - .5 Anchor Attachments:
 - .1 Anchor Attachment to Black-Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME BPVC-IX, "Welding and Brazing Qualifications."
 - .2 Anchor Attachment to Galvanized-Steel Pipe: Attach with pipe hangers. Use MSS SP-69, Type 42, riser clamp welded to anchor.
 - .3 Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24, U-bolts bolted to anchor.
 - .6 Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.
 - .1 Anchor Attachment to Steel Structural Members: Attach by welding.
 - .2 Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.
 - .7 Use grout to form flat bearing surfaces for guides and anchors attached to concrete.
 - .8 Construct concrete anchors of poured-in-place concrete of dimensions indicated and include embedded fasteners.
 - .9 Install pipe anchors according to expansion-joint manufacturer's written instructions if expansion joints or compensators are indicated.
 - .10 Use grout to form flat bearing surfaces for expansion fittings, guides, and anchors installed on or in concrete.
- .3 Pipe Bends and Loops
 - .1 Install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.
 - .2 Connect risers and branch connections to mains with at least five pipe fittings including tee in main.
 - .3 Connect risers and branch connections to terminal units with at least four pipe fittings including tee in riser.

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- .4 Connect mains and branch connections to terminal units with at least four pipe fittings including tee in main.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- .1 Thermometers.
 - .1 Bimetallic-Actuated Thermometers.
 - .2 Filled-System Thermometers.
 - .1 Direct-Mounted, Metal-Case, Vapor-Actuated Thermometers.
 - .2 Direct-Mounted, Plastic-Case, Vapor-Actuated Thermometers.
 - .3 Remote-Mounted, Metal-Case, Vapor-Actuated Thermometers.
 - .4 Remote-Mounted, Plastic-Case, Vapor-Actuated Thermometers.
 - .3 Liquid-In-Glass Thermometers.
 - .1 Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers.
 - .2 Plastic-Case, Industrial-Style, Liquid-in-Glass Thermometers.
 - .3 Metal-Case, Compact-Style, Liquid-in-Glass Thermometers.
 - .4 Plastic-Case, Compact-Style, Liquid-in-Glass Thermometers.
 - .4 Duct-Type, Liquid-in-Glass Thermometers.
 - .5 Duct-Thermometer Mounting Brackets.
- .2 Pressure Gages.
 - .1 Direct-Mounted Pressure Gages
 - .1 Direct-Mounted, Metal-Case, Dial-Type Pressure Gages.
 - .2 Direct-Mounted, Plastic-Case, Dial-Type Pressure Gages.
- .3 Gage Attachments.
- .4 Test Plugs.
- .5 Test-Plug Kits.

1.2 GENERAL REFERENCES

- .1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.
- .2 Division 20, including all Common Mechanical Requirements in Section 20 00 00, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.

1.3 RELATED REQUIREMENTS

1.4 SUBMITTALS

- .1 Action Submittals
 - .1 Product Data: Provide list that indicates use, operating range, total range and location for manufactured components.
 - .2 Shop Drawings: Schedule for thermometers, gages, flowmeters, and thermal-energy meters indicating manufacturer's number, scale range, and location for each.
 - .3 Product Certificates: For each type of thermometer, signed by product manufacturer.
- .2 Operation and Maintenance Materials
 - .1 For flowmeters to include in emergency, operation, and maintenance manuals.
- .3 Record Documents
 - .1 Record actual locations of components and instrumentation.

1.5 MOCK-UPS AND SAMPLES

- .1 Submit two of each type of instrument specified.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.

1.7 EXTRA MATERIALS

- .1 Extra Gauge Oil for Inclined Manometers: One bottle.
- .2 Extra Pressure Gauges: One of each type and size.

PART 2 PRODUCTS

2.1 THERMOMETERS

- .1 Bimetallic-Actuated Thermometers
 - .1 Manufacturers:
 - .1 Ashcroft.
 - .2 Miljoco Corporation.
 - .3 Terice.
 - .4 Watts.
 - .5 Weiss Instruments.
 - .2 Standard: ASME B40.200.
 - .3 Case: Liquid-filled and sealed type(s); stainless steel with 3 inch (76 mm) nominal diameter.
 - .4 Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg F (deg C).
 - .5 Connector Type(s): Union joint, adjustable angle rigid, back and rigid, bottom, with unified-inch screw threads.
 - .6 Connector Size: 1/2 inch (13 mm), with ASME B1.1 screw threads.
 - .7 Stem: 0.25 or 0.375 inch (6.4 or 9.4 mm) in diameter; stainless steel.
 - .8 Window: Plain glass or plastic.
 - .9 Ring: Stainless steel.
 - .10 Element: Bimetal coil.
 - .11 Pointer: Dark-colored metal.
 - .12 Accuracy: Plus or minus 1.5 percent of scale range.
- .2 Filled-System Thermometers
 - .1 Direct-Mounted, Metal-Case, Vapor-Actuated Thermometers:
 - .1 Manufacturers:
 - .1 Ashcroft.
 - .2 Marsh Bellofram.
 - .3 Miljoco Corporation.
 - .4 Palmer Wahl Instrumentation Group.
 - .5 REOTEMP Instrument Corporation.
 - .6 Terice.
 - .7 Weiss Instruments.
 - .2 Standard: ASME B40.200.

- .3 Case: Sealed type, cast aluminum or drawn steel; 4 1/2 inch (114 mm) nominal diameter.
- .4 Element: Bourdon tube or other type of pressure element.
- .5 Movement: Mechanical, dampening type, with link to pressure element and connection to pointer.
- .6 Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C).
- .7 Pointer: Dark-colored metal.
- .8 Window: Glass or plastic.
- .9 Ring: Metal.
- .10 Connector Type(s): Union joint, adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device, rigid, back, and rigid, bottom; 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.
 - .1 Design for Air-Duct Installation: With ventilated shroud.
 - .2 Design for Thermowell Installation: Bare stem.
- .12 Accuracy: Plus or minus 1 percent of scale range.
- .2 Direct-Mounted, Plastic-Case, Vapor-Actuated Thermometers:
 - .1 Manufacturers:
 - .1 Ashcroft.
 - .2 Miljoco Corporation.
 - .3 REOTEMP Instrument Corporation.
 - .2 Standard: ASME B40.200.
 - .3 Case: Sealed type, plastic; 4 1/2 inch (114 mm) 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: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C).
 - .7 Pointer: Dark-colored metal.
 - .8 Window: Glass or plastic.
 - .9 Ring: Metal or plastic.
 - .10 Connector Type(s): Union joint, adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device rigid, back and rigid, bottom; 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.
 - .1 Design for Air-Duct Installation: With ventilated shroud.
 - .2 Design for Thermowell Installation: Bare stem.
 - .12 Accuracy: Plus or minus 1 percent of scale range.
 - .13 Remote-Mounted, Metal-Case, Vapor-Actuated Thermometers:
 - .1 Manufacturers:
 - .1 AMETEK.
 - .2 Ashcroft.

- .3 Marsh Bellofram.
- .4 Miljoco Corporation.
- .5 Palmer Wahl Instrumentation Group.
- .6 REOTEMP Instrument Corporation.
- .7 Terice.
- .8 Weiss Instruments.
- .9 WIKA Instrument Corporation - USA.
- .2 Standard: ASME B40.200.
- .3 Case: Sealed type, cast aluminum or drawn steel; 4 1/2 inch (114 mm) nominal diameter with back flange and holes for panel mounting.
- .4 Element: Bourdon tube or other type of pressure element.
- .5 Movement: Mechanical, with link to pressure element and connection to pointer.
- .6 Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C).
- .7 Pointer: Dark-colored metal.
- .8 Window: Glass or plastic.
- .9 Ring: Metal.
- .10 Connector Type(s): Union joint, back; 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.
 - .1 Design for Air-Duct Installation: With ventilated shroud.
 - .2 Design for Thermowell Installation: Bare stem.
- .12 Accuracy: Plus or minus 1 percent of scale range.
- .14 Remote-Mounted, Plastic-Case, Vapor-Actuated Thermometers:
 - .1 Manufacturers:
 - .1 AMETEK.
 - .2 Ashcroft.
 - .3 Miljoco Corporation.
 - .4 REOTEMP Instrument Corporation.
 - .5 Terice.
 - .2 Standard: ASME B40.200.
 - .3 Case: Sealed type, plastic; 4 1/2 inch (114 mm) nominal diameter with back flange and holes for panel mounting.
 - .4 Element: Bourdon tube or other type of pressure element.
 - .5 Movement: Mechanical, with link to pressure element and connection to pointer.
 - .6 Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C).
 - .7 Pointer: Dark-colored metal.
 - .8 Window: Glass or plastic.
 - .9 Ring: Metal or plastic.
 - .10 Connector Type(s): Union joint, threaded, back; 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.
 - .1 Design for Air-Duct Installation: With ventilated shroud.
 - .2 Design for Thermowell Installation: Bare stem.
- .12 Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.
- .3 Liquid-In-Glass Thermometers
 - .1 Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:
 - .1 Manufacturers:
 - .1 Flo Fab.
 - .2 Miljoco Corporation.
 - .3 Palmer Wahl Instrumentation Group.
 - .4 Tel-Tru Manufacturing Company.
 - .5 Terice.
 - .6 Weiss Instruments.
 - .7 Winters Instruments - U.S.
 - .2 Standard: ASME B40.200.
 - .3 Case: Cast aluminum; 9 inch (229 mm) nominal size unless otherwise indicated.
 - .4 Case Form: Adjustable angle Back angle unless otherwise indicated.
 - .5 Tube: Glass with magnifying lens and blue or red organic liquid.
 - .6 Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C).
 - .7 Window: Glass or plastic.
 - .8 Stem: Aluminum and of length to suit installation.
 - .1 Design for Air-Duct Installation: With ventilated shroud.
 - .2 Design for Thermowell Installation: Bare stem.
 - .9 Connector: 1-1/4 inches (32 mm), with ASME B1.1 screw threads.
 - .10 Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.
 - .2 Plastic-Case, Industrial-Style, Liquid-in-Glass Thermometers:
 - .1 Manufacturers:
 - .1 Miljoco Corporation.
 - .2 Watts.
 - .3 Weiss Instruments.
 - .2 Standard: ASME B40.200.
 - .3 Case: Plastic; 7 inch (178 mm) nominal size unless otherwise indicated.
 - .4 Case Form: Adjustable angle Back angle unless otherwise indicated.
 - .5 Tube: Glass with magnifying lens and blue or red organic liquid.
 - .6 Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C).
 - .7 Window: Glass or plastic.
 - .8 Stem: Aluminum, brass, or stainless steel Aluminum and of length to suit installation.

- .1 Design for Air-Duct Installation: With ventilated shroud.
 - .2 Design for Thermowell Installation: Bare stem.
 - .9 Connector: 1-1/4 inches (32 mm) , with ASME B1.1 screw threads.
 - .10 Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.
- .3 Metal-Case, Compact-Style, Liquid-in-Glass Thermometers:
 - .1 Manufacturers:
 - .1 Miljoco Corporation.
 - .2 Terice.
 - .2 Standard: ASME B40.200.
 - .3 Case: Cast aluminum; 6-inch (152-mm) nominal size.
 - .4 Case Form: Back angle unless otherwise indicated.
 - .5 Tube: Glass with magnifying lens and blue or red organic liquid.
 - .6 Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C).
 - .7 Window: Glass or plastic.
 - .8 Stem: Aluminum or brass and of length to suit installation.
 - .1 Design for Air-Duct Installation: With ventilated shroud.
 - .2 Design for Thermowell Installation: Bare stem.
 - .9 Connector: 3/4 inch (19 mm), with ASME B1.1 screw threads.
 - .10 Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.
- .4 Plastic-Case, Compact-Style, Liquid-in-Glass Thermometers:
 - .1 Manufacturers:
 - .1 Flo Fab.
 - .2 Miljoco Corporation.
 - .3 Tel-Tru Manufacturing Company.
 - .4 Watts.
 - .5 Weiss Instruments.
 - .6 WIKA Instrument Corporation - USA.
 - .2 Standard: ASME B40.200.
 - .3 Case: Plastic; 6-inch (152-mm) nominal size.
 - .4 Case Form: Back angle unless otherwise indicated.
 - .5 Tube: Glass with magnifying lens and blue or red organic liquid.
 - .6 Tube Background: Nonreflective with permanently etched scale markings graduated in deg F (deg C).
 - .7 Window: Glass or plastic.
 - .8 Stem: Aluminum or brass and of length to suit installation.
 - .1 Design for Air-Duct Installation: With ventilated shroud.
 - .2 Design for Thermowell Installation: Bare stem.
 - .9 Connector: 3/4 inch (19 mm) , with ASME B1.1 screw threads.
 - .10 Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.
- .4 Duct-Type, Liquid-In-Glass Thermometers

- .1 Manufacturers:
 - .1 Miljoco Corporation.
 - .2 Terice.
 - .3 Weiss Instruments.
- .2 Case: Die-cast aluminum, 7 inches (178 mm) long.
- .3 Tube: Red or blue reading, mercury or organic filled, with magnifying lens.
- .4 Tube Background: Satin-faced, nonreflective aluminum with permanently etched scale markings.
- .5 Window: Glass or plastic.
- .6 Connector: Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.
- .7 Stem: Metal, for installation in mounting bracket and of length to suit installation.
- .8 Mounting Bracket: Flanged fitting for attachment to duct and made to hold thermometer stem.
- .9 Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

2.2 DUCT-THERMOMETER MOUNTING BRACKETS

- .1 Description: Flanged bracket with screw holes, for attachment to air duct and made to hold thermometer stem.

2.3 PRESSURE GAGES

- .1 Direct-Mounted Pressure Gages
 - .1 Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:
 - .1 Manufacturers:
 - .1 AMETEK.
 - .2 Ashcroft.
 - .3 Ernst Flow Industries.
 - .4 Flo Fab.
 - .5 Marsh Bellofram.
 - .6 Miljoco Corporation.
 - .7 Noshok.
 - .8 Palmer Wahl Instrumentation Group.
 - .9 REOTEMP Instrument Corporation.
 - .10 Tel-Tru Manufacturing Company.
 - .11 Terice.
 - .12 Watts.
 - .13 Weiss Instruments.
 - .14 WIKA Instrument Corporation - USA.
 - .15 Winters Instruments - U.S.
 - .2 Standard: ASME B40.100.
 - .3 Case: Indicating type(s); cast aluminum or drawn steel; 4 1/2 inch (114 mm) nominal diameter.
 - .4 Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
 - .5 Pressure Connection: Brass, with NPS 1/4 (DN 8) or NPS 1/2 (DN 15), ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is

- indicated.
- .6 Movement: Mechanical, with link to pressure element and connection to pointer.
- .7 Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi (kPa).
- .8 Pointer: Dark-colored metal.
- .9 Window: Glass or plastic.
- .10 Ring: Metal Brass.
- .11 Vacuum-Pressure Range: 30-in. Hg of vacuum to 15 psig of pressure (100 kPa of vacuum to 103 kPa of pressure).
- .12 Range for Fluids under Pressure: Two times operating pressure.
- .13 Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.
- .2 Direct-Mounted, Plastic-Case, Dial-Type Pressure Gages:
 - .1 Manufacturers:
 - .1 AMETEK.
 - .2 Ashcroft.
 - .3 Flo Fab.
 - .4 Marsh Bellofram.
 - .5 Miljoco Corporation.
 - .6 Noshok.
 - .7 Palmer Wahl Instrumentation Group.
 - .8 REOTEMP Instrument Corporation.
 - .9 Tel-Tru Manufacturing Company.
 - .10 Terice.
 - .11 Weiss Instruments.
 - .12 WIKA Instrument Corporation - USA.
 - .13 Winters Instruments - U.S.
 - .2 Standard: ASME B40.100.
 - .3 Case: Sealed type; plastic; 4 1/2 inch (114 mm) nominal diameter.
 - .4 Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
 - .5 Pressure Connection: Brass, with NPS 1/4 (DN 8) or NPS 1/2 (DN 15), ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
 - .6 Movement: Mechanical, with link to pressure element and connection to pointer.
 - .7 Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi (kPa).
 - .8 Pointer: Dark-colored metal.
 - .9 Window: Glass or plastic.
 - .10 Vacuum-Pressure Range: 30-in. Hg of vacuum to 15 psig of pressure (100 kPa of vacuum to 103 kPa of pressure).
 - .11 Range for Fluids under Pressure: Two times operating pressure.
 - .12 Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.4 GAGE ATTACHMENTS

- .1 Snubbers: ASME B40.100, brass; with NPS 1/4 (DN 8) or NPS 1/2 (DN 15), ASME B1.20.1 pipe threads and porous-metal piston-type surge-dampening device. Include extension for use on insulated piping.
- .2 Siphons: Loop-shaped section of brass stainless-steel pipe with NPS 1/4 (DN 8) or NPS 1/2 (DN 15) pipe threads.
- .3 Valves: Brass ball, with NPS 1/4 (DN 8) or NPS 1/2 (DN 15), ASME B1.20.1 pipe threads.

2.5 TEST PLUGS

- .1 Manufacturers:
 - .1 Flow Design.
 - .2 Miljoco Corporation.
 - .3 National Meter.
 - .4 Peterson Equipment Co.
 - .5 Sisco Manufacturing Company.
 - .6 Trerice.
 - .7 Watts.
 - .8 Weiss Instruments.
- .2 Description: Test-station fitting made for insertion into piping tee fitting.
- .3 Body: Corrosion-resistant brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
- .4 Thread Size: NPS 1/4 (DN 8) or NPS 1/2 (DN 15), ASME B1.20.1 pipe thread.
- .5 Minimum Pressure and Temperature Rating: 500 psig at 200 deg F (3450 kPa at 93 deg C).
- .6 Core Inserts: One or two self-sealing rubber valves.
 - .1 Insert material for air, water, oil, or gas service at 20 to 200 deg F (minus 7 to plus 93 deg C) shall be CR.
 - .2 Insert material for air or water service at minus 30 to plus 275 deg F (minus 35 to plus 136 deg C) shall be EPDM.

2.6 TEST-PLUG KITS

- .1 Manufacturers:
 - .1 Flow Design.
 - .2 Miljoco Corporation.
 - .3 National Meter.
 - .4 Peterson Equipment Co.
 - .5 Sisco Manufacturing Company.
 - .6 Trerice.
 - .7 Watts.
 - .8 Weiss Instruments.
- .2 Furnish one test kit(s) containing one pressure gage and adaptor, one thermometer(s), and carrying case. Pressure gage, adapter probes, and thermometer sensing elements shall be of diameter to fit test plugs and of length to project into piping.
- .3 Low-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch- (25- to 51-mm-) diameter dial and tapered-end sensing element. Dial range shall be at least 25 to 125 deg F (minus 4 to plus 52 deg C).
- .4 High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch- (25- to 51-mm-) diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220 deg F (minus 18 to plus 104 deg C).

- .5 Pressure Gage: Small, Bourdon-tube insertion type with 2- to 3-inch- (51- to 76-mm-) diameter dial and probe. Dial range shall be at least 0 to 200 psig (0 to 1380 kPa).
- .6 Carrying Case: Metal or plastic, with formed instrument padding.

PART 3 EXECUTION

3.1 APPLICATION

- .1 Thermometers
 - .1 Install thermometers in the following locations:
 - .1 Plumbing Systems:
 - .1 Inlet and outlet of each water heater.
 - .2 Inlets and outlets of each domestic water heat exchanger.
 - .3 Inlet and outlet of each domestic hot-water storage tank.
 - .4 Inlet and outlet of each remote domestic water chiller.
 - .5 Two inlets of each mixing valve.
 - .2 HVAC Systems:
 - .1 Inlet and outlet of each hydronic zone.
 - .2 Inlet and outlet of each hydronic boiler.
 - .3 Two inlets and two outlets of each chiller.
 - .4 Two inlets and two outlets of each hydronic heat exchanger.
 - .5 Inlet and outlet of each thermal-storage tank.
 - .6 Outside-, return-, supply-, and mixed-air ducts.
 - .2 Thermometer Schedule
 - .1 Thermometers at inlet and outlet of each domestic water heater shall be one of the following:
 - .1 Industrial-style, liquid-in-glass type.
 - .2 Liquid-filled, bimetallic-actuated type.
 - .3 Direct-mounted, metal-case, vapor-actuated type.
 - .4 Direct-mounted, light-activated type.
 - .5 Test plug with EPDM self-sealing rubber inserts.
 - .2 Thermometers at inlets and outlets of each domestic water heat exchanger shall be one of the following:
 - .1 Industrial-style, liquid-in-glass type.
 - .2 Liquid-filled, bimetallic-actuated type.
 - .3 Direct-mounted, metal-case, vapor-actuated type.
 - .4 Direct-mounted, light-activated type.
 - .5 Test plug with EPDM self-sealing rubber inserts.
 - .3 Thermometers at inlet and outlet of each domestic hot-water storage tank shall be one of the following:
 - .1 Industrial-style, liquid-in-glass type.
 - .2 Industrial-style, liquid-in-glass type.
 - .3 Liquid-filled, bimetallic-actuated type.
 - .4 Direct-mounted, metal-case, vapor-actuated type.
 - .5 Direct-mounted, light-activated type.
 - .6 Test plug with EPDM self-sealing rubber inserts.

- .4 Thermometers at inlet and outlet of each remote domestic water chiller shall be one of the following:
 - .1 Liquid-filled, bimetallic-actuated type.
 - .2 Direct-mounted, metal-case, vapor-actuated type.
 - .3 Compact-style, liquid-in-glass type.
 - .4 Direct-mounted, light-activated type.
 - .5 Test plug with EPDM self-sealing rubber inserts.
- .5 Thermometers at inlet and outlet of each hydronic zone shall be one of the following:
 - .1 Industrial-style, liquid-in-glass type.
 - .2 Liquid-filled, bimetallic-actuated type.
 - .3 Direct-mounted, metal-case, vapor-actuated type.
 - .4 Direct-mounted, light-activated type.
 - .5 Test plug with EPDM self-sealing rubber inserts.
- .6 Thermometers at inlet and outlet of each hydronic boiler shall be one of the following:
 - .1 Industrial-style, liquid-in-glass type.
 - .2 Liquid-filled, bimetallic-actuated type.
 - .3 Direct-mounted, metal-case, vapor-actuated type.
 - .4 Direct-mounted, light-activated type.
 - .5 Test plug with EPDM self-sealing rubber inserts.
- .7 Thermometers at inlets and outlets of each chiller shall be one of the following:
 - .1 Industrial-style, liquid-in-glass type.
 - .2 Liquid-filled, bimetallic-actuated type.
 - .3 Direct-mounted, metal-case, vapor-actuated type.
 - .4 Direct-mounted, light-activated type.
 - .5 Test plug with EPDM self-sealing rubber inserts.
- .8 Thermometers at inlet and outlet of each hydronic coil in air-handling units and built-up central systems shall be one of the following:
 - .1 Industrial-style, liquid-in-glass type.
 - .2 Liquid-filled, bimetallic-actuated type.
 - .3 Direct-mounted, metal-case, vapor-actuated type.
 - .4 Direct-mounted, light-activated type.
 - .5 Test plug with EPDM self-sealing rubber inserts.
- .9 Thermometers at inlets and outlets of each hydronic heat exchanger shall be [one of] the following:
 - .1 Industrial-style, liquid-in-glass type.
 - .2 Liquid-filled, bimetallic-actuated type.
 - .3 Direct-mounted, metal-case, vapor-actuated type.
 - .4 Direct-mounted, light-activated type.
 - .5 Test plug with EPDM self-sealing rubber inserts.
- .10 Thermometers at inlet and outlet of each hydronic heat-recovery unit shall be [one of] the following:
 - .1 Industrial-style, liquid-in-glass type.

- .2 Liquid-filled, bimetallic-actuated type.
 - .3 Direct-mounted, metal-case, vapor-actuated type.
 - .4 Direct-mounted, light-activated type.
 - .5 Test plug with EPDM self-sealing rubber inserts.
- .11 Thermometers at inlet and outlet of each thermal-storage tank shall be [one of] the following:
 - .1 Industrial -style, liquid-in-glass type.
 - .2 Liquid-filled, bimetallic-actuated type.
 - .3 Direct-mounted, metal-case, vapor-actuated type.
 - .4 Direct-mounted, light-activated type.
 - .5 Test plug with EPDM self-sealing rubber inserts.
- .12 Thermometers at outside-, return-, supply-, and mixed-air ducts shall be [one of] the following:
 - .1 Industrial-style, liquid-in-glass type.
 - .2 Liquid-filled, bimetallic-actuated type.
 - .3 Direct-mounted, metal-case, vapor-actuated type.
 - .4 Direct-mounted, light-activated type.
- .13 Thermometers at suction and discharge of each pump shall be the following:
 - .1 Dry-case-type, bimetallic-actuated dial thermometers at suction and discharge of each pump.
- .3 Thermometer Scale-Range Schedule
 - .1 Scale Range for Domestic Cold-Water Piping: 0 to 100 deg F (minus 20 to plus 50 deg C).
 - .2 Scale Range for Domestic Hot-Water Piping: 0 to 250 deg F (0 to 150 deg C).
 - .3 Scale Range for Domestic Cooled-Water Piping: 0 to 100 deg F (minus 20 to plus 50 deg C).
 - .4 Scale Range for Chilled-Water Piping: minus 40 to plus 160 deg F (minus 40 to plus 100 deg C).
 - .5 Scale Range for Condenser-Water Piping: 0 to 100 deg F (minus 20 to plus 50 deg C).
 - .6 Scale Range for Heating, Hot-Water Piping: 0 to 250 deg F (0 to 150 deg C).
 - .7 Scale Range for Steam and Steam-Condensate Piping: 0 to 250 deg F (0 to 150 deg C).
 - .8 Scale Range for Air Ducts: minus 40 to plus 110 deg F (minus 40 to plus 45 deg C).
- .2 Pressure Gages:
 - .1 Install pressure gages in the following locations:
 - .1 Plumbing Systems:
 - .1 Building water service entrance into building.
 - .2 Inlet and outlet of each pressure-reducing valve.
 - .3 Suction and discharge of each domestic water pump.
 - .2 HVAC Systems:
 - .1 Inlet and outlet of each pressure-reducing valve.
 - .2 Inlet and outlet of each chiller chilled-water and condenser-water connection.

- .3 Suction and discharge of each pump.
- .2 Pressure-Gage Schedule
 - .1 Pressure gages at discharge of each water service into building shall be one of the following:
 - .1 Liquid-filled, direct-mounted, metal case.
 - .2 Sealed, direct-mounted, plastic case.
 - .3 Test plug with EPDM self-sealing rubber inserts.
 - .2 Pressure gages at inlet and outlet of each water pressure-reducing valve shall be one of the following:
 - .1 Liquid-filled, direct-mounted, metal case.
 - .2 Sealed, direct-mounted, plastic case.
 - .3 Test plug with EPDM self-sealing rubber inserts.
 - .3 Pressure gages at suction and discharge of each domestic water pump shall be one of the following:
 - .1 Liquid-filled, direct-mounted, metal case.
 - .2 Sealed, direct-mounted, plastic case.
 - .3 Test plug with EPDM self-sealing rubber inserts.
 - .4 Pressure gages at discharge of each hydronic pressure-reducing valve shall be one of the following:
 - .1 Liquid-filled, direct-mounted, metal case.
 - .2 Sealed, direct-mounted, plastic case.
 - .3 Test plug with EPDM self-sealing rubber inserts.
 - .5 Pressure gages at inlet and outlet of each chiller chilled-water and condenser-water connection shall be one of the following:
 - .1 Liquid-filled, direct-mounted, metal case.
 - .2 Sealed, direct-mounted, plastic case.
 - .3 Test plug with EPDM self-sealing rubber inserts.
 - .6 Pressure gages at suction and discharge of each HVAC pump shall be one of the following:
 - .1 Liquid-filled, direct-mounted, metal case.
 - .2 Sealed, direct-mounted, plastic case.
 - .3 Test plug with EPDM self-sealing rubber inserts.
- .3 Pressure Gauge Scale-Range Schedule
 - .1 Scale Range for Water Service Piping: 0 to 100 psi (0 to 600 kPa).
 - .2 Scale Range for Domestic Water Piping: 0 to 100 psi (0 to 600 kPa).
 - .3 Scale Range for Chilled-Water Piping: 30 in Hg to 15 psi (minus 100 to 0 kPa).
 - .4 Scale Range for Condenser-Water Piping: 30 in Hg to 15 psi (minus 100 to 0 kPa).
 - .5 Scale Range for Heating, Hot-Water Piping: 30 in Hg to 15 psi (minus 100 to 0 kPa).
 - .6 Scale Range for Steam Piping: 30 in Hg to 15 psi (minus 100 to 0 kPa).
 - .7 Scale Range for Steam Piping (steam less than 15 psig): 0 to 30 psi (0 to 240 kPa).
 - .8 Scale Range for Steam Piping (steam 15 psig to 75 psig): 0 to 100 psi (0 to 600 kPa).

- .9 Scale Range for Steam Piping (steam 75 psig to 100 psig): 0 to 160 psi (0 to 1100 kPa).
- .10 Scale Range for Steam Piping: 0 to 200 psi (0 to 1400 kPa).

3.2 INSTALLATION

- .1 General
 - .1 Install permanent indicators on walls or brackets in accessible and readable positions.
 - .2 Install connection fittings in accessible locations for attachment to portable indicators.
 - .3 Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.
- .2 Thermometers
 - .1 Thermometer stems shall be of length to match thermowell insertion length.
 - .2 Inlet and outlet of each hydronic coil in air-handling units.
- .3 Duct-Thermometer Mounting Brackets: Install duct-thermometer mounting brackets in walls of ducts. Attach to duct with screws.
- .4 Direct-Mounted Pressure Gauges:
 - .1 Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
 - .2 Install valve and snubber in piping for each pressure gage for fluids (except steam).
 - .3 Install valve and syphon fitting in piping for each pressure gage for steam.
- .5 Test Plugs: Install test plugs in piping tees.

3.3 ADJUSTING

- .1 After installation, calibrate meters according to manufacturer's written instructions.
- .2 Adjust faces of meters and gages to proper angle for best visibility.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- .1 Bronze angle valves.
- .2 Brass ball valves.
- .3 Bronze ball valves.
- .4 Iron ball valves.
- .5 Iron, single-flange butterfly valves.
- .6 Iron, grooved-end butterfly valves.
- .7 High-performance butterfly valves.
- .8 Bronze lift check valves.
- .9 Bronze swing check valves.
- .10 Iron swing check valves.
- .11 Iron swing check valves with closure control.
- .12 Iron, grooved-end swing-check valves.
- .13 Iron, center-guided check valves.
- .14 Iron, plate-type check valves.
- .15 Bronze gate valves.
- .16 Iron gate valves.
- .17 Bronze globe valves.
- .18 Iron globe valves.
- .19 Lubricated plug valves.
- .20 Eccentric plug valves.
- .21 Drain Valves.
- .22 Chainwheels.

1.2 GENERAL REFERENCES

- .1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.
- .2 Division 20, including all Common Mechanical Requirements in Section 20 00 00, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.

1.3 SUBMITTALS

- .1 Action Submittals
 - .1 Product Data: For each type of valve indicated.

1.4 QUALITY ASSURANCE

- .1 Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- .2 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.
- .3 NSF Compliance: NSF 61 and NSF 372 for valve materials for potable-water service.

1.5 DELIVERY, STORAGE AND HANDLING

- .1 Prepare valves for shipping as follows:
 - .1 Protect internal parts against rust and corrosion.
 - .2 Protect threads, flange faces, grooves, and weld ends.
 - .3 Set angle, gate, and globe valves closed to prevent rattling.
 - .4 Set ball and plug valves open to minimize exposure of functional surfaces.
 - .5 Set butterfly valves closed or slightly open.
 - .6 Block check valves in either closed or open position.
- .2 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.
- .3 Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 PRODUCTS

2.1 GENERAL

- .1 Refer to valve schedule articles for applications of valves.
- .2 Obtain each type of valve from single source from single manufacturer.
- .3 Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- .4 If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.
- .5 Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.
- .6 Valve Sizes: Same as upstream piping unless otherwise indicated.
- .7 Valve Actuator Types:
 - .1 Gear Actuator: For quarter-turn valves NPS 8 (DN 200) and larger.
 - .2 Handwheel: For valves other than quarter-turn types.
 - .3 Handlever: For quarter-turn valves NPS 6 (DN 150) and smaller except plug valves.
 - .4 Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 5 plug valves, for each size square plug-valve head.
 - .5 Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.
- .8 Valves in Insulated Piping: With 2-inch (50-mm) stem extensions and the following features:
 - .1 Gate Valves: With rising stem.
 - .2 Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
 - .3 Butterfly Valves: With extended neck.
- .9 Valve-End Connections:
 - .1 Flanged: With flanges according to ASME B16.1 for iron valves.
 - .2 Grooved: With grooves according to AWWA C606.
 - .3 Solder Joint: With sockets according to ASME B16.18.

- .1 Caution: Disassemble valves when soldering, as recommended by the manufacturer, to prevent damage to internal parts.
- .4 Threaded: With threads according to ASME B1.20.1.
- .10 Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE ANGLE VALVES

- .1 Class 125, Bronze Angle Valves with Bronze Disc:
 - .1 Manufacturers:
 - .1 Hammond Valve.
 - .2 Milwaukee Valve Company.
 - .2 Description:
 - .1 Standard: MSS SP-80, Type 1.
 - .2 CWP Rating: 200 psig (1380 kPa).
 - .3 Body Material: ASTM B62, bronze with integral seat and screw-in bonnet.
 - .4 Ends: Threaded.
 - .5 Stem and Disc: Bronze.
 - .6 Packing: Asbestos free.
 - .7 Handwheel: Malleable iron, bronze, or aluminum.
- .2 Class 125, Bronze Angle Valves with Nonmetallic Disc:
 - .1 Manufacturers:
 - .1 American Valve, Inc.
 - .2 NIBCO INC.
 - .2 Description:
 - .1 Standard: MSS SP-80, Type 2.
 - .2 CWP Rating: 200 psig (1380 kPa)).
 - .3 Body Material: ASTM B62, bronze with integral seat and screw-in bonnet.
 - .4 Ends: Threaded.
 - .5 Stem: Bronze.
 - .6 Disc: PTFE or TFE.
 - .7 Packing: Asbestos free.
 - .8 Handwheel: Malleable iron, bronze, or aluminum.
- .3 Class 150, Bronze Angle Valves with Bronze Disc:
 - .1 Manufacturers:
 - .1 Crane Co.
 - .2 Kitz Corporation.
 - .2 Description:
 - .1 Standard: MSS SP-80, Type 1.
 - .2 CWP Rating: 300 psig (2070 kPa).
 - .3 Body Material: ASTM B62, bronze with integral seat and union-ring bonnet.
 - .4 Ends: Threaded.
 - .5 Stem and Disc: Bronze.
 - .6 Packing: Asbestos free.
 - .7 Handwheel: Malleable iron, bronze, or aluminum.
- .4 Class 150, Bronze Angle Valves with Nonmetallic Disc:

- .1 Manufacturers:
 - .1 Crane Valve Group; Crane Valves.
 - .2 Crane Valve Group; Jenkins Valves.
 - .3 Crane Valve Group; Stockham Division.
 - .4 Hammond Valve.
 - .5 Milwaukee Valve Company.
 - .6 Nibco.
 - .7 Powell Valves.
- .2 Description:
 - .1 Standard: MSS SP-80, Type 2.
 - .2 CWP Rating: 300 psig (2070 kPa).
 - .3 Body Material: ASTM B62, bronze with integral seat and union-ring bonnet.
 - .4 Ends: Threaded.
 - .5 Stem: Bronze.
 - .6 Disc: PTFE or TFE.
 - .7 Packing: Asbestos free.
 - .8 Handwheel: Malleable iron, bronze, or aluminum.

2.3 BRASS BALL VALVES

- .1 One-Piece, Reduced-Port, Brass Ball Valves with Brass Trim:
 - .1 Manufacturers:
 - .1 Kitz Corporation.
 - .2 Watts
 - .3 Stockham
 - .2 Description:
 - .1 Standard: MSS SP-110.
 - .2 CWP Rating: 400 psig (2760 kPa).
 - .3 Body Design: One piece.
 - .4 Body Material: Forged brass.
 - .5 Ends: Threaded.
 - .6 Seats: PTFE or TFE.
 - .7 Stem: Brass.
 - .8 Ball: Chrome-plated brass.
 - .9 Port: Reduced.
- .2 Two-Piece, Full-Port, Brass Ball Valves with Brass Trim:
 - .1 Manufacturers:
 - .1 Crane Co.; Crane Valve Group; Crane Valves.
 - .2 Crane Co.; Crane Valve Group; Jenkins Valves.
 - .3 DynaQuip Controls.
 - .4 Flow-Tek, Inc.
 - .5 Hammond Valve.
 - .6 Jamesbury; a subsidiary of Metso Automation.
 - .7 Jomar Valve.
 - .8 Kitz Corporation.

- .9 Legend Valve.
- .10 Marwin Valve.
- .11 Milwaukee Valve Company.
- .12 NIBCO.
- .13 Red-White Valve Corporation.
- .14 RuB.
- .2 Description:
 - .1 Standard: MSS SP-110.
 - .2 SWP Rating: 150 psig (1035 kPa).
 - .3 CWP Rating: 600 psig (4140 kPa).
 - .4 Body Design: Two piece.
 - .5 Body Material: Forged brass.
 - .6 Ends: Threaded.
 - .7 Seats: PTFE or TFE.
 - .8 Stem: Brass.
 - .9 Ball: Chrome-plated brass.
 - .10 Port: Full.
- .3 Two-Piece, Full-Port, Brass Ball Valves with Stainless-Steel Trim:
 - .1 Manufacturers:
 - .1 Crane Co.; Crane Valve Group; Crane Valves.
 - .2 Crane Co.; Crane Valve Group; Jenkins Valves.
 - .3 Flow-Tek, Inc.
 - .4 Hammond Valve.
 - .5 Jamesbury.
 - .6 Kitz Corporation.
 - .7 Marwin Valve.
 - .8 Milwaukee Valve Company.
 - .9 RuB.
 - .2 Description:
 - .1 Standard: MSS SP-110.
 - .2 SWP Rating: 150 psig (1035 kPa) .
 - .3 CWP Rating: 600 psig (4140 kPa).
 - .4 Body Design: Two piece.
 - .5 Body Material: Forged brass.
 - .6 Ends: Threaded.
 - .7 Seats: PTFE or TFE.
 - .8 Stem: Stainless steel.
 - .9 Ball: Stainless steel, vented.
 - .10 Port: Full.
- .4 Two-Piece, Regular-Port, Brass Ball Valves with Brass Trim:
 - .1 Manufacturers:
 - .1 Hammond Valve.
 - .2 Jamesbury.

- .3 Legend Valve.
- .4 Marwin Valve.
- .5 Milwaukee Valve Company.
- .2 Description:
 - .1 Standard: MSS SP-110.
 - .2 SWP Rating: 150 psig (1035 kPa).
 - .3 CWP Rating: 600 psig (4140 kPa).
 - .4 Body Design: Two piece.
 - .5 Body Material: Forged brass.
 - .6 Ends: Threaded.
 - .7 Seats: PTFE or TFE.
 - .8 Stem: Brass.
 - .9 Ball: Chrome-plated brass.
 - .10 Port: Regular.
- .5 Two-Piece, Regular-Port, Brass Ball Valves with Stainless-Steel Trim:
 - .1 Manufacturers:
 - .1 Jamesbury.
 - .2 Marwin Valve.
 - .3 Apollo
 - .4 St
 - .5 Watts
 - .2 Description:
 - .1 Standard: MSS SP-110.
 - .2 SWP Rating: 150 psig (1035 kPa).
 - .3 CWP Rating: 600 psig (4140 kPa).
 - .4 Body Design: Two piece.
 - .5 Body Material: Brass or bronze.
 - .6 Ends: Threaded.
 - .7 Seats: PTFE or TFE.
 - .8 Stem: Stainless steel.
 - .9 Ball: Stainless steel, vented.
 - .10 Port: Regular.
- .6 Three-Piece, Full-Port, Brass Ball Valves with Brass Trim:
 - .1 Manufacturers:
 - .1 Jomar Valve.
 - .2 Kitz Corporation.
 - .3 Red-White Valve Corporation.
 - .4 Watts.
 - .2 Description:
 - .1 Standard: MSS SP-110.
 - .2 SWP Rating: 150 psig (1035 kPa).
 - .3 CWP Rating: 600 psig (4140 kPa).
 - .4 Body Design: Three piece.

- .5 Body Material: Forged brass.
- .6 Ends: Threaded.
- .7 Seats: PTFE or TFE.
- .8 Stem: Brass.
- .9 Ball: Chrome-plated brass.
- .10 Port: Full.
- .7 Three-Piece, Full-Port, Brass Ball Valves with Stainless-Steel Trim:
 - .1 Manufacturers:
 - .1 Jomar Valve.
 - .2 Kitz Corporation.
 - .3 Marwin Valve.
 - .4 Watts.
 - .2 Description:
 - .1 Standard: MSS SP-110.
 - .2 SWP Rating: 150 psig (1035 kPa).
 - .3 CWP Rating: 600 psig (4140 kPa).
 - .4 Body Design: Three piece.
 - .5 Body Material: Forged brass.
 - .6 Ends: Threaded.
 - .7 Seats: PTFE or TFE.
 - .8 Stem: Stainless steel.
 - .9 Ball: Stainless steel, vented.
 - .10 Port: Full.

2.4 BRONZE BALL VALVES

- .1 One-Piece, Reduced-Port, Bronze Ball Valves with Bronze Trim:
 - .1 Manufacturers:
 - .1 American Valve.
 - .2 Conbraco Industries; Apollo Valves.
 - .3 Nibco.
 - .2 Description:
 - .1 Standard: MSS SP-110.
 - .2 CWP Rating: 400 psig (2760 kPa).
 - .3 Body Design: One piece.
 - .4 Body Material: Bronze.
 - .5 Ends: Threaded.
 - .6 Seats: PTFE or TFE.
 - .7 Stem: Bronze.
 - .8 Ball: Chrome-plated brass.
 - .9 Port: Reduced.
- .2 One-Piece, Reduced-Port, Bronze Ball Valves with Stainless-Steel Trim:
 - .1 Manufacturers:
 - .1 Conbraco Industries; Apollo Valves.
 - .2 Nibco.

- .2 Description:
 - .1 Standard: MSS SP-110.
 - .2 CWP Rating: 600 psig (4140 kPa).
 - .3 Body Design: One piece.
 - .4 Body Material: Bronze.
 - .5 Ends: Threaded.
 - .6 Seats: PTFE or TFE.
 - .7 Stem: Stainless steel.
 - .8 Ball: Stainless steel, vented.
 - .9 Port: Reduced.
- .3 Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:
 - .1 Manufacturers:
 - .1 American Valve.
 - .2 Conbraco Industries; Apollo Valves.
 - .3 Crane Co.; Crane Valve Group; Crane Valves.
 - .4 Hammond Valve.
 - .5 Lance Valves.
 - .6 Legend Valve.
 - .7 Milwaukee Valve Company.
 - .8 Nibco.
 - .9 Red-White Valve Corporation.
 - .10 Watts.
 - .2 Description:
 - .1 Standard: MSS SP-110.
 - .2 SWP Rating: 150 psig (1035 kPa).
 - .3 CWP Rating: 600 psig (4140 kPa).
 - .4 Body Design: Two piece.
 - .5 Body Material: Bronze.
 - .6 Ends: Threaded.
 - .7 Seats: PTFE or TFE.
 - .8 Stem: Bronze.
 - .9 Ball: Chrome-plated brass.
 - .10 Port: Full.
- .4 Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:
 - .1 Manufacturers:
 - .1 Conbraco Industries.; Apollo Valves.
 - .2 Crane Co.; Crane Valve Group; Crane Valves.
 - .3 Hammond Valve.
 - .4 Lance Valves.
 - .5 Milwaukee Valve Company.
 - .6 Nibco.
 - .7 Watts.
 - .2 Description:

- .1 Standard: MSS SP-110.
 - .2 SWP Rating: 150 psig (1035 kPa).
 - .3 CWP Rating: 600 psig (4140 kPa).
 - .4 Body Design: Two piece.
 - .5 Body Material: Bronze.
 - .6 Ends: Threaded.
 - .7 Seats: PTFE or TFE.
 - .8 Stem: Stainless steel.
 - .9 Ball: Stainless steel, vented.
 - .10 Port: Full.
- .5 Two-Piece, Regular-Port, Bronze Ball Valves with Bronze Trim:
- .1 Manufacturers:
 - .1 American Valve.
 - .2 Conbraco Industries.; Apollo Valves.
 - .3 Crane Co.; Crane Valve Group; Jenkins Valves.
 - .4 Crane Co.; Crane Valve Group; Stockham Division.
 - .5 DynaQuip Controls.
 - .6 Hammond Valve.
 - .7 Lance Valves.
 - .8 Milwaukee Valve Company.
 - .9 Nibco.
 - .2 Description:
 - .1 Standard: MSS SP-110.
 - .2 SWP Rating: 150 psig (1035 kPa).
 - .3 CWP Rating: 600 psig (4140 kPa).
 - .4 Body Design: Two piece.
 - .5 Body Material: Bronze.
 - .6 Ends: Threaded.
 - .7 Seats: PTFE or TFE.
 - .8 Stem: Bronze.
 - .9 Ball: Chrome-plated brass.
 - .10 Port: Regular.
- .6 Two-Piece, Regular-Port, Bronze Ball Valves with Stainless-Steel Trim:
- .1 Manufacturers:
 - .1 Conbraco Industries.; Apollo Valves.
 - .2 Crane Co.; Crane Valve Group; Jenkins Valves.
 - .3 Hammond Valve.
 - .4 Milwaukee Valve Company.
 - .2 Description:
 - .1 Standard: MSS SP-110.
 - .2 SWP Rating: 150 psig (1035 kPa).
 - .3 CWP Rating: 600 psig (4140 kPa).
 - .4 Body Design: Two piece.

- .5 Body Material: Bronze.
- .6 Ends: Threaded.
- .7 Seats: PTFE or TFE.
- .8 Stem: Stainless steel.
- .9 Ball: Stainless steel, vented.
- .10 Port: Regular.
- .7 Three-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:
 - .1 Manufacturers:
 - .1 Conbraco Industries; Apollo Valves.
 - .2 DynaQuip Controls.
 - .3 Hammond Valve.
 - .4 Milwaukee Valve Company.
 - .5 Nibco.
 - .6 Red-White Valve Corporation.
 - .2 Description:
 - .1 Standard: MSS SP-110.
 - .2 SWP Rating: 150 psig (1035 kPa).
 - .3 CWP Rating: 600 psig (4140 kPa).
 - .4 Body Design: Three piece.
 - .5 Body Material: Bronze.
 - .6 Ends: Threaded.
 - .7 Seats: PTFE or TFE.
 - .8 Stem: Bronze.
 - .9 Ball: Chrome-plated brass.
 - .10 Port: Full.
- .8 Three-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:
 - .1 Manufacturers:
 - .1 Conbraco Industries; Apollo Valves.
 - .2 Hammond Valve.
 - .3 Milwaukee Valve Company.
 - .4 Nibco.
 - .2 Description:
 - .1 Standard: MSS SP-110.
 - .2 SWP Rating: 150 psig (1035 kPa).
 - .3 CWP Rating: 600 psig (4140 kPa).
 - .4 Body Design: Three piece.
 - .5 Body Material: Bronze.
 - .6 Ends: Threaded.
 - .7 Seats: PTFE or TFE.
 - .8 Stem: Stainless steel.
 - .9 Ball: Stainless steel, vented.
 - .10 Port: Full.

2.5 IRON BALL VALVES

- .1 Class 125, Iron Ball Valves:
 - .1 Manufacturers:
 - .1 American Valve.
 - .2 Conbraco Industries; Apollo Valves.
 - .3 Kitz Corporation.
 - .4 Sure Flow Equipment.
 - .5 Watts.
 - .2 Description:
 - .1 Standard: MSS SP-72.
 - .2 CWP Rating: 200 psig (1380 kPa).
 - .3 Body Design: Split body.
 - .4 Body Material: ASTM A126, gray iron.
 - .5 Ends: Flanged.
 - .6 Seats: PTFE or TFE.
 - .7 Stem: Stainless steel.
 - .8 Ball: Stainless steel.
 - .9 Port: Full.

2.6 IRON, SINGLE-FLANGE BUTTERFLY VALVES

- .1 150 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:
 - .1 Manufacturers:
 - .1 ABZ Valve and Controls.
 - .2 Bray Controls.
 - .3 Conbraco Industries; Apollo Valves.
 - .4 Cooper Cameron Valves.
 - .5 Crane Co.; Crane Valve Group; Jenkins Valves.
 - .6 Crane Co.; Crane Valve Group; Stockham Division.
 - .7 DeZurik Water Controls.
 - .8 Hammond Valve.
 - .9 Kitz Corporation.
 - .10 Milwaukee Valve Company.
 - .11 Nibco.
 - .12 Norriseal.
 - .13 Red-White Valve Corporation.
 - .14 Spence Strainers International.
 - .15 Tyco Valves & Controls.
 - .16 Watts.
 - .2 Description:
 - .1 Standard: MSS SP-67, Type I.
 - .2 CWP Rating: 150 psig (1035 kPa).
 - .3 Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - .4 Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
 - .5 Seat: EPDM.

- .6 Stem: One- or two-piece stainless steel.
- .7 Disc: Aluminum bronze.
- .2 150 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Aluminum-Bronze Disc:
 - .1 Manufacturers:
 - .1 ABZ Valve and Controls.
 - .2 Bray Controls.
 - .3 Conbraco Industries.; Apollo Valves.
 - .4 Cooper Cameron Valves.
 - .5 Crane Co.; Crane Valve Group; Jenkins Valves.
 - .6 Crane Co.; Crane Valve Group; Stockham Division.
 - .7 DeZurik Water Controls.
 - .8 Hammond Valve.
 - .9 Kitz Corporation.
 - .10 Milwaukee Valve Company.
 - .11 Nibco.
 - .12 Norriseal.
 - .13 Red-White Valve Corporation.
 - .14 Spence Strainers International.
 - .15 Tyco Valves & Controls.
 - .16 Watts.
 - .2 Description:
 - .1 Standard: MSS SP-67, Type I.
 - .2 CWP Rating: 150 psig (1035 kPa).
 - .3 Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - .4 Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
 - .5 Seat: NBR.
 - .6 Stem: One- or two-piece stainless steel.
 - .7 Disc: Aluminum bronze.
- .3 150 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Ductile-Iron Disc:
 - .1 Manufacturers:
 - .1 ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
 - .2 Bray Controls; a division of Bray International.
 - .3 Conbraco Industries, Inc.; Apollo Valves.
 - .4 Cooper Cameron Valves; a division of Cooper Cameron Corp.
 - .5 Crane Co.; Crane Valve Group; Center Line.
 - .6 Crane Co.; Crane Valve Group; Stockham Division.
 - .7 DeZurik Water Controls.
 - .8 Hammond Valve.
 - .9 Kitz Corporation.
 - .10 Milwaukee Valve Company.
 - .11 Mueller Steam Specialty; a division of SPX Corporation.
 - .12 NIBCO INC.

- .13 Norriseal; a Dover Corporation company.
- .14 Spence Strainers International; a division of CIRCOR International.
- .15 Sure Flow Equipment Inc.
- .16 Tyco Valves & Controls; a unit of Tyco Flow Control.
- .17 Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- .2 Description:
 - .1 Standard: MSS SP-67, Type I.
 - .2 CWP Rating: 150 psig (1035 kPa).
 - .3 Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - .4 Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
 - .5 Seat: EPDM.
 - .6 Stem: One- or two-piece stainless steel.
 - .7 Disc: Nickel-plated or -coated ductile iron.
- .4 150 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Ductile-Iron Disc:
 - .1 Manufacturers:
 - .1 ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
 - .2 Bray Controls; a division of Bray International.
 - .3 Conbraco Industries, Inc.; Apollo Valves.
 - .4 Cooper Cameron Valves; a division of Cooper Cameron Corp.
 - .5 Crane Co.; Crane Valve Group; Center Line.
 - .6 Crane Co.; Crane Valve Group; Stockham Division.
 - .7 DeZurik Water Controls.
 - .8 Hammond Valve.
 - .9 Kitz Corporation.
 - .10 Milwaukee Valve Company.
 - .11 Mueller Steam Specialty; a division of SPX Corporation.
 - .12 NIBCO INC.
 - .13 Norriseal; a Dover Corporation company.
 - .14 Spence Strainers International; a division of CIRCOR International.
 - .15 Sure Flow Equipment Inc.
 - .16 Tyco Valves & Controls; a unit of Tyco Flow Control.
 - .17 Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - .2 Description:
 - .1 Standard: MSS SP-67, Type I.
 - .2 CWP Rating: 150 psig (1035 kPa).
 - .3 Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - .4 Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
 - .5 Seat: NBR.
 - .6 Stem: One- or two-piece stainless steel.
 - .7 Disc: Nickel-plated or -coated ductile iron.
- .5 150 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Stainless-Steel Disc:

- .1 Manufacturers:
 - .1 ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
 - .2 Bray Controls; a division of Bray International.
 - .3 Conbraco Industries, Inc.; Apollo Valves.
 - .4 Cooper Cameron Valves; a division of Cooper Cameron Corp.
 - .5 Crane Co.; Crane Valve Group; Jenkins Valves.
 - .6 Crane Co.; Crane Valve Group; Stockham Division.
 - .7 DeZurik Water Controls.
 - .8 Hammond Valve.
 - .9 Kitz Corporation.
 - .10 Milwaukee Valve Company.
 - .11 Mueller Steam Specialty; a division of SPX Corporation.
 - .12 NIBCO INC.
 - .13 Norriseal; a Dover Corporation company.
 - .14 Red-White Valve Corporation.
 - .15 Spence Strainers International; a division of CIRCOR International.
 - .16 Sure Flow Equipment Inc.
 - .17 Tyco Valves & Controls; a unit of Tyco Flow Control.
 - .18 Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- .2 Description:
 - .1 Standard: MSS SP-67, Type I.
 - .2 CWP Rating: 150 psig (1035 kPa).
 - .3 Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - .4 Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
 - .5 Seat: EPDM.
 - .6 Stem: One- or two-piece stainless steel.
 - .7 Disc: Stainless steel.
- .6 150 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Stainless-Steel Disc:
 - .1 Manufacturers:
 - .1 ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
 - .2 Bray Controls; a division of Bray International.
 - .3 Conbraco Industries, Inc.; Apollo Valves.
 - .4 Cooper Cameron Valves; a division of Cooper Cameron Corp.
 - .5 Crane Co.; Crane Valve Group; Jenkins Valves.
 - .6 Crane Co.; Crane Valve Group; Stockham Division.
 - .7 DeZurik Water Controls.
 - .8 Hammond Valve.
 - .9 Kitz Corporation.
 - .10 Milwaukee Valve Company.
 - .11 Mueller Steam Specialty; a division of SPX Corporation.
 - .12 NIBCO INC.
 - .13 Norriseal; a Dover Corporation company.

- .14 Red-White Valve Corporation.
- .15 Spence Strainers International; a division of CIRCOR International.
- .16 Sure Flow Equipment Inc.
- .17 Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- .2 Description:
 - .1 Standard: MSS SP-67, Type I.
 - .2 CWP Rating: 150 psig (1035 kPa).
 - .3 Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - .4 Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
 - .5 Seat: NBR.
 - .6 Stem: One- or two-piece stainless steel.
 - .7 Disc: Stainless steel.
- .7 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:
 - .1 Manufacturers:
 - .1 ABZ Valve and Controls; a division of ABZ Manufacturing.
 - .2 Conbraco Industries; Apollo Valves.
 - .3 Cooper Cameron Valves; a division of Cooper Cameron Corp.
 - .4 Crane Valve Group; Jenkins Valves.
 - .5 Crane Valve Group; Stockham Division.
 - .6 DeZurik Water Controls.
 - .7 Flo Fab.
 - .8 Hammond Valve.
 - .9 Kitz Corporation.
 - .10 Legend Valve.
 - .11 Milwaukee Valve Company.
 - .12 Nibco.
 - .13 Norriseal; a Dover Corporation company.
 - .14 Red-White Valve Corporation.
 - .15 Spence Strainers International; a division of CIRCOR International.
 - .16 Watts Regulator Co.; a division of Watts Water Technologies.
 - .2 Description:
 - .1 Standard: MSS SP-67, Type I.
 - .2 CWP Rating: 200 psig (1380 kPa).
 - .3 Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - .4 Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
 - .5 Seat: EPDM.
 - .6 Stem: One- or two-piece stainless steel.
 - .7 Disc: Aluminum bronze.
- .8 200 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Aluminum-Bronze Disc:
 - .1 Manufacturers:
 - .1 ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.

- .2 Conbraco Industries, Inc.; Apollo Valves.
- .3 Cooper Cameron Valves; a division of Cooper Cameron Corp.
- .4 Crane Co.; Crane Valve Group; Jenkins Valves.
- .5 Crane Co.; Crane Valve Group; Stockham Division.
- .6 DeZurik Water Controls.
- .7 Flo Fab Inc.
- .8 Hammond Valve.
- .9 Kitz Corporation.
- .10 Legend Valve.
- .11 Milwaukee Valve Company.
- .12 NIBCO INC.
- .13 Norriseal; a Dover Corporation company.
- .14 Red-White Valve Corporation.
- .15 Spence Strainers International; a division of CIRCOR International.
- .16 Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- .2 Description:
 - .1 Standard: MSS SP-67, Type I.
 - .2 CWP Rating: 200 psig (1380 kPa).
 - .3 Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - .4 Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
 - .5 Seat: NBR.
 - .6 Stem: One- or two-piece stainless steel.
 - .7 Disc: Aluminum bronze.
- .9 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Ductile-Iron Disc:
 - .1 Manufacturers:
 - .1 ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
 - .2 American Valve, Inc.
 - .3 Conbraco Industries, Inc.; Apollo Valves.
 - .4 Cooper Cameron Valves; a division of Cooper Cameron Corp.
 - .5 Crane Co.; Crane Valve Group; Center Line.
 - .6 Crane Co.; Crane Valve Group; Stockham Division.
 - .7 DeZurik Water Controls.
 - .8 Flo Fab Inc.
 - .9 Hammond Valve.
 - .10 Kitz Corporation.
 - .11 Legend Valve.
 - .12 Milwaukee Valve Company.
 - .13 Mueller Steam Specialty; a division of SPX Corporation.
 - .14 NIBCO INC.
 - .15 Norriseal; a Dover Corporation company.
 - .16 Spence Strainers International; a division of CIRCOR International.
 - .17 Sure Flow Equipment Inc.

- .18 Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- .2 Description:
 - .1 Standard: MSS SP-67, Type I.
 - .2 CWP Rating: 200 psig (1380 kPa).
 - .3 Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - .4 Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
 - .5 Seat: EPDM.
 - .6 Stem: One- or two-piece stainless steel.
 - .7 Disc: Nickel-plated or -coated ductile iron.
- .10 200 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Ductile-Iron Disc:
 - .1 Manufacturers:
 - .1 ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
 - .2 American Valve, Inc.
 - .3 Conbraco Industries, Inc.; Apollo Valves.
 - .4 Cooper Cameron Valves; a division of Cooper Cameron Corp.
 - .5 Crane Co.; Crane Valve Group; Center Line.
 - .6 Crane Co.; Crane Valve Group; Stockham Division.
 - .7 DeZurik Water Controls.
 - .8 Flo Fab Inc.
 - .9 Hammond Valve.
 - .10 Kitz Corporation.
 - .11 Legend Valve.
 - .12 Milwaukee Valve Company.
 - .13 Mueller Steam Specialty; a division of SPX Corporation.
 - .14 NIBCO INC.
 - .15 Norriseal; a Dover Corporation company.
 - .16 Spence Strainers International; a division of CIRCOR International.
 - .17 Sure Flow Equipment Inc.
 - .18 Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - .2 Description:
 - .1 Standard: MSS SP-67, Type I.
 - .2 CWP Rating: 200 psig (1380 kPa).
 - .3 Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - .4 Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
 - .5 Seat: NBR.
 - .6 Stem: One- or two-piece stainless steel.
 - .7 Disc: Nickel-plated or -coated ductile iron.
- .11 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Stainless-Steel Disc:
 - .1 Manufacturers:
 - .1 ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
 - .2 American Valve, Inc.

- .3 Conbraco Industries, Inc.; Apollo Valves.
- .4 Cooper Cameron Valves; a division of Cooper Cameron Corp.
- .5 Crane Co.; Crane Valve Group; Jenkins Valves.
- .6 Crane Co.; Crane Valve Group; Stockham Division.
- .7 DeZurik Water Controls.
- .8 Flo Fab Inc.
- .9 Hammond Valve.
- .10 Kitz Corporation.
- .11 Legend Valve.
- .12 Milwaukee Valve Company.
- .13 Mueller Steam Specialty; a division of SPX Corporation.
- .14 NIBCO INC.
- .15 Norriseal; a Dover Corporation company.
- .16 Red-White Valve Corporation.
- .17 Spence Strainers International; a division of CIRCOR International.
- .18 Sure Flow Equipment Inc.
- .19 Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- .2 Description:
 - .1 Standard: MSS SP-67, Type I.
 - .2 CWP Rating: 200 psig (1380 kPa).
 - .3 Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - .4 Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
 - .5 Seat: EPDM.
 - .6 Stem: One- or two-piece stainless steel.
 - .7 Disc: Stainless steel.
- .12 200 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Stainless-Steel Disc:
 - .1 Manufacturers:
 - .1 ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
 - .2 American Valve, Inc.
 - .3 Conbraco Industries, Inc.; Apollo Valves.
 - .4 Cooper Cameron Valves; a division of Cooper Cameron Corp.
 - .5 Crane Co.; Crane Valve Group; Jenkins Valves.
 - .6 Crane Co.; Crane Valve Group; Stockham Division.
 - .7 DeZurik Water Controls.
 - .8 Flo Fab Inc.
 - .9 Hammond Valve.
 - .10 Kitz Corporation.
 - .11 Legend Valve.
 - .12 Milwaukee Valve Company.
 - .13 Mueller Steam Specialty; a division of SPX Corporation.
 - .14 NIBCO INC.
 - .15 Norriseal; a Dover Corporation company.

- .16 Red-White Valve Corporation.
- .17 Spence Strainers International; a division of CIRCOR International.
- .18 Sure Flow Equipment Inc.
- .19 Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- .2 Description:
 - .1 Standard: MSS SP-67, Type I.
 - .2 CWP Rating: 200 psig (1380 kPa).
 - .3 Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - .4 Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
 - .5 Seat: NBR.
 - .6 Stem: One- or two-piece stainless steel.
 - .7 Disc: Stainless steel.

2.7 IRON, GROOVED-END BUTTERFLY VALVES

- .1 175 CWP, Iron, Grooved-End Butterfly Valves:
 - .1 Manufacturers:
 - .1 Kennedy Valve; a division of McWane, Inc.
 - .2 Shurjoint Piping Products.
 - .3 Tyco Fire Products LP; Grinnell Mechanical Products.
 - .4 Victaulic Company.
 - .2 Description:
 - .1 Standard: MSS SP-67, Type I.
 - .2 CWP Rating: 175 psig (1200 kPa).
 - .3 Body Material: Coated, ductile iron.
 - .4 Stem: Two-piece stainless steel.
 - .5 Disc: Coated, ductile iron.
 - .6 Seal: EPDM.
- .2 300 CWP, Iron, Grooved-End Butterfly Valves:
 - .1 Manufacturers:
 - .1 Anvil International, Inc.
 - .2 Kennedy Valve; a division of McWane, Inc.
 - .3 Mueller Steam Specialty; a division of SPX Corporation.
 - .4 NIBCO INC.
 - .5 Shurjoint Piping Products.
 - .6 Tyco Fire Products LP; Grinnell Mechanical Products.
 - .7 Victaulic Company.
 - .2 Description:
 - .1 Standard: MSS SP-67, Type I.
 - .2 NPS 8 (DN 50) and Smaller CWP Rating: 300 psig (2070 kPa).
 - .3 NPS 10 (DN 250) and Larger CWP Rating: 200 psig (1380 kPa).
 - .4 Body Material: Coated, ductile iron.
 - .5 Stem: Two-piece stainless steel.
 - .6 Disc: Coated, ductile iron.

.7 Seal: EPDM.

2.8 HIGH-PERFORMANCE BUTTERFLY VALVES

.1 Class 150, Single-Flange, High-Performance Butterfly Valves:

.1 Manufacturers:

- .1 ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
- .2 Bray Controls; a division of Bray International.
- .3 Cooper Cameron Valves; a division of Cooper Cameron Corp.
- .4 Crane Valve Group; Flowseal.
- .5 Crane Valve Group; Stockham Division.
- .6 DeZurik Water Controls.
- .7 Hammond Valve.
- .8 Jamesbury; a subsidiary of Metso Automation.
- .9 Milwaukee Valve Company.
- .10 NIBCO INC.
- .11 Process Development & Control, Inc.
- .12 Tyco Valves & Controls; a unit of Tyco Flow Control.
- .13 Xomox Corporation.

.2 Description:

- .1 Standard: MSS SP-68.
- .2 CWP Rating: 285 psig (1965 kPa) at 100 deg F (38 deg C).
- .3 Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
- .4 Body Material: Carbon steel, cast iron, ductile iron, or stainless steel.
- .5 Seat: Reinforced PTFE or metal.
- .6 Stem: Stainless steel; offset from seat plane.
- .7 Disc: Carbon steel.
- .8 Service: Bidirectional.

.2 Class 300, Single-Flange, High-Performance Butterfly Valves:

.1 Manufacturers:

- .1 ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
- .2 Bray Controls; a division of Bray International.
- .3 Cooper Cameron Valves; a division of Cooper Cameron Corp.
- .4 Crane Valve Group; Flowseal.
- .5 Crane Valve Group; Stockham Division.
- .6 DeZurik Water Controls.
- .7 Hammond Valve.
- .8 Jamesbury; a subsidiary of Metso Automation.
- .9 Milwaukee Valve Company.
- .10 NIBCO INC.
- .11 Process Development & Control, Inc.
- .12 Tyco Valves & Controls; a unit of Tyco Flow Control.
- .13 Xomox Corporation.

.2 Description:

- .1 Standard: MSS SP-68.
- .2 CWP Rating: 720 psig (4965 kPa) at 100 deg F (38 deg C).
- .3 Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
- .4 Body Material: Carbon steel, cast iron, or ductile iron.
- .5 Seat: Reinforced PTFE or metal.
- .6 Stem: Stainless steel; offset from seat plane.
- .7 Disc: Carbon steel.
- .8 Service: Bidirectional.

2.9 BRONZE LIFT CHECK VALVES

- .1 Class 125, Lift Check Valves with Bronze Disc:
 - .1 Manufacturers:
 - .1 Crane Co.; Crane Valve Group; Crane Valves.
 - .2 Crane Co.; Crane Valve Group; Jenkins Valves.
 - .3 Crane Co.; Crane Valve Group; Stockham Division.
 - .2 Description:
 - .1 Standard: MSS SP-80, Type 1.
 - .2 CWP Rating: 200 psig (1380 kPa).
 - .3 Body Design: Vertical flow.
 - .4 Body Material: ASTM B61 or ASTM B62, bronze.
 - .5 Ends: Threaded.
 - .6 Disc: Bronze.
- .2 Class 125, Lift Check Valves with Nonmetallic Disc:
 - .1 Manufacturers:
 - .1 Flo Fab Inc.
 - .2 Hammond Valve.
 - .3 Kitz Corporation.
 - .4 Milwaukee Valve Company.
 - .5 Mueller Steam Specialty; a division of SPX Corporation.
 - .6 NIBCO INC.
 - .7 Red-White Valve Corporation.
 - .8 Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - .2 Description:
 - .1 Standard: MSS SP-80, Type 2.
 - .2 CWP Rating: 200 psig (1380 kPa).
 - .3 Body Design: Vertical flow.
 - .4 Body Material: ASTM B61 or ASTM B62, bronze.
 - .5 Ends: Threaded.
 - .6 Disc: NBR, PTFE, or TFE.

2.10 BRONZE SWING CHECK VALVES

- .1 Class 125, Bronze Swing Check Valves with Bronze Disc:
 - .1 Manufacturers:

- .1 American Valve, Inc.
 - .2 Crane Co.; Crane Valve Group; Crane Valves.
 - .3 Crane Co.; Crane Valve Group; Jenkins Valves.
 - .4 Crane Co.; Crane Valve Group; Stockham Division.
 - .5 Hammond Valve.
 - .6 Kitz Corporation.
 - .7 Milwaukee Valve Company.
 - .8 NIBCO INC.
 - .9 Powell Valves.
 - .10 Red-White Valve Corporation.
 - .11 Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - .12 Zy-Tech Global Industries, Inc.
- .2 Description:
 - .1 Standard: MSS SP-80, Type 3.
 - .2 CWP Rating: 200 psig (1380 kPa).
 - .3 Body Design: Horizontal flow.
 - .4 Body Material: ASTM B62, bronze.
 - .5 Ends: Threaded.
 - .6 Disc: Bronze.
- .2 Class 125, Bronze Swing Check Valves with Nonmetallic Disc:
 - .1 Manufacturers:
 - .1 Crane Co.; Crane Valve Group; Crane Valves.
 - .2 Crane Co.; Crane Valve Group; Jenkins Valves.
 - .3 Crane Co.; Crane Valve Group; Stockham Division.
 - .4 Hammond Valve.
 - .5 Kitz Corporation.
 - .6 Milwaukee Valve Company.
 - .7 NIBCO INC.
 - .8 Red-White Valve Corporation.
 - .9 Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - .2 Description:
 - .1 Standard: MSS SP-80, Type 4.
 - .2 CWP Rating: 200 psig (1380 kPa).
 - .3 Body Design: Horizontal flow.
 - .4 Body Material: ASTM B62, bronze.
 - .5 Ends: Threaded.
 - .6 Disc: PTFE or TFE.
- .3 Class 150, Bronze Swing Check Valves with Bronze Disc:
 - .1 Manufacturers:
 - .1 American Valve, Inc.
 - .2 Crane Co.; Crane Valve Group; Crane Valves.
 - .3 Crane Co.; Crane Valve Group; Jenkins Valves.
 - .4 Crane Co.; Crane Valve Group; Stockham Division.

- .5 Kitz Corporation.
- .6 Milwaukee Valve Company.
- .7 NIBCO INC.
- .8 Red-White Valve Corporation.
- .9 Zy-Tech Global Industries, Inc.
- .2 Description:
 - .1 Standard: MSS SP-80, Type 3.
 - .2 CWP Rating: 300 psig (2070 kPa).
 - .3 Body Design: Horizontal flow.
 - .4 Body Material: ASTM B62, bronze.
 - .5 Ends: Threaded.
 - .6 Disc: Bronze.
- .4 Class 150, Bronze Swing Check Valves with Nonmetallic Disc:
 - .1 Manufacturers:
 - .1 Crane Co.; Crane Valve Group; Crane Valves.
 - .2 Crane Co.; Crane Valve Group; Jenkins Valves.
 - .3 Hammond Valve.
 - .4 Milwaukee Valve Company.
 - .5 NIBCO INC.
 - .6 Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - .2 Description:
 - .1 Standard: MSS SP-80, Type 4.
 - .2 CWP Rating: 300 psig (2070 kPa).
 - .3 Body Design: Horizontal flow.
 - .4 Body Material: ASTM B62, bronze.
 - .5 Ends: Threaded.
 - .6 Disc: PTFE or TFE.

2.11 IRON SWING CHECK VALVES

- .1 Class 125, Iron Swing Check Valves with Metal Seats:
 - .1 Manufacturers:
 - .1 Crane Valve Group; Crane Valves.
 - .2 Crane Valve Group; Jenkins Valves.
 - .3 Crane Valve Group; Stockham Division.
 - .4 Hammond Valve.
 - .5 Kitz Corporation.
 - .6 Legend Valve.
 - .7 Milwaukee Valve Company.
 - .8 Nibco.
 - .9 Powell Valves.
 - .10 Red-White Valve Corporation.
 - .11 Sure Flow Equipment.
 - .12 Watts Regulator Co.; a division of Watts Water Technologies.
 - .13 Zy-Tech Global Industries.

- .2 Description:
 - .1 Standard: MSS SP-71, Type I.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
 - .4 Body Design: Clear or full waterway.
 - .5 Body Material: ASTM A126, gray iron with bolted bonnet.
 - .6 Ends: Flanged.
 - .7 Trim: Bronze.
 - .8 Gasket: Asbestos free.
- .2 Class 125, Iron Swing Check Valves with Nonmetallic-to-Metal Seats:
 - .1 Manufacturers:
 - .1 Crane Co.; Crane Valve Group; Crane Valves.
 - .2 Crane Co.; Crane Valve Group; Stockham Division.
 - .2 Description:
 - .1 Standard: MSS SP-71, Type I.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: CWP Rating: 200 psig (1380 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
 - .4 Body Design: Clear or full waterway.
 - .5 Body Material: ASTM A126, gray iron with bolted bonnet.
 - .6 Ends: Flanged.
 - .7 Trim: Composition.
 - .8 Seat Ring: Bronze.
 - .9 Disc Holder: Bronze.
 - .10 Disc: PTFE or TFE.
 - .11 Gasket: Asbestos free.
- .3 Class 250, Iron Swing Check Valves with Metal Seats:
 - .1 Manufacturers:
 - .1 Crane Valve Group; Crane Valves.
 - .2 Crane Valve Group; Jenkins Valves.
 - .3 Crane Valve Group; Stockham Division.
 - .4 Hammond Valve.
 - .5 Milwaukee Valve Company.
 - .6 NIBCO INC.
 - .7 Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - .2 Description:
 - .1 Standard: MSS SP-71, Type I.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 500 psig (3450 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 300 psig (2070 kPa).
 - .4 Body Design: Clear or full waterway.
 - .5 Body Material: ASTM A126, gray iron with bolted bonnet.
 - .6 Ends: Flanged.
 - .7 Trim: Bronze.

.8 Gasket: Asbestos free.

2.12 IRON SWING CHECK VALVES WITH CLOSURE CONTROL

- .1 Class 125, Iron Swing Check Valves with Lever- and Spring-Closure Control:
 - .1 Manufacturers:
 - .1 NIBCO INC.
 - .2 Description:
 - .1 Standard: MSS SP-71, Type I.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
 - .4 Body Design: Clear or full waterway.
 - .5 Body Material: ASTM A126, gray iron with bolted bonnet.
 - .6 Ends: Flanged.
 - .7 Trim: Bronze.
 - .8 Gasket: Asbestos free.
 - .9 Closure Control: Factory-installed, exterior lever and spring.
- .2 Class 125, Iron Swing Check Valves with Lever and Weight-Closure Control:
 - .1 Manufacturers:
 - .1 Crane Co.; Crane Valve Group; Crane Valves.
 - .2 Crane Co.; Crane Valve Group; Jenkins Valves.
 - .3 Crane Co.; Crane Valve Group; Stockham Division.
 - .4 Hammond Valve.
 - .5 Milwaukee Valve Company.
 - .6 NIBCO INC.
 - .7 Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - .2 Description:
 - .1 Standard: MSS SP-71, Type I.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
 - .4 Body Design: Clear or full waterway.
 - .5 Body Material: ASTM A126, gray iron with bolted bonnet.
 - .6 Ends: Flanged.
 - .7 Trim: Bronze.
 - .8 Gasket: Asbestos free.
 - .9 Closure Control: Factory-installed, exterior lever and weight.

2.13 IRON, GROOVED-END SWING-CHECK VALVES

- .1 300 CWP, Iron, Grooved-End Swing Check Valves:
 - .1 Manufacturers:
 - .1 Anvil International, Inc.
 - .2 Shurjoint Piping Products.
 - .3 Tyco Fire Products LP; Grinnell Mechanical Products.
 - .4 Victaulic Company.
 - .2 Description:

- .1 CWP Rating: 300 psig (2070 kPa).
- .2 Body Material: ASTM A536, ductile iron.
- .3 Seal: EPDM.
- .4 Disc: Spring operated ductile iron or stainless steel.

2.14 IRON, CENTER-GUIDED CHECK VALVES

- .1 Class 125, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat:
 - .1 Manufacturers:
 - .1 Anvil International, Inc.
 - .2 APCO Willamette Valve and Primer Corporation.
 - .3 Crispin Valve.
 - .4 DFT Inc.
 - .5 Flo Fab Inc.
 - .6 GA Industries, Inc.
 - .7 Hammond Valve.
 - .8 Metraflex, Inc.
 - .9 Milwaukee Valve Company.
 - .10 Mueller Steam Specialty; a division of SPX Corporation.
 - .11 NIBCO INC.
 - .12 Spence Strainers International; a division of CIRCOR International.
 - .13 Sure Flow Equipment Inc.
 - .14 Val-Matic Valve & Manufacturing Corp.
 - .2 Description:
 - .1 Standard: MSS SP-125.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
 - .4 Body Material: ASTM A126, gray iron.
 - .5 Style: Compact wafer.
 - .6 Seat: Bronze.
- .2 Class 125, Iron, Globe, Center-Guided Check Valves with Metal Seat:
 - .1 Manufacturers:
 - .1 APCO Willamette Valve and Primer Corporation.
 - .2 Crispin Valve.
 - .3 DFT Inc.
 - .4 Flomatic Corporation.
 - .5 Hammond Valve.
 - .6 Metraflex, Inc.
 - .7 Milwaukee Valve Company.
 - .8 Mueller Steam Specialty; a division of SPX Corporation.
 - .9 NIBCO INC.
 - .10 Spence Strainers International; a division of CIRCOR International.
 - .11 Sure Flow Equipment Inc.
 - .12 Val-Matic Valve & Manufacturing Corp.

- .13 Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- .2 Description:
 - .1 Standard: MSS SP-125 .
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
 - .4 Body Material: ASTM A126, gray iron.
 - .5 Style: Globe, spring loaded.
 - .6 Ends: Flanged.
 - .7 Seat: Bronze.
- .3 Class 150, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat:
 - .1 Manufacturers:
 - .1 APCO Willamette Valve and Primer Corporation.
 - .2 Crispin Valve.
 - .3 Val-Matic Valve & Manufacturing Corp.
 - .2 Description:
 - .1 Standard: MSS SP-125.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 300 psig (2070 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 250 psig (1725 kPa).
 - .4 Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
 - .5 Style: Compact wafer.
 - .6 Seat: Bronze.
- .4 Class 150, Iron, Globe, Center-Guided Check Valves with Metal Seat:
 - .1 Manufacturers:
 - .1 APCO Willamette Valve and Primer Corporation.
 - .2 Crispin Valve.
 - .3 Val-Matic Valve & Manufacturing Corp.
 - .2 Description:
 - .1 Standard: MSS SP-125.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 300 psig (2070 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 250 psig (1725 kPa).
 - .4 Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
 - .5 Style: Globe, spring loaded.
 - .6 Ends: Flanged.
 - .7 Seat: Bronze.
- .5 Class 250, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat:
 - .1 Manufacturers:
 - .1 APCO Willamette Valve and Primer Corporation.
 - .2 Crispin Valve.
 - .3 DFT Inc.
 - .4 Flo Fab Inc.
 - .5 Hammond Valve.
 - .6 Metraflex, Inc.
 - .7 Milwaukee Valve Company.

- .8 NIBCO INC.
- .9 Sure Flow Equipment Inc.
- .10 Val-Matic Valve & Manufacturing Corp.
- .2 Description:
 - .1 Standard: MSS SP-125.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 400 psig (2760 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 300 psig (2070 kPa).
 - .4 Body Material: ASTM A126, gray iron.
 - .5 Style: Compact wafer, spring loaded.
 - .6 Seat: Bronze.
- .6 Class 250, Iron, Globe, Center-Guided Check Valves with Metal Seat:
 - .1 Manufacturers:
 - .1 APCO Willamette Valve and Primer Corporation.
 - .2 Crispin Valve.
 - .3 DFT Inc.
 - .4 Flomatic Corporation.
 - .5 Hammond Valve.
 - .6 Metraflex, Inc.
 - .7 Milwaukee Valve Company.
 - .8 Mueller Steam Specialty; a division of SPX Corporation.
 - .9 NIBCO INC.
 - .10 Val-Matic Valve & Manufacturing Corp.
 - .2 Description:
 - .1 Standard: MSS SP-125.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 400 psig (2760 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 300 psig (2070 kPa).
 - .4 Body Material: ASTM A126, gray iron.
 - .5 Style: Globe, spring loaded.
 - .6 Ends: Flanged.
 - .7 Seat: Bronze.
- .7 Class 300, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat:
 - .1 Manufacturers:
 - .1 APCO Willamette Valve and Primer Corporation.
 - .2 Crispin Valve.
 - .3 Val-Matic Valve & Manufacturing Corp.
 - .2 Description:
 - .1 Standard: MSS SP-125.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 500 psig (3450 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 400 psig (2760 kPa).
 - .4 Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
 - .5 Style: Compact wafer, spring loaded.
 - .6 Seat: Bronze.
- .8 Class 300, Iron, Globe, Center-Guided Check Valves with Metal Seat:

- .1 Manufacturers:
 - .1 APCO Willamette Valve and Primer Corporation.
 - .2 Crispin Valve.
 - .3 Val-Matic Valve & Manufacturing Corp.
- .2 Description:
 - .1 Standard: MSS SP-125.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 500 psig (3450 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 400 psig (2760 kPa).
 - .4 Body Material: ASTM A395/A395M or ASTM A536 ASTM A 536, ductile iron.
 - .5 Style: Globe, spring loaded.
 - .6 Ends: Flanged.
 - .7 Seat: Bronze.
- .9 Class 125, Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat:
 - .1 Manufacturers:
 - .1 APCO Willamette Valve and Primer Corporation.
 - .2 Crispin Valve.
 - .3 DFT Inc.
 - .4 Flo Fab Inc.
 - .5 Hammond Valve.
 - .6 Milwaukee Valve Company.
 - .7 NIBCO INC.
 - .8 Spence Strainers International; a division of CIRCOR International.
 - .9 Sure Flow Equipment Inc.
 - .10 Val-Matic Valve & Manufacturing Corp.
 - .2 Description:
 - .1 Standard: MSS SP-125.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
 - .4 Body Material: ASTM A126, gray iron.
 - .5 Style: Compact wafer.
 - .6 Seat: EPDM or NBR.
- .10 Class 125, Iron, Globe, Center-Guided Check Valves with Resilient Seat:
 - .1 Manufacturers:
 - .1 Anvil International, Inc.
 - .2 APCO Willamette Valve and Primer Corporation.
 - .3 Crispin Valve.
 - .4 DFT Inc.
 - .5 GA Industries, Inc.
 - .6 Hammond Valve.
 - .7 Milwaukee Valve Company.
 - .8 NIBCO INC.
 - .9 Sure Flow Equipment Inc.
 - .10 Val-Matic Valve & Manufacturing Corp.

- .2 Description:
 - .1 Standard: MSS SP-125.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
 - .4 Body Material: ASTM A126, gray iron.
 - .5 Style: Globe, spring loaded.
 - .6 Ends: Flanged.
 - .7 Seat: EPDM or NBR.
- .11 Class 150, Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat:
 - .1 Manufacturers:
 - .1 APCO Willamette Valve and Primer Corporation.
 - .2 Crispin Valve.
 - .3 Val-Matic Valve & Manufacturing Corp.
 - .2 Description:
 - .1 Standard: MSS SP-125.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 300 psig (2070 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 250 psig (1725 kPa).
 - .4 Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
 - .5 Style: Compact wafer.
 - .6 Seat: EPDM or NBR.
- .12 Class 150, Iron, Globe, Center-Guided Check Valves with Resilient Seat:
 - .1 Manufacturers:
 - .1 APCO Willamette Valve and Primer Corporation.
 - .2 Crispin Valve.
 - .3 DFT Inc.
 - .4 Val-Matic Valve & Manufacturing Corp.
 - .2 Description:
 - .1 Standard: MSS SP-125.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 300 psig (2070 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 250 psig (1725 kPa).
 - .4 Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
 - .5 Style: Globe, spring loaded.
 - .6 Ends: Flanged.
 - .7 Seat: EPDM or NBR.
- .13 Class 250, Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat:
 - .1 Manufacturers:
 - .1 APCO Willamette Valve and Primer Corporation.
 - .2 Crispin Valve.
 - .3 DFT Inc.
 - .4 Flo Fab Inc.
 - .5 Hammond Valve.
 - .6 Milwaukee Valve Company.
 - .7 NIBCO INC.

- .8 Sure Flow Equipment Inc.
- .9 Val-Matic Valve & Manufacturing Corp.
- .2 Description:
 - .1 Standard: MSS SP-125.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 400 psig (2760 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 300 psig (2070 kPa).
 - .4 Body Material: ASTM A126, gray iron.
 - .5 Style: Compact wafer, spring loaded.
 - .6 Seat: EPDM or NBR.
- .14 Class 250, Iron, Globe, Center-Guided Check Valves with Resilient Seat:
 - .1 Manufacturers:
 - .1 APCO Willamette Valve and Primer Corporation.
 - .2 Crispin Valve.
 - .3 DFT Inc.
 - .4 Hammond Valve.
 - .5 Milwaukee Valve Company.
 - .6 NIBCO INC.
 - .7 Val-Matic Valve & Manufacturing Corp.
 - .2 Description:
 - .1 Standard: MSS SP-125 MSS SP-125.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 400 psig (2760 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 300 psig (2070 kPa).
 - .4 Body Material: ASTM A126, gray iron.
 - .5 Style: Globe, spring loaded.
 - .6 Ends: Flanged.
 - .7 Seat: EPDM or NBR.
- .15 Class 300, Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat:
 - .1 Manufacturers:
 - .1 APCO Willamette Valve and Primer Corporation.
 - .2 Crispin Valve.
 - .3 Val-Matic Valve & Manufacturing Corp.
 - .2 Description:
 - .1 Standard: MSS SP-125.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 500 psig (3450 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 400 psig (2760 kPa).
 - .4 Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
 - .5 Style: Compact wafer, spring loaded.
 - .6 Seat: EPDM or NBR.
- .16 Class 300, Iron, Globe, Center-Guided Check Valves with Resilient Seat:
 - .1 Manufacturers:
 - .1 APCO Willamette Valve and Primer Corporation.
 - .2 Crispin Valve.
 - .3 Val-Matic Valve & Manufacturing Corp.

- .2 Description:
 - .1 Standard: MSS SP-125.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 500 psig (3450 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 400 psig (2760 kPa).
 - .4 Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
 - .5 Style: Globe, spring loaded.
 - .6 Ends: Flanged.
 - .7 Seat: EPDM or NBR.

2.15 IRON, PLATE-TYPE CHECK VALVES

- .1 Class 125, Iron, Dual-Plate Check Valves with Metal Seat:
 - .1 Manufacturers:
 - .1 APCO Willamette Valve and Primer Corporation.
 - .2 Crane Co.; Crane Valve Group; Crane Valves.
 - .3 Flomatic Corporation.
 - .4 Mueller Steam Specialty; a division of SPX Corporation.
 - .2 Description:
 - .1 Standard: API STD 594.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
 - .4 Body Design: Wafer, spring-loaded plates.
 - .5 Body Material: ASTM A126, gray iron.
 - .6 Seat: Bronze.
- .2 Class 150, Iron, Dual-Plate Check Valves with Metal Seat:
 - .1 Manufacturers:
 - .1 APCO Willamette Valve and Primer Corporation.
 - .2 Crane Co.; Crane Valve Group; Crane Valves.
 - .3 Mueller Steam Specialty; a division of SPX Corporation.
 - .4 Val-Matic Valve & Manufacturing Corp.
 - .2 Description:
 - .1 Standard: API STD 594.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 300 psig (2070 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 250 psig (1725 kPa).
 - .4 Body Design: Wafer, spring-loaded plates.
 - .5 Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
 - .6 Seat: Bronze.
- .3 Class 250, Iron, Dual-Plate Check Valves with Metal Seat:
 - .1 Manufacturers:
 - .1 APCO Willamette Valve and Primer Corporation.
 - .2 Crane Co.; Crane Valve Group; Crane Valves.
 - .2 Description:
 - .1 Standard: API STD 594.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 400 psig (2760 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 300 psig (2070 kPa).

- .4 Body Design: Wafer, spring-loaded plates.
- .5 Body Material: ASTM A126, gray iron.
- .6 Seat: Bronze.
- .4 Class 300, Iron, Dual-Plate Check Valves with Metal Seat:
 - .1 Manufacturers:
 - .1 APCO Willamette Valve and Primer Corporation.
 - .2 Crane Co.; Crane Valve Group; Crane Valves.
 - .3 Mueller Steam Specialty; a division of SPX Corporation.
 - .4 Val-Matic Valve & Manufacturing Corp.
 - .2 Description:
 - .1 Standard: API STD 594.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 500 psig (3450 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 400 psig (2760 kPa).
 - .4 Body Design: Wafer, spring-loaded plates.
 - .5 Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
 - .6 Seat: Bronze.
- .5 Class 125, Iron, Single-Plate Check Valves with Resilient Seat:
 - .1 Manufacturers:
 - .1 Flo Fab Inc.
 - .2 Sure Flow Equipment Inc.
 - .2 Description:
 - .1 Standard: API STD 594.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
 - .4 Body Design: Wafer, spring-loaded plate.
 - .5 Body Material: ASTM A126, gray iron.
 - .6 Seat: EPDM or NBR.
- .6 Class 125, Iron, Dual-Plate Check Valves with Resilient Seat:
 - .1 Manufacturers:
 - .1 APCO Willamette Valve and Primer Corporation.
 - .2 Cooper Cameron Valves TVB Techno.
 - .3 Crane Co.; Crane Valve Group; Crane Valves.
 - .4 Crane Co.; Crane Valve Group; Stockham Division.
 - .5 NIBCO INC.
 - .6 Spence Strainers International; a division of CIRCOR International.
 - .7 Sure Flow Equipment Inc.
 - .8 Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - .2 Description:
 - .1 Standard: API STD 594.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
 - .4 Body Design: Wafer, spring-loaded plates.
 - .5 Body Material: ASTM A126, gray iron.

- .6 Seat: EPDM or NBR.
- .7 Class 150, Iron, Dual-Plate Check Valves with Resilient Seat:
 - .1 Manufacturers:
 - .1 APCO Willamette Valve and Primer Corporation.
 - .2 Crane Co.; Crane Valve Group; Crane Valves.
 - .3 Crane Co.; Crane Valve Group; Jenkins Valves.
 - .4 Val-Matic Valve & Manufacturing Corp.
 - .2 Description:
 - .1 Standard: API STD 594.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 300 psig (2070 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 250 psig (1725 kPa).
 - .4 Body Design: Wafer, spring-loaded plates.
 - .5 Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
 - .6 Seat: EPDM or NBR.
- .8 Class 250, Iron, Wafer, Single-Plate Check Valves with Resilient Seat:
 - .1 Manufacturers:
 - .1 Sure Flow Equipment Inc.
 - .2 Description:
 - .1 Standard: API STD 594.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 400 psig (2760 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 300 psig (2070 kPa).
 - .4 Body Design: Wafer, spring-loaded plate.
 - .5 Body Material: ASTM A126, gray iron.
 - .6 Seat: EPDM or NBR.
- .9 Class 250, Iron, Dual-Plate Check Valves with Resilient Seat:
 - .1 Manufacturers:
 - .1 APCO Willamette Valve and Primer Corporation.
 - .2 Crane Co.; Crane Valve Group; Crane Valves.
 - .3 Sure Flow Equipment Inc.
 - .2 Description:
 - .1 Standard: API STD 594.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 400 psig (2760 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 300 psig (2070 kPa).
 - .4 Body Design: Wafer, spring-loaded plates.
 - .5 Body Material: ASTM A126, gray iron.
 - .6 Seat: EPDM or NBR.
- .10 Class 300, Iron, Dual-Plate Check Valves with Resilient Seat:
 - .1 Manufacturers:
 - .1 APCO Willamette Valve and Primer Corporation.
 - .2 Val-Matic Valve & Manufacturing Corp.
 - .2 Description:
 - .1 Standard: API STD 594 API 594.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 500 psig (3450 kPa).

- .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 400 psig (2760 kPa).
- .4 Body Design: Wafer, spring-loaded plates.
- .5 Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
- .6 Seat: EPDM or NBR.

2.16 BRONZE GATE VALVES

.1 Class 125, NRS Bronze Gate Valves:

.1 Manufacturers:

- .1 American Valve.
- .2 Crane Valve Group; Crane Valves.
- .3 Crane Valve Group; Jenkins Valves.
- .4 Crane Valve Group; Stockham Division.
- .5 Hammond Valve.
- .6 Kitz Corporation.
- .7 Milwaukee Valve Company.
- .8 Nibco.
- .9 Powell Valves.
- .10 Red-White Valve Corporation.
- .11 Watts Regulator Co.; a division of Watts Water Technologies.
- .12 Zy-Tech Global Industries.

.2 Description:

- .1 Standard: MSS SP-80, Type 1.
- .2 CWP Rating: 200 psig (1380 kPa).
- .3 Body Material: ASTM B62, bronze with integral seat and screw-in bonnet.
- .4 Ends: Threaded or soldier joint.
- .5 Stem: Bronze.
- .6 Disc: Solid wedge; bronze.
- .7 Packing: Asbestos free.
- .8 Handwheel: Malleable iron, bronze, or aluminum.

.2 Class 125, RS Bronze Gate Valves:

.1 Manufacturers:

- .1 American Valve, Inc.
- .2 Crane Co.; Crane Valve Group; Crane Valves.
- .3 Crane Co.; Crane Valve Group; Jenkins Valves.
- .4 Crane Co.; Crane Valve Group; Stockham Division.
- .5 Hammond Valve.
- .6 Kitz Corporation.
- .7 Milwaukee Valve Company.
- .8 NIBCO INC.
- .9 Powell Valves.
- .10 Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- .11 Zy-Tech Global Industries, Inc.

.2 Description:

- .1 Standard: MSS SP-80, Type 2.

- .2 CWP Rating: 200 psig (1380 kPa).
- .3 Body Material: ASTM B62, bronze with integral seat and screw-in bonnet.
- .4 Ends: Threaded or soldier joint.
- .5 Stem: Bronze.
- .6 Disc: Solid wedge; bronze.
- .7 Packing: Asbestos free.
- .8 Handwheel: Malleable iron, bronze, or aluminum.
- .3 Class 150, NRS Bronze Gate Valves:
 - .1 Manufacturers:
 - .1 Hammond Valve.
 - .2 Kitz Corporation.
 - .3 Milwaukee Valve Company.
 - .4 NIBCO INC.
 - .5 Powell Valves.
 - .6 Red-White Valve Corporation.
 - .7 Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - .2 Description:
 - .1 Standard: MSS SP-80, Type 1.
 - .2 CWP Rating: 300 psig (2070 kPa).
 - .3 Body Material: ASTM B62, bronze with integral seat and union-ring bonnet.
 - .4 Ends: Threaded.
 - .5 Stem: Bronze.
 - .6 Disc: Solid wedge; bronze.
 - .7 Packing: Asbestos free.
 - .8 Handwheel: Malleable iron, bronze, or aluminum.
- .4 Class 150, RS Bronze Gate Valves:
 - .1 Manufacturers:
 - .1 Crane Co.; Crane Valve Group; Crane Valves.
 - .2 Crane Co.; Crane Valve Group; Stockham Division.
 - .3 Hammond Valve.
 - .4 Kitz Corporation.
 - .5 Milwaukee Valve Company.
 - .6 NIBCO INC.
 - .7 Powell Valves.
 - .8 Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - .9 Zy-Tech Global Industries, Inc.
 - .2 Description:
 - .1 Standard: MSS SP-80, Type 2.
 - .2 CWP Rating: 300 psig (2070 kPa).
 - .3 Body Material: ASTM B62, bronze with integral seat and union-ring bonnet.
 - .4 Ends: Threaded.
 - .5 Stem: Bronze.
 - .6 Disc: Solid wedge; bronze.

- .7 Packing: Asbestos free.
- .8 Handwheel: Malleable iron, bronze, or aluminum.

2.17 IRON GATE VALVES

- .1 Class 125, NRS, Iron Gate Valves:
 - .1 Manufacturers:
 - .1 Crane Co.; Crane Valve Group; Crane Valves.
 - .2 Crane Co.; Crane Valve Group; Jenkins Valves.
 - .3 Crane Co.; Crane Valve Group; Stockham Division.
 - .4 Flo Fab Inc.
 - .5 Hammond Valve.
 - .6 Kitz Corporation.
 - .7 Legend Valve.
 - .8 Milwaukee Valve Company.
 - .9 NIBCO INC.
 - .10 Powell Valves.
 - .11 Red-White Valve Corporation.
 - .12 Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - .13 Zy-Tech Global Industries, Inc.
 - .2 Description:
 - .1 Standard: MSS SP-70, Type I.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa)).
 - .4 Body Material: ASTM A126, gray iron with bolted bonnet.
 - .5 Ends: Flanged.
 - .6 Trim: Bronze.
 - .7 Disc: Solid wedge.
 - .8 Packing and Gasket: Asbestos free.
- .2 Class 125, OS&Y, Iron Gate Valves:
 - .1 Manufacturers:
 - .1 Crane Co.; Crane Valve Group; Crane Valves.
 - .2 Crane Co.; Crane Valve Group; Jenkins Valves.
 - .3 Crane Co.; Crane Valve Group; Stockham Division.
 - .4 Flo Fab Inc.
 - .5 Hammond Valve.
 - .6 Kitz Corporation.
 - .7 Legend Valve.
 - .8 Milwaukee Valve Company.
 - .9 NIBCO INC.
 - .10 Powell Valves.
 - .11 Red-White Valve Corporation.
 - .12 Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - .13 Zy-Tech Global Industries, Inc.
 - .2 Description:

- .1 Standard: MSS SP-70, Type I.
- .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
- .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
- .4 Body Material: ASTM A126, gray iron with bolted bonnet.
- .5 Ends: Flanged.
- .6 Trim: Bronze.
- .7 Disc: Solid wedge.
- .8 Packing and Gasket: Asbestos free.
- .3 Class 250, NRS, Iron Gate Valves:
 - .1 Manufacturers:
 - .1 Crane Co.; Crane Valve Group; Crane Valves.
 - .2 Crane Co.; Crane Valve Group; Stockham Division.
 - .3 NIBCO INC.
 - .2 Description:
 - .1 Standard: MSS SP-70, Type I.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 500 psig (3450 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 300 psig (2070 kPa).
 - .4 Body Material: ASTM A126, gray iron with bolted bonnet.
 - .5 Ends: Flanged.
 - .6 Trim: Bronze.
 - .7 Disc: Solid wedge.
 - .8 Packing and Gasket: Asbestos free.
- .4 Class 250, OS&Y, Iron Gate Valves:
 - .1 Manufacturers:
 - .1 Crane Co.; Crane Valve Group; Crane Valves.
 - .2 Crane Co.; Crane Valve Group; Stockham Division.
 - .3 Hammond Valve.
 - .4 Milwaukee Valve Company.
 - .5 NIBCO INC.
 - .6 Powell Valves.
 - .7 Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - .2 Description:
 - .1 Standard: MSS SP-70, Type I.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 500 psig (3450 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 300 psig (2070 kPa).
 - .4 Body Material: ASTM A126, gray iron with bolted bonnet.
 - .5 Ends: Flanged.
 - .6 Trim: Bronze.
 - .7 Disc: Solid wedge.
 - .8 Packing and Gasket: Asbestos free.

2.18 BRONZE GLOBE VALVES

- .1 Class 125, Bronze Globe Valves with Bronze Disc:
 - .1 Manufacturers:

- .1 Crane Co.; Crane Valve Group; Crane Valves.
 - .2 Crane Co.; Crane Valve Group; Stockham Division.
 - .3 Hammond Valve.
 - .4 Kitz Corporation.
 - .5 Milwaukee Valve Company.
 - .6 NIBCO INC.
 - .7 Powell Valves.
 - .8 Red-White Valve Corporation.
 - .9 Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - .10 Zy-Tech Global Industries, Inc.
- .2 Description:
 - .1 Standard: MSS SP-80, Type 1.
 - .2 CWP Rating: 200 psig (1380 kPa).
 - .3 Body Material: ASTM B62, bronze with integral seat and screw-in bonnet.
 - .4 Ends: Threaded or soldier joint.
 - .5 Stem and Disc: Bronze.
 - .6 Packing: Asbestos free.
 - .7 Handwheel: Malleable iron, bronze, or aluminum.
- .2 Class 125, Bronze Globe Valves with Nonmetallic Disc:
 - .1 Manufacturers:
 - .1 Crane Co.; Crane Valve Group; Crane Valves.
 - .2 Crane Co.; Crane Valve Group; Stockham Division.
 - .3 NIBCO INC.
 - .4 Red-White Valve Corporation.
 - .2 Description:
 - .1 Standard: MSS SP-80, Type 2.
 - .2 CWP Rating: 200 psig (1380 kPa).
 - .3 Body Material: ASTM B62, bronze with integral seat and screw-in bonnet.
 - .4 Ends: Threaded or soldier joint.
 - .5 Stem: Bronze.
 - .6 Disc: PTFE or TFE.
 - .7 Packing: Asbestos free.
 - .8 Handwheel: Malleable iron, bronze, or aluminum.
- .3 Class 150, Bronze Globe Valves with Nonmetallic Disc:
 - .1 Manufacturers:
 - .1 Crane Valve Group; Crane Valves.
 - .2 Hammond Valve.
 - .3 Kitz Corporation.
 - .4 Milwaukee Valve Company.
 - .5 Nibco.
 - .6 Powell Valves.
 - .7 Red-White Valve Corporation.
 - .8 Watts Regulator Co.; a division of Watts Water Technologies.

- .9 Zy-Tech Global Industries.
- .2 Description:
 - .1 Standard: MSS SP-80, Type 2.
 - .2 CWP Rating: 300 psig (2070 kPa).
 - .3 Body Material: ASTM B62, bronze with integral seat and union-ring bonnet.
 - .4 Ends: Threaded.
 - .5 Stem: Bronze.
 - .6 Disc: PTFE or TFE.
 - .7 Packing: Asbestos free.
 - .8 Handwheel: Malleable iron, bronze, or aluminum.

2.19 IRON GLOBE VALVES

- .1 Class 125, Iron Globe Valves:
 - .1 Manufacturers:
 - .1 Crane Co.; Crane Valve Group; Crane Valves.
 - .2 Crane Co.; Crane Valve Group; Jenkins Valves.
 - .3 Crane Co.; Crane Valve Group; Stockham Division.
 - .4 Hammond Valve.
 - .5 Kitz Corporation.
 - .6 Milwaukee Valve Company.
 - .7 NIBCO INC.
 - .8 Powell Valves.
 - .9 Red-White Valve Corporation.
 - .10 Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - .11 Zy-Tech Global Industries, Inc.
 - .2 Description:
 - .1 Standard: MSS SP-85, Type I.
 - .2 CWP Rating: 200 psig (1380 kPa).
 - .3 Body Material: ASTM A126, gray iron with bolted bonnet.
 - .4 Ends: Flanged.
 - .5 Trim: Bronze.
 - .6 Packing and Gasket: Asbestos free.
- .2 Class 250, Iron Globe Valves:
 - .1 Manufacturers:
 - .1 Crane Co.; Crane Valve Group; Crane Valves.
 - .2 Crane Co.; Crane Valve Group; Jenkins Valves.
 - .3 Crane Co.; Crane Valve Group; Stockham Division.
 - .4 Hammond Valve.
 - .5 Milwaukee Valve Company.
 - .6 NIBCO INC.
 - .7 Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - .2 Description:
 - .1 Standard: MSS SP-85, Type I.
 - .2 CWP Rating: 500 psig (3450 kPa).

- .3 Body Material: ASTM A126, gray iron with bolted bonnet.
- .4 Ends: Flanged.
- .5 Trim: Bronze.
- .6 Packing and Gasket: Asbestos free.

2.20 LUBRICATED PLUG VALVES

- .1 Class 125, Regular-Gland, Lubricated Plug Valves with Threaded Ends:
 - .1 Manufacturers:
 - .1 Nordstrom Valves, Inc.
 - .2 Description:
 - .1 Standard: MSS SP-78, Type II.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
 - .4 Body Material: ASTM A48/A48M or ASTM A126, cast iron with lubrication-sealing system.
 - .5 Pattern: Regular or short.
 - .6 Plug: Cast iron or bronze with sealant groove.
- .2 Class 125, Regular-Gland, Lubricated Plug Valves with Flanged Ends:
 - .1 Manufacturers:
 - .2 Description:
 - .1 Standard: MSS SP-78, Type II.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa)a).
 - .4 Body Material: ASTM A48/A48M or ASTM A126, cast iron with lubrication-sealing system.
 - .5 Pattern: Regular or short.
 - .6 Plug: Cast iron or bronze with sealant groove.
- .3 Class 125, Cylindrical, Lubricated Plug Valves with Threaded Ends:
 - .1 Manufacturers:
 - .1 Homestead Valve; a division of Olson Technologies, Inc.
 - .2 Milliken Valve Company.
 - .3 R & M Energy Systems; a unit of Robbins & Myers, Inc.
 - .2 Description:
 - .1 Standard: MSS SP-78, Type IV.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
 - .4 Body Material: ASTM A48/A48M or ASTM A126, cast iron with lubrication-sealing system.
 - .5 Pattern: Regular or short.
 - .6 Plug: Cast iron or bronze with sealant groove.
- .4 Class 125, Cylindrical, Lubricated Plug Valves with Flanged Ends:
 - .1 Manufacturers:
 - .1 Homestead Valve; a division of Olson Technologies, Inc.
 - .2 Milliken Valve Company.

- .3 R & M Energy Systems; a unit of Robbins & Myers, Inc.
- .2 Description:
 - .1 Standard: MSS SP-78, Type IV.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
 - .4 Body Material: ASTM A48/A48M or ASTM A126, cast iron with lubrication-sealing system.
 - .5 Pattern: Regular or short.
 - .6 Plug: Cast iron or bronze with sealant groove.
- .5 Class 250, Regular-Gland, Lubricated Plug Valves with Threaded Ends:
 - .1 Manufacturers:
 - .1 Nordstrom Valves, Inc.
 - .2 Description:
 - .1 Standard: MSS SP-78, Type II.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 400 psig (2760 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 300 psig (2070 kPa).
 - .4 Body Material: ASTM A48/A48M or ASTM A126, cast iron with lubrication-sealing system.
 - .5 Pattern: Regular or short.
 - .6 Plug: Cast iron or bronze with sealant groove.
- .6 Class 250, Regular-Gland, Lubricated Plug Valves with Flanged Ends:
 - .1 Manufacturers:
 - .1 Nordstrom Valves, Inc.
 - .2 Description:
 - .1 Standard: MSS SP-78, Type II.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 400 psig (2760 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 300 psig (2070 kPa).
 - .4 Body Material: ASTM A48/A48M or ASTM A126, cast iron with lubrication-sealing system.
 - .5 Pattern: Regular or short.
 - .6 Plug: Cast iron or bronze with sealant groove.
- .7 Class 250, Cylindrical, Lubricated Plug Valves with Threaded Ends:
 - .1 Manufacturers:
 - .1 Homestead Valve; a division of Olson Technologies, Inc.
 - .2 Milliken Valve Company.
 - .3 R & M Energy Systems; a unit of Robbins & Myers, Inc.
 - .2 Description:
 - .1 Standard: MSS SP-78, Type IV.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 400 psig (2760 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 300 psig (2070 kPa).
 - .4 Body Material: ASTM A48/A48M or ASTM A126, cast iron with lubrication-sealing system.
 - .5 Pattern: Regular or short.
 - .6 Plug: Cast iron or bronze with sealant groove.

- .8 Class 250, Cylindrical, Lubricated Plug Valves with Flanged Ends:
 - .1 Manufacturers:
 - .1 Homestead Valve; a division of Olson Technologies, Inc.
 - .2 Milliken Valve Company.
 - .3 R & M Energy Systems; a unit of Robbins & Myers, Inc.
 - .2 Description:
 - .1 Standard: MSS SP-78, Type IV.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 400 psig (2760 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 300 psig (2070 kPa).
 - .4 Body Material: ASTM A48/A48M or ASTM A126, Grade 40 cast iron with lubrication-sealing system.
 - .5 Pattern: Regular or short.
 - .6 Plug: Cast iron or bronze with sealant groove.

2.21 ECCENTRIC PLUG VALVES

- .1 175 CWP, Eccentric Plug Valves with Resilient Seating.
 - .1 Manufacturers:
 - .1 Clow Valve Co.; a division of McWane, Inc.
 - .2 DeZurik Water Controls.
 - .3 Homestead Valve; a division of Olson Technologies, Inc.
 - .4 M&H Valve Company; a division of McWane, Inc.
 - .5 Milliken Valve Company.
 - .6 Henry Pratt Company.
 - .7 Val-Matic Valve & Manufacturing Corp.
 - .2 Description:
 - .1 Standard: MSS SP-108.
 - .2 CWP Rating: 175 psig (1200 kPa) minimum.
 - .3 Body and Plug: ASTM A48/A48M, gray iron; ASTM A126, gray iron; or ASTM A536, ductile iron.
 - .4 Bearings: Oil-impregnated bronze or stainless steel.
 - .5 Ends: Flanged.
 - .6 Stem-Seal Packing: Asbestos free.
 - .7 Plug, Resilient-Seating Material: Suitable for potable-water service unless otherwise indicated.

2.22 DRAIN VALVES

- .1 Ball-Valve-Type, Hose-End Drain Valves:
 - .1 Bronze ball valve as specified in this Section.
 - .2 Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.23 CHAINWHEELS

- .1 Manufacturers:
 - .1 Babbitt Steam Specialty Co.
 - .2 Roto Hammer Industries.
 - .3 Trumbull Industries.

- .2 Description: Valve actuation assembly with sprocket rim, brackets, and chain.
 - .1 Brackets: Type, number, size, and fasteners required to mount actuator on valve.
 - .2 Attachment: For connection to butterfly ball, gate, globe and plug valve stems.
 - .3 Sprocket Rim with Chain Guides: Ductile iron, of type and size required for valve. Include zinc coating.
 - .4 Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

PART 3 EXECUTION

3.1 APPLICATION

- .1 General Requirements for Valve Applications
 - .1 If valve applications are not indicated, use the following:
 - .1 Shutoff Service: Ball, butterfly, or gate valves.
 - .2 Butterfly Valve Dead-End Service: Single-flange (lug) type.
 - .3 Throttling Service except Steam: Globe, ball, or butterfly valves.
 - .4 Throttling Service, Steam: Globe or butterfly valves.
 - .5 Pump-Discharge Check Valves:
 - .1 NPS 2 (DN 50) and Smaller: Bronze swing check valves with bronze or nonmetallic disc.
 - .2 NPS 2-1/2 (DN 65) and Larger for Hydronic: Iron swing check valves with lever and weight or with spring or iron, center-guided, metal or resilient-seat check valves.
 - .2 Select valves, except wafer types, with the following end connections:
 - .1 For Copper Tubing, NPS 2 (DN 50) and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
 - .2 For Copper Tubing, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.
 - .3 For Copper Tubing, NPS 5 (DN 125) and Larger: Flanged ends.
 - .4 For Steel Piping, NPS 2 (DN 50) and Smaller: Threaded ends.
 - .5 For Steel Piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.
 - .6 For Steel Piping, NPS 5 (DN 125) and Larger: Flanged ends.
 - .7 For Grooved-End Copper Tubing and Steel Piping except Steam and Steam Condensate Piping: Valve ends may be grooved.
- .2 Chilled Water Valve Schedule
 - .1 Pipe NPS 2 (DN 50) and Smaller:
 - .1 Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
 - .2 Bronze Angle Valves: Class 125, bronze disc.
 - .3 Ball Valves: One piece, full port, brass or bronze with brass trim.
 - .4 Bronze Swing Check Valves: Class 125, bronze disc.
 - .5 Bronze Gate Valves: Class 125, NRS, bronze.
 - .6 Bronze Globe Valves: Class 125, bronze disc.
 - .2 Pipe NPS 2-1/2 (DN 65) and Larger:
 - .1 Iron Valves, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): May be provided with threaded ends instead of flanged ends.

- .2 Iron Ball Valves, NPS 2-1/2 to NPS 10 (DN 65 to DN 250): Class 150.
- .3 Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): 200 CWP, EPDM seat, aluminum-bronze disc.
- .4 Iron, Single-Flange Butterfly Valves, NPS 14 to NPS 24 (DN 350 to DN 600): 150 CWP, EPDM seat, aluminum-bronze disc.
- .5 Iron, Grooved-End Butterfly Valves, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): 175 CWP.
- .6 High-Performance Butterfly Valves: Class 150, single flange.
- .7 Iron Swing Check Valves: Class 125, metal seats.
- .8 Iron Swing Check Valves with Closure Control, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): Class 125, lever and spring.
- .9 Iron, Grooved-End Check Valves, NPS 3 to NPS 12 (DN 80 to DN 300): 300 CWP.
- .10 Iron, Center-Guided Check Valves: Class 125, compact-wafer, metal seat.
- .11 Iron, Plate-Type Check Valves: Class 125; single plate; metal seat.
- .12 Iron Gate Valves: Class 125, NRS.
- .13 Iron Globe Valves: Class 125.
- .14 Lubricated Plug Valves: Class 125, regular gland, threaded.
- .15 Eccentric Plug Valves: 175 CWP, resilient seating.
- .3 Heating Water Valve Schedule
 - .1 Pipe NPS 2 (DN 50) and Smaller:
 - .1 Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
 - .2 Bronze Angle Valves: Class 125, bronze disc.
 - .3 Ball Valves: One piece, full port, brass or bronze with brass trim.
 - .4 Bronze Swing Check Valves: Class 125, bronze disc.
 - .5 Bronze Gate Valves: Class 125, NRS.
 - .6 Bronze Globe Valves: Class 125, bronze disc.
 - .2 Pipe NPS 2-1/2 (DN 65) and Larger:
 - .1 Iron Valves, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): May be provided with threaded ends instead of flanged ends.
 - .2 Iron Ball Valves, NPS 2-1/2 to NPS 10 (DN 65 to DN 250): Class 150.
 - .3 Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): 200 CWP, EPDM seat, aluminum-bronze disc.
 - .4 Iron, Single-Flange Butterfly Valves, NPS 14 to NPS 24 (DN 350 to DN 600): 150 CWP, EPDM seat, aluminum-bronze disc.
 - .5 Iron, Grooved-End Butterfly Valves, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): 175 CWP.
 - .6 High-Performance Butterfly Valves: Class 150, single flange.
 - .7 Iron Swing Check Valves: Class 125, metal seats.
 - .8 Iron Swing Check Valves with Closure Control, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): Class 125, lever and spring.
 - .9 Iron, Grooved-End Check Valves, NPS 3 to NPS 12 (DN 80 to DN 300): 300 CWP.
 - .10 Iron, Center-Guided Check Valves: Class 125, compact-wafer, metal seat.
 - .11 Iron, Plate-Type Check Valves: Class 125; single plate; metal seat.

.12 Iron Gate Valves: Class 125, NRS.

.13 Iron Globe Valves, NPS 2-1/2 to NPS 12 (DN 65 to DN 300): Class 125.

3.2 EXAMINATION

- .1 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.
- .2 Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- .3 Examine threads on valve and mating pipe for form and cleanliness.
- .4 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.
- .5 Do not attempt to repair defective valves; replace with new valves.

3.3 INSTALLATION

- .1 Valves
 - .1 Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
 - .2 Locate valves for easy access and provide separate support where necessary.
 - .3 Install valves in horizontal piping with stem at or above center of pipe.
 - .4 Install valves in position to allow full stem movement.
 - .5 Install chainwheels on operators for butterfly ball, gate, globe and plug valves NPS 4 (DN 100) and larger and more than 96 inches (2400 mm) above floor. Extend chains to 60 inches (1520 mm) above finished floor.
 - .6 Check valves: Install check valves for proper direction of flow and as follows:
 - .1 Swing Check Valves: In horizontal position with hinge pin level.
 - .2 Center-Guided and Plate-Type Check Valves: In horizontal or vertical position, between flanges.
 - .3 Lift Check Valves: With stem upright and plumb.

3.4 ADJUSTING

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

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- .1 Steel Pipe Hangers and Supports.
- .2 Trapeze Pipe Hangers.
- .3 Non-Metallic Pipe Hangers.
 - .1 Clevis-Type, Fiberglass Pipe Hangers.
 - .2 Strap-Type, Fiberglass Pipe Hangers.
- .4 Metal Framing Systems.
- .5 Non-Metallic Strut Systems.
- .6 Thermal-Hanger Shield Inserts.
- .7 Fastener Systems.
 - .1 Powder-Actuated Fasteners.
 - .2 Mechanical-Expansion Anchors.
- .8 Pipe Stand Fabrication.
 - .1 Compact Pipe Stand.
 - .2 Low-Type, Single-Pipe Stand.
 - .3 High-Type, Single-Pipe Stand.
 - .4 High-Type, Multiple-Pipe Stand.
 - .5 Curb-Mounting-Type Pipe Stand.
- .9 Pipe Positioning Systems.
- .10 Equipment Supports.
- .11 Miscellaneous Materials.

1.2 GENERAL REFERENCES

- .1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.
- .2 Division 20, including all Common Mechanical Requirements in Section 20 00 00, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.

1.3 RELATED REQUIREMENTS

- .1 Section 05 50 00 - Metal Fabrications: Materials and requirements for fabricated metal supports.

1.4 SUBMITTALS

- .1 Action Submittals
 - .1 Product Data: Provide manufacturer's standard catalog pages and data sheets for channel (strut) framing systems, nonpenetrating rooftop supports, post-installed concrete and masonry anchors, and thermal insulated pipe supports.
 - .2 Fiberglass Channel (Strut) Framing Systems: Include requirements for strength derating according to ambient temperature.
 - .3 Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution.
 - .1 Application of protective inserts, saddles, and shields at pipe hangers for each type of insulation and hanger.

- .4 Derating Calculations for Fiberglass Channel (Strut) Framing Systems: Indicate load ratings adjusted for applicable service conditions.
- .5 Evaluation Reports: For products specified as requiring evaluation and recognition by ICC Evaluation Service, LLC (ICC-ES), provide current ICC-ES evaluation reports upon request.
- .6 Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- .7 Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.5 QUALITY ASSURANCE

- .1 Comply with applicable building code.
- .2 Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- .3 Installer Qualifications for Powder-Actuated Fasteners (when specified): Certified by fastener system manufacturer with current operator's license.
- .4 Installer Qualifications for Field-Welding: As specified in Section 05 50 00.
- .5 Installer's Qualifications: Include evidence of compliance with specified requirements.

1.6 COORDINATION

- .1 Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
- .2 Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
- .3 Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
- .4 Coordinate the work with other trades to provide additional framing and materials required for installation.
- .5 Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
- .6 Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
- .7 Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- .8 Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section {CH#104419}.

1.7 DELIVERY, STORAGE AND HANDLING

- .1 Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 STEEL PIPE HANGERS AND SUPPORTS

- .1 Manufacturers:
 - .1 AAA Technology & Specialties Co., Inc.
 - .2 Anvil International.
 - .3 Bergen-Power Pipe Supports.

- .4 B-Line Systems, Inc.; a division of Cooper Industries.
- .5 Carpenter & Paterson, Inc.
- .6 Empire Industries, Inc.
- .7 ERICO/Michigan Hanger Co.
- .8 Globe Pipe Hanger Products, Inc.
- .9 Grinnell Corp.
- .10 GS Metals Corp.
- .11 National Pipe Hanger Corporation.
- .12 PHD Manufacturing, Inc.
- .13 PHS Industries, Inc.
- .14 Piping Technology & Products, Inc.
- .15 Tolco Inc.
- .2 Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.
- .3 Galvanized, Metallic Coatings: Pregalvanized or hot dipped.
- .4 Non-metallic Coatings: Plastic coating, jacket, or liner.
- .5 Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.2 TRAPEZE PIPE HANGERS

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

2.3 NON-METALLIC PIPE HANGERS

- .1 Manufacturers:
 - .1 Plasti-Fab, Inc.
- .2 Clevis-Type, Fiberglass Pipe Hangers: Similar to MSS Type 1, steel pipe hanger except hanger is made of fiberglass and continuous-thread rod and nuts are made of polyurethane or stainless steel.
- .3 Strap-Type, Fiberglass Pipe Hangers: Made of fiberglass loop with stainless-steel continuous-thread rod, nuts, and support hook.

2.4 METAL FRAMING SYSTEMS

- .1 Manufacturers:
 - .1 Anvil International.
 - .2 B-Line Systems, Inc.; a division of Cooper Industries.
 - .3 ERICO/Michigan Hanger Co.; ERISTRUT Div.
 - .4 GS Metals Corp.
 - .5 Power-Strut Div.; Tyco International, Ltd.
 - .6 Thomas & Betts Corporation.
 - .7 Tolco Inc.
 - .8 Unistrut Corp.; Tyco International, Ltd.
- .2 Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel or stainless steel channels and other components with appropriate finish based on location of use.

- .3 Coatings: Manufacturer's standard finish, unless bare metal or galvanized surfaces are indicated.
- .4 Non-metallic Coatings: Plastic coating, jacket, or liner.

2.5 NON-METALLIC STRUT SYSTEMS

- .1 Manufacturers:
 - .1 Anvil International.
 - .2 B-Line Systems, Inc.; a division of Cooper Industries.
 - .3 Champion Fiberglass, Inc.
 - .4 Cope, T. J., Inc.; Tyco International Ltd.
 - .5 Seasafe, Inc.
- .2 Description: Shop- or field-fabricated pipe-support assembly, similar to MFMA-3, made of fiberglass channels and other components.

2.6 THERMAL-HANGER SHEILD INSERTS

- .1 Manufacturers:
 - .1 Carpenter & Paterson, Inc.
 - .2 ERICO/Michigan Hanger Co.
 - .3 PHS Industries, Inc.
 - .4 Pipe Shields, Inc., a subsidiary of Piping Technology & Products, Inc.
 - .5 Rilco Manufacturing Company, Inc.
 - .6 Value Engineered Products, Inc.
- .2 Description: 100-psig- (690-kPa-) minimum, compressive-strength insulation insert encased in sheet metal shield.
- .3 Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C533 , Type I calcium silicate with vapor barrier.
- .4 Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C533 , Type I calcium silicate.
- .5 Insulation-Insert Material for Closed Cell Foam Insulated Piping: As manufactured by Klosure or approved equal.
- .6 For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- .7 For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- .8 Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

2.7 FASTENER SYSTEMS

- .1 Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened Portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
 - .1 Manufacturers:
 - .1 Hilti, Inc.
 - .2 ITW Ramset/Red Head.
 - .3 Masterset Fastening Systems, Inc.
 - .4 MKT Fastening, LLC.
 - .5 Powers Fasteners.

- .2 Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel, for use in hardened Portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

- .1 Manufacturers:

- .1 B-Line Systems, Inc.; a division of Cooper Industries.
- .2 Empire Industries, Inc.
- .3 Hilti, Inc.
- .4 ITW Ramset/Red Head.
- .5 MKT Fastening, LLC.
- .6 Powers Fasteners.

2.8 PIPE STAND FABRICATION

- .1 Pipe Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping, ductwork and equipment.

- .2 Compact Pipe Stand: One-piece plastic unit with integral-rod-roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

- .1 Manufacturers:

- .1 ERICO/Michigan Hanger Co.
- .2 MIRO Industries.
- .3 Portable Pipe Hangers.

- .3 Low-Type, Single-Pipe Stand: One-piece plastic base unit with plastic roller, for roof installation without membrane penetration.

- .1 Manufacturers:

- .1 MIRO Industries.

- .4 High-Type, Single-Pipe Stand: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.

- .1 Manufacturers:

- .1 ERICO/Michigan Hanger Co.
- .2 MIRO Industries.
- .3 Portable Pipe Hangers.

- .2 Base: Plastic.

- .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.

- .5 High-Type, Multiple-Pipe Stand: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.

- .1 Manufacturers:

- .1 Portable Pipe Hangers.

- .2 Bases: One or more plastic.

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

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

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

- .6 Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe support made from hot dip galvanized components including structural-steel shape, continuous-thread rods, and rollers for mounting on permanent stationary roof curb.

2.9 PIPE POSITIONING SYSTEMS

- .1 Manufacturers:
 - .1 C & S Mfg. Corp.
 - .2 HOLDRITE Corp.; Hubbard Enterprises.
 - .3 Samco Stamping, Inc.
 - .4 Sioux Chief Manufacturing Co.
- .2 Description: IAPMO PS 42, system of metal brackets, clips, and straps for positioning piping in pipe spaces for plumbing fixtures for commercial applications.

2.10 EQUIPMENT SUPPORTS

- .1 Description: Welded, shop- or field-fabricated equipment support made from structural-steel or stainless steel shapes with appropriate finish based on location of use.

2.11 MISCELLANEOUS MATERIALS

- .1 Structural Steel: ASTM A36/A36M, steel plates, shapes, and bars; black and galvanized.
- .2 Stainless Steel: ASTM A304, stainless steel plates, shapes, and bars.
- .3 Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and non-metallic grout; suitable for interior and exterior applications.
 - .1 Properties: Nonstaining, noncorrosive, and nongaseous.
 - .2 Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

PART 3 EXECUTION

3.1 APPLICATION

- .1 Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.
- .2 Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.
- .3 Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.
- .4 Use non-metallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- .5 Use padded hangers for piping that is subject to scratching.
- .6 Holes shall not be drilled or punched in beams and supporting members. Do not support piping from roof deck, other piping, ducts, or equipment.
- .7 Hangers and supports shall also be provided at every change in direction and within 12 inches of any pipe fitting and valves.
- .8 Pipe hangers in fan rooms and in mechanical equipment rooms shall be provided with spring hangers with elastomeric inserts to eliminate noise transmission between piping and the building structure. Refer to Division 20 "Vibration and Seismic Controls."
- .9 Hanger components shall not be used for purposes other than for which they were designed.
- .10 Vertical runs of piping not subject to appreciable expansion shall be supported by approved wrought steel clamps or collars, securely clamped to the risers. Where required, spring supports and guides shall be provided.
- .11 Where negligible movement of pipe occurs at hanger locations, rod hangers may be used for suspended lines. For piping supported from below, braces, brackets or structural cross members may be used.

- .12 If the vertical angle of the hanger is greater than 4 degrees, a traveling device shall be provided for horizontal movement. For piping supported from below, rollers or roll carriages shall be used.
- .13 Where significant vertical movement of the pipe occurs at the hanger location, a resilient support shall be used. Spring cushion hangers may be used where vertical movement does not exceed 1/4 inches.
- .14 Pipe attachments for insulated pipe shall be outside the insulation. Insulation protection shields or high density insulation inserts shall be provided to protect the insulation.
- .15 Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - .1 Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30 (DN 15 to DN 750).
 - .2 Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F (49 to 232 deg C) pipes, NPS 4 to NPS 16 (DN 100 to DN 400), requiring up to 4 inches (100 mm) of insulation.
 - .3 Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24 (DN 20 to DN 600), requiring clamp flexibility and up to 4 inches (100 mm) of insulation.
 - .4 Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24 (DN 15 to DN 600), if little or no insulation is required.
 - .5 Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4 (DN 15 to DN 100), to allow off-center closure for hanger installation before pipe erection.
 - .6 Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS 3/4 to NPS 8 (DN 20 to DN 200).
 - .7 Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8 (DN 15 to DN 200).
 - .8 Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8 (DN 15 to DN 200).
 - .9 Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2 (DN 15 to DN 50).
 - .10 Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8 (DN 10 to DN 200).
 - .11 Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 3 (DN 10 to DN 80).
 - .12 U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30 (DN 15 to DN 750).
 - .13 Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
 - .14 Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36 (DN 100 to DN 900), with steel pipe base stanchion support and cast-iron floor flange.
 - .15 Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36 (DN 100 to DN 900), with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.
 - .16 Adjustable, Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36 (DN 65 to DN 900), 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 (DN 25 to DN 750), from 2 rods if longitudinal movement caused by expansion and contraction might occur.

- .18 Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20 (DN 65 to DN 500), 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 (DN 50 to DN 1050), 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 (DN 50 to DN 600), 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 (DN 50 to DN 750), if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- .16 Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - .1 Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20 (DN 20 to DN 500).
 - .2 Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20 (DN 20 to DN 500), if longer ends are required for riser clamps.
- .17 Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - .1 Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.
 - .2 Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) piping installations.
 - .3 Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 - .4 Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 - .5 Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F (49 to 232 deg C) piping installations.
- .18 Building Attachments: Use of "C" clamps and beam clamps of "C" pattern and any modification thereof for pipe sizes 2-1/2 inches and larger is prohibited 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 Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 - .3 Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 - .4 Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 - .5 Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 - .6 Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 - .7 Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 - .8 Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.

- .9 Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 - .1 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:
 - .2 Light (MSS Type 31): 750 lb. (340 kg).
 - .3 Medium (MSS Type 32): 11500 lb. (680 kg).
 - .4 Heavy (MSS Type 33): 3000 lb. (1360 kg).
- .10 Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
- .11 Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
- .12 Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- .19 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.
- .20 Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - .1 Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 - .2 Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches (32 mm).
 - .3 Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
 - .4 Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 - .5 Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.
 - .6 Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
 - .7 Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.
 - .8 Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - .1 Horizontal (MSS Type 54): Mounted horizontally.
 - .2 Vertical (MSS Type 55): Mounted vertically.
 - .3 Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- .21 Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.

- .22 Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.
- .23 Use mechanical-expansion anchors instead of building attachments where required in concrete construction.
- .24 Use pipe positioning systems (Sioux Chief or approved equal) in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

3.2 INSTALLATION

- .1 Provide necessary piping and equipment supporting elements including building structure attachments, supplementary steel, hanger rods, stanchions and fixtures, vertical pipe attachments, horizontal pipe attachments, anchors, guides, spring supports in accordance with the referenced codes, standards, and requirements specified. Support piping and equipment from building structure, not from roof deck, floor slab, or other pipes, ducts, or equipment.
- .2 Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- .3 Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
 - .1 Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
 - .2 Field fabricate from ASTM A36/A36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- .4 Non-metallic Pipe Hanger Installation: Comply with applicable portions of MSS SP-69 and MSS SP-89. Install hangers and attachments as required to properly support piping from building structure.
- .5 Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.
- .6 Non-metallic Strut System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled fiberglass struts.
- .7 Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- .8 Fastener System Installation:
 - .1 Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches (100 mm) 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.
- .9 Pipe Stand Installation:
 - .1 Pipe Stand Types except Curb-Mounting Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane. Bases shall have sufficient footprint direct contact area to limit loading on roof membrane to be within roofing manufacturer's limitations so as to not void the roofing warranty.
 - .2 Curb-Mounting-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. Refer to Division 07 Section "Roof Accessories" for curbs.
- .10 Pipe Positioning System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture. Refer to Division 22 Section "Plumbing Fixtures"

- for plumbing fixtures.
- .11 Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
 - .12 Equipment Support Installation: Fabricate from welded-structural-steel shapes.
 - .13 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.
 - .14 Install lateral bracing with pipe hangers and supports to prevent swaying.
 - .15 Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 (DN 65) and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
 - .16 Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
 - .17 Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.
 - .18 Insulated Piping: Comply with the following:
 - .1 Attach clamps and spacers to piping.
 - .1 Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - .2 Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - .3 Do not exceed pipe stress limits according to ASME B31.1 for power piping and 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.
 - .1 Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
 - .3 Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - .1 Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
 - .4 Shield Dimensions for Pipe: Not less than the following:
 - .1 NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
 - .2 NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.
 - .3 NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.
 - .4 NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.
 - .5 NPS 16 to NPS 24 (DN 400 to DN 600): 24 inches (610 mm) long and 0.105 inch (2.67 mm) thick.
 - .5 Pipes NPS 8 (DN 200) and Larger: Include wood inserts.
 - .6 Insert Material: Length at least as long as protective shield.

- .7 Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.
- .19 Equipment Supports
 - .1 Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
 - .2 Grouting: Place grout under supports for equipment and make smooth bearing surface.
 - .3 Provide lateral bracing, to prevent swaying, for equipment supports.
- .20 Miscellaneous Materials
 - .1 Supplementary Steel: Where it is necessary to frame structural members between existing structural steel members or where structural steel members are used in lieu of commercially rated supports, install such supplementary steel in accordance with American Institute of Steel Construction Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings. Connection to the existing steel shall be with clamps unless otherwise approved by the Engineer.

3.3 PAINTING

- .1 Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - .1 Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).
- .2 Touch Up: 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.
- .3 Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780/A780M.

3.4 ADJUSTING

- .1 Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- .2 Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches (40 mm).

3.5 METAL FABRICATIONS

- .1 Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- .2 Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- .3 Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
 - .1 Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - .2 Obtain fusion without undercut or overlap.
 - .3 Remove welding flux immediately.
 - .4 Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- .1 Elastomeric isolation pads.
- .2 Elastomeric isolation mounts.
- .3 Restrained elastomeric isolation mounts.
- .4 Open-spring isolators.
- .5 Housed-spring isolators.
- .6 Restrained-spring isolators.
- .7 Housed-restrained-spring isolators.
- .8 Pipe-riser resilient supports.
- .9 Resilient pipe guides.
- .10 Air-spring isolators.
- .11 Restrained-air-spring isolators.
- .12 Elastomeric hangers.
- .13 Spring hangers.
- .14 Snubbers.
- .15 Restraint channel bracings.
- .16 Restraint cables.
- .17 Seismic-restraint accessories.
- .18 Mechanical anchor bolts.
- .19 Adhesive anchor bolts.
- .20 Vibration isolation equipment bases.
- .21 Restrained isolation roof-curb rails.

1.2 GENERAL REFERENCES

- .1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.
- .2 Division 20, including all Common Mechanical Requirements in Section 20 00 00, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.

1.3 RELATED REQUIREMENTS

1.4 PERFORMANCE REQUIREMENTS

- .1 Wind-Restraint Loading:
 - .1 Basic Wind Speed: .
 - .2 Building Classification Category: I.
 - .3 Minimum 10 lb/sq. ft. (48.8 kg/sq. m) multiplied by maximum area of HVAC component projected on vertical plane normal to wind direction, and 45 degrees either side of normal.
- .2 Seismic-Restraint Loading:
 - .1 Site Class as Defined in the IBC: A.
 - .2 Assigned Seismic Use Group or Building Category as Defined in the IBC: I.
 - .1 Component Importance Factor: 1.0.

- .2 Component Response Modification Factor: 1.5.
- .3 Component Amplification Factor: 1.0.
- .3 Design Spectral Response Acceleration at Short Periods (0.2 Second): .
- .4 Design Spectral Response Acceleration at 1.0-Second Period: .
- .5 Rated strengths, features, and applications shall be as defined in reports by an evaluation service member of ICC-ES.
 - .1 Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they are subjected.

1.5 SUBMITTALS

- .1 Action Submittals
 - .1 Product Data: For each type of product.
 - .1 Include rated load, rated deflection, and overload capacity for each vibration isolation device.
 - .2 Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device and seismic-restraint component required.
 - .1 Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an evaluation service member of ICC-ES.
 - .2 Annotate to indicate application of each product submitted and compliance with requirements.
 - .3 Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.
 - .2 Shop Drawings:
 - .1 Detail fabrication and assembly of equipment bases. Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
 - .2 Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
 - .3 Delegated-Design Submittal: For each vibration isolation and seismic-restraint device.
 - .1 Include design calculations and details for selecting vibration isolators, seismic restraints, and vibration isolation bases complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - .2 Design Calculations: Calculate static and dynamic loading due to equipment weight, operation, and seismic and wind forces required to select vibration isolators and seismic and wind restraints and for designing vibration isolation bases.
 - .1 Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
 - .3 Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system was examined for excessive stress and that none

- exists.
- .4 Seismic and Wind-Restraint Details:
 - .1 Design Analysis: To support selection and arrangement of seismic and wind restraints. Include calculations of combined tensile and shear loads.
 - .2 Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
 - .3 Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
 - .4 Preapproval and Evaluation Documentation: By an evaluation service member of ICC-ES, showing maximum ratings of restraint items and the basis for approval (tests or calculations).
 - .4 Qualification Data: For professional engineer and testing agency.
 - .5 Welding certificates.
 - .6 Air-Mounting System Performance Certification: Include natural frequency, load, and damping test data performed by an independent agency.
 - .7 Field quality-control reports.
 - .2 Operation and Maintenance Materials
 - .1 Operation and Maintenance Data: For air-spring mounts and restrained-air-spring mounts to include in operation and maintenance manuals.

1.6 QUALITY ASSURANCE

- .1 Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7 and that is acceptable to authorities having jurisdiction.
- .2 Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- .3 Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- .4 Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are unavailable, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

1.7 COORDINATION

- .1 Coordination Drawings: Show coordination of vibration isolation device installation and seismic bracing for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.

PART 2 PRODUCTS

2.1 ELASTOMERIC ISOLATION PADS

- .1 Manufacturers:
 - .1 Ace Mountings Co., Inc.
 - .2 California Dynamics Corporation.
 - .3 Isolation Technology, Inc.
 - .4 Kinetics Noise Control, Inc.
 - .5 Mason Industries, Inc.
 - .6 Vibration Eliminator Co., Inc.
 - .7 Vibration Isolation.
 - .8 Vibration Mountings & Controls, Inc.
- .2 Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
- .3 Size: Factory or field cut to match requirements of supported equipment.
- .4 Pad Material: Oil and water resistant with elastomeric properties.
- .5 Surface Pattern: Smooth pattern.
- .6 Infused nonwoven cotton or synthetic fibers.
- .7 Load-bearing metal plates adhered to pads.
- .8 Sandwich-Core Material: Resilient and elastomeric.
 - .1 Surface Pattern: Smooth pattern.
 - .2 Infused nonwoven cotton or synthetic fibers.

2.2 ELASTOMERIC ISOLATION MOUNTS

- .1 Manufacturers:
 - .1 Ace Mountings Co., Inc.
 - .2 California Dynamics Corporation.
 - .3 Isolation Technology, Inc.
 - .4 Kinetics Noise Control, Inc.
 - .5 Mason Industries, Inc.
 - .6 Vibration Eliminator Co., Inc.
 - .7 Vibration Isolation.
 - .8 Vibration Mountings & Controls, Inc.
- .2 Mounting Plates:
 - .1 Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded with threaded studs or bolts.
 - .2 Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.
- .3 Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.3 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

- .1 Manufacturers:
 - .1 Ace Mountings Co., Inc.
 - .2 California Dynamics Corporation.
 - .3 Isolation Technology, Inc.
 - .4 Kinetics Noise Control, Inc.
 - .5 Mason Industries, Inc.
 - .6 Vibration Eliminator Co., Inc.

- .7 Vibration Isolation.
- .8 Vibration Mountings & Controls, Inc.
- .2 Description: All-directional isolator with seismic restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
- .3 Housing: Cast-ductile iron or welded steel.
- .4 Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.4 OPEN-SPRING ISOLATORS

- .1 Freestanding, Laterally Stable, Open-Spring Isolators: .
 - .1 Manufacturers:
 - .1 Ace Mountings Co., Inc.
 - .2 California Dynamics Corporation.
 - .3 Isolation Technology, Inc.
 - .4 Kinetics Noise Control, Inc.
 - .5 Mason Industries, Inc.
 - .6 Vibration Eliminator Co., Inc.
 - .7 Vibration Isolation.
 - .8 Vibration Mountings & Controls, Inc.
 - .2 Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - .3 Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - .4 Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - .5 Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 - .6 Baseplates: Factory-drilled steel plate for bolting to structure with an elastomeric isolator pad attached to the underside. Baseplates shall limit floor load to 500 psig (3447 kPa).
 - .7 Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

2.5 HOUSED-SPRING ISOLATORS

- .1 Freestanding, Laterally Stable, Open-Spring Isolators in Two-Part Telescoping Housing: .
 - .1 Manufacturers:
 - .1 Ace Mountings Co., Inc.
 - .2 California Dynamics Corporation.
 - .3 Isolation Technology, Inc.
 - .4 Kinetics Noise Control, Inc.
 - .5 Mason Industries, Inc.
 - .6 Vibration Eliminator Co., Inc.
 - .7 Vibration Isolation.
 - .8 Vibration Mountings & Controls, Inc.
 - .2 Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - .3 Minimum Additional Travel: 50 percent of the required deflection at rated load.

- .4 Lateral Stiffness: More than 80 percent of rated vertical stiffness.
- .5 Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
- .6 Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators.
 - .1 Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig (3447 kPa).
 - .2 Top housing with attachment and leveling bolt.

2.6 RESTRAINED-SPRING ISOLATORS

- .1 Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint:
 - .1 Manufacturers:
 - .1 Ace Mountings Co., Inc.
 - .2 California Dynamics Corporation.
 - .3 Isolation Technology, Inc.
 - .4 Kinetics Noise Control, Inc.
 - .5 Mason Industries, Inc.
 - .6 Vibration Eliminator Co., Inc.
 - .7 Vibration Isolation.
 - .8 Vibration Mountings & Controls, Inc.
 - .2 Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.
 - .1 Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig (3447 kPa).
 - .2 Top plate with threaded mounting holes.
 - .3 Internal leveling bolt that acts as blocking during installation.
 - .3 Restraint: Limit stop as required for equipment and authorities having jurisdiction.
 - .4 Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - .5 Minimum Additional Travel: 50 percent of the required deflection at rated load.
 - .6 Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - .7 Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.7 HOUSED-RESTRAINED-SPRING ISOLATORS

- .1 Freestanding, Steel, Open-Spring Isolators with Vertical-Limit Stop Restraint in Two-Part Telescoping Housing:
 - .1 Manufacturers:
 - .1 Ace Mountings Co., Inc.
 - .2 California Dynamics Corporation.
 - .3 Isolation Technology, Inc.
 - .4 Kinetics Noise Control, Inc.
 - .5 Mason Industries, Inc.
 - .6 Vibration Eliminator Co., Inc.

- .7 Vibration Isolation.
- .8 Vibration Mountings & Controls, Inc.
- .2 Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators. Housings are equipped with adjustable snubbers to limit vertical movement.
 - .1 Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig (3447 kPa).
 - .2 Threaded top housing with adjustment bolt and cap screw to fasten and level equipment.
- .3 Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
- .4 Minimum Additional Travel: 50 percent of the required deflection at rated load.
- .5 Lateral Stiffness: More than 80 percent of rated vertical stiffness.
- .6 Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.8 PIPE-RISER RESILIENT SUPPORTS

- .1 Description: All-directional, acoustical pipe anchor consisting of two steel tubes separated by a minimum 1/2-inch- (13-mm-) thick neoprene .
 - .1 Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
 - .2 Maximum Load Per Support: 500 psig (3.45 MPa) on isolation material providing equal isolation in all directions.

2.9 RESILIENT PIPE GUIDES

- .1 Description: Telescopic arrangement of two steel tubes or post and sleeve arrangement separated by a minimum 1/2-inch- (13-mm-) thick neoprene .
 - .1 Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.10 AIR-SPRING ISOLATORS

- .1 Freestanding, Single or Multiple, Compressed-Air Bellows: .
 - .1 Manufacturers:
 - .1 Firestone Industrial Products Company.
 - .2 Mason Industries, Inc.
 - .2 Bellows Assembly: Upper and lower powder-coated steel sections connected by a replaceable, flexible, nylon-reinforced neoprene bellows or similar elastomeric material.
 - .3 Maximum Natural Frequency: 3 Hz.
 - .4 Operating Pressure Range: 25 to 100 psig (172 to 690 kPa).
 - .5 Burst Pressure: At least three times manufacturer's published maximum operating pressure.
 - .6 Tank valves.

2.11 RESTRAINED-AIR-SPRING ISOLATORS

- .1 Freestanding, Single or Multiple, Compressed-Air Bellows with Vertical-Limit Stop Restraint: .

- .1 Manufacturers:
 - .1 Firestone Industrial Products Company.
 - .2 Mason Industries, Inc.
- .2 Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.
 - .1 Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig (3447 kPa)).
 - .2 Top plate with threaded mounting holes.
 - .3 Internal leveling bolt that acts as blocking during installation.
- .3 Restraint: Limit stop as required for equipment and authorities having jurisdiction.
- .4 Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
- .5 Minimum Additional Travel: 50 percent of the required deflection at rated load.
- .6 Lateral Stiffness: More than 80 percent of rated vertical stiffness.
- .7 Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
- .8 Bellows Assembly: Upper and lower powder-coated steel sections connected by a replaceable, flexible, nylon-reinforced neoprene bellows or similar elastomeric material.
- .9 Maximum Natural Frequency: 3 Hz.
- .10 Operating Pressure Range: 25 to 100 psig (172 to 690 kPa)a).
- .11 Burst Pressure: At least three times manufacturer's published maximum operating pressure.
- .12 Tank valves.

2.12 ELASTOMERIC HANGERS

- .1 Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods: .
 - .1 Manufacturers:
 - .1 Ace Mountings Co., Inc.
 - .2 California Dynamics Corporation.
 - .3 Isolation Technology, Inc.
 - .4 Kinetics Noise Control, Inc.
 - .5 Mason Industries, Inc.
 - .6 Vibration Eliminator Co., Inc.
 - .7 Vibration Mountings & Controls, Inc.
 - .2 Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
 - .3 Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

2.13 SPRING HANGERS

- .1 Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression: .
 - .1 Manufacturers:

- .1 Ace Mountings Co., Inc.
- .2 California Dynamics Corporation.
- .3 Kinetics Noise Control, Inc.
- .4 Mason Industries, Inc.
- .5 Vibration Eliminator Co., Inc.
- .6 Vibration Isolation.
- .7 Vibration Mountings & Controls, Inc.
- .2 Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
- .3 Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
- .4 Minimum Additional Travel: 50 percent of the required deflection at rated load.
- .5 Lateral Stiffness: More than 80 percent of rated vertical stiffness.
- .6 Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
- .7 Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
- .8 Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
- .9 Self-centering hanger-rod cap to ensure concentricity between hanger rod and support spring coil.

2.14 SNUBBERS

- .1 Manufacturers:
 - .1 Kinetics Noise Control, Inc.
 - .2 Mason Industries, Inc.
 - .3 Vibration Mountings & Controls, Inc.
- .2 Description: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
 - .1 Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
 - .2 Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
 - .3 Maximum 1/4-inch (6-mm) air gap, and minimum 1/4-inch (6-mm) thick resilient cushion.

2.15 RESTRAINT CHANNEL BRACINGS

- .1 Manufacturers:
 - .1 Cooper B-Line, Inc.
 - .2 Hilti, Inc.
 - .3 Mason Industries, Inc.
 - .4 Unistrut.
- .2 Description: MFMA-4, shop- or field-fabricated bracing assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; rated in tension, compression, and torsion forces.

2.16 RESTRAINT CABLES

- .1 Manufacturers:
 - .1 Kinetics Noise Control, Inc.
 - .2 Loos & Co., Inc.
 - .3 Vibration Mountings & Controls, Inc.
- .2 Restraint Cables: ASTM A603 galvanized-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; with a minimum of two clamping bolts for cable engagement.

2.17 SEISMIC-RESTRAINT ACCESSORIES

- .1 Manufacturers:
 - .1 Cooper B-Line, Inc.
 - .2 Kinetics Noise Control, Inc.
 - .3 Mason Industries, Inc.
 - .4 TOLCO.
- .2 Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.
- .3 Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings.
- .4 Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.
- .5 Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.
- .6 Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.18 MECHANICAL ANCHOR BOLTS

- .1 Manufacturers:
 - .1 Cooper B-Line, Inc.
 - .2 Hilti, Inc.
 - .3 Kinetics Noise Control, Inc.
 - .4 Mason Industries, Inc.
- .2 Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488/E488M.

2.19 ADHESIVE ANCHOR BOLTS

- .1 Manufacturers:
 - .1 Hilti, Inc.
 - .2 Kinetics Noise Control, Inc.
 - .3 Mason Industries, Inc.
- .2 Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E488/E488M.

2.20 VIBRATION ISOLATION EQUIPMENT BASES

- .1 Manufacturers:
 - .1 California Dynamics Corporation.
 - .2 Kinetics Noise Control.
 - .3 Mason Industries, Inc.
 - .4 Vibration Eliminator Co., Inc.
 - .5 Vibration Isolation.
 - .6 Vibration Mountings & Controls, Inc.
- .2 Steel Rails: Factory-fabricated, welded, structural-steel rails.
 - .1 Design Requirements: Lowest possible mounting height with not less than 1-inch (25-mm) clearance above the floor. Include equipment anchor bolts and auxiliary motor slide rails.
 - .1 Include supports for suction and discharge elbows for pumps.
 - .2 Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Rails shall have shape to accommodate supported equipment.
 - .3 Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
- .3 Steel Bases: Factory-fabricated, welded, structural-steel bases and rails.
 - .1 Design Requirements: Lowest possible mounting height with not less than 1-inch (25-mm) clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
 - .1 Include supports for suction and discharge elbows for pumps.
 - .2 Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Bases shall have shape to accommodate supported equipment.
 - .3 Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
- .4 Concrete Inertia Base: Factory-fabricated or field-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.
 - .1 Design Requirements: Lowest possible mounting height with not less than 1-inch (25-mm) clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
 - .1 Include supports for suction and discharge elbows for pumps.
 - .2 Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Bases shall have shape to accommodate supported equipment.
 - .3 Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
 - .4 Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

2.21 RESTRAINED ISOLATION ROOF-CURB RAILS

- .1 Manufacturers:
 - .1 Ace Mountings Co., Inc.
 - .2 California Dynamics Corporation.
 - .3 Kinetics Noise Control.
 - .4 Mason Industries, Inc.

- .5 Thybar Corporation.
- .2 Description: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment and to withstand seismic and wind forces.
- .3 Upper Frame: The upper frame shall provide continuous support for equipment and shall be captive to resiliently resist seismic and wind forces.
- .4 Lower Support Assembly: The lower support assembly shall be formed sheet metal section containing adjustable and removable steel springs that support the upper frame. The lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials, and shall be insulated with a minimum of 2 inches (50 mm) of rigid, glass-fiber insulation on inside of assembly. Adjustable, restrained-spring isolators shall be mounted on elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations. Isolators shall be located so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.
- .5 Snubber Bushings: All-directional, elastomeric snubber bushings at least 1/4 inch (6 mm) thick.
- .6 Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counterflashed over roof materials.

PART 3 EXECUTION

3.1 APPLICATION

- .1 Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an evaluation service member of ICC-ES.
- .2 Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
- .3 Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength is adequate to carry present and future static and seismic loads within specified loading limits.

3.2 EXAMINATION

- .1 Examine areas and equipment to receive vibration isolation and seismic-and wind-control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- .2 Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- .3 Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION

- .1 Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Division 03 Section 03 30 00 "Cast-in-Place Concrete."
- .2 Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.
- .3 Comply with requirements in Division 07 Section 07 72 00 "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.
- .4 Equipment Restraints:
 - .1 Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and

- supporting structure.
- .2 Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
- .3 Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES that provides required submittals for component.
- .5 Piping Restraints:
 - .1 Comply with requirements in MSS SP-127.
 - .2 Space lateral supports a maximum of 40 feet (12 m) o.c., and longitudinal supports a maximum of 80 feet (24 m) o.c.
 - .3 Brace a change of direction longer than 12 feet (3.7 m).
- .6 Install cables so they do not bend across edges of adjacent equipment or building structure.
- .7 Install seismic-restraint devices using methods approved by an evaluation service member of ICC-ES that provides required submittals for component.
- .8 Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- .9 Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- .10 Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- .11 Drilled-in Anchors:
 - .1 Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
 - .2 Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 - .3 Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
 - .4 Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
 - .5 Set anchors to manufacturer's recommended torque, using a torque wrench.
 - .6 Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.
- .12 Accommodation of Differential Seismic Motion
 - .1 Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Division 23 Section 23 21 13 "Hydronic Piping" for piping flexible connections.
- .13 Air-Spring Isolator Installation
 - .1 Independent Isolator Installation:
 - .1 Install tank valve into each air isolator.

- .2 Inflate each isolator to height and pressure specified on Drawings.
- .2 Pressure-Regulated Isolator Installation:
 - .1 Coordinate the constant pressure-regulated air supply to air springs with the requirements for piping and connections specified in Division 22 Section 22 15 13 "General-Service Compressed-Air Piping."
 - .2 Connect all pressure regulators to a single dry, filtered facility air supply.
 - .3 Inflate isolators to height [height] [and] [or] [pressure] specified on Drawings.
- .14 Vibration Isolation Equipment Base Installation
 - .1 Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Division 03 Section 03 30 00 "Cast-in-Place Concrete."

3.4 FIELD QUALITY CONTROL

- .1 Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- .2 Perform tests and inspections.
- .3 Tests and Inspections:
 - .1 Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
 - .2 Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
 - .3 Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
 - .4 Test at least four of each type and size of installed anchors and fasteners selected by Architect.
 - .5 Test to 90 percent of rated proof load of device.
 - .6 Measure isolator restraint clearance.
 - .7 Measure isolator deflection.
 - .8 Verify snubber minimum clearances.
 - .9 Test and adjust restrained-air-spring isolator controls and safeties.
- .4 Remove and replace malfunctioning units and retest as specified above.
- .5 Prepare test and inspection reports.

3.5 ADJUSTING

- .1 Adjust isolators after piping system is at operating weight.
- .2 Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- .1 Equipment Labels.
 - .1 Metal Labels for Equipment.
 - .2 Plastic Labels for Equipment.
- .2 Warning Signs and Labels.
- .3 Pipe Labels.
- .4 Duct Labels.
- .5 Stencils.
- .6 Valve Tags.
- .7 Warning Tags.

1.2 GENERAL REFERENCES

- .1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.
- .2 Division 20, including all Common Mechanical Requirements in Section 20 00 00, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.

1.3 RELATED REQUIREMENTS

1.4 SUBMITTALS

- .1 Action Submittals
 - .1 List: Submit list of wording, symbols, letter size, and color coding for mechanical identification.
 - .2 Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
 - .3 Product Data: Provide manufacturers catalog literature for each product required.
 - .4 Manufacturer's Installation Instructions: Indicate special procedures, and installation.
- .2 Record Documents
 - .1 Record actual locations of tagged valves.

PART 2 PRODUCTS

2.1 GENERAL

- .1 Manufacturers
 - .1 Brady Co.
 - .2 Bramer.
 - .3 Craftmark.
 - .4 Emed.
 - .5 Marking Services, Inc.
 - .1 Seton Name Plate Corp.

2.2 EQUIPMENT LABELS

- .1 Metal Labels for Equipment:

- .1 Material and Thickness: Brass, 0.032-inch (0.8-mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
- .2 Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
- .3 Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- .4 Fasteners: Stainless-steel self-tapping screws.
- .5 Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- .2 Plastic Labels for Equipment:
 - .1 Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm) thick, and having predrilled holes for attachment hardware.
 - .2 Letter Color: Black
 - .3 Background Color: Black
 - .4 Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
 - .5 Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
 - .6 Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 - .7 Fasteners: Stainless-steel self-tapping screws.
 - .8 Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- .3 Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.
- .4 Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch (A4) bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.3 WARNING SIGNS AND LABELS

- .1 Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm) thick, and having predrilled holes for attachment hardware.
- .2 Letter Color: Blue
- .3 Background Color: Yellow
- .4 Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
- .5 Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
- .6 Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- .7 Fasteners: Stainless-steel self-tapping screws.

- .8 Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- .9 Label Content: Include caution and warning information, plus emergency notification instructions.

2.4 PIPE LABELS

- .1 General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- .2 Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.
- .3 Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- .4 Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
 - .1 Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
 - .2 Lettering Size: At least 1-1/2 inches (38 mm) high.

2.5 DUCT LABELS

- .1 Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm) thick, and having predrilled holes for attachment hardware.
- .2 Letter Color: Black, unless specified otherwise in application schedule Blue
- .3 Background Color: White, unless specified otherwise in application schedule Blue
- .4 Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
- .5 Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
- .6 Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- .7 Fasteners: Stainless-steel self-tapping screws.
- .8 Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- .9 Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.
 - .1 Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions, or as separate unit on each duct label to indicate flow direction.
 - .2 Lettering Size: At least 1-1/2 inches (38 mm) high.

2.6 STENCILS

- .1 Stencils: Prepared with letter sizes according to ASME A13.1 for piping; minimum letter height of 1-1/4 inches (32 mm) for ducts; and minimum letter height of 3/4 inch (19 mm) for access panel and door labels, equipment labels, and similar operational instructions.
 - .1 Stencil Material: Aluminum
 - .2 Stencil Paint: Exterior, gloss, alkyd enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.
 - .3 Identification Paint: Exterior, alkyd enamel in colors according to ASME A13.1 unless otherwise indicated.

2.7 VALVE TAGS

- .1 Valve Tags: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping system abbreviation and 1/2-inch (13-mm) numbers.

- .1 Tag Material: Stainless steel, 0.025-inch (0.64-mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
- .2 Fasteners: Brass wire-link or beaded chain; or S-hook wire-link chain
- .2 Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
 - .1 Valve-tag schedule shall be included in operation and maintenance data.

2.8 WARNING TAGS

- .1 Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
 - .1 Size: 3 by 5-1/4 inches (75 by 133 mm) minimum .
 - .2 Fasteners: Brass grommet and wire.
 - .3 Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
 - .4 Color: Yellow background with black lettering.

PART 3 EXECUTION

3.1 PREPARATION

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

3.2 INSTALLATION

- .1 Equipment Labels
 - .1 Install or permanently fasten labels on each major item of mechanical equipment.
 - .2 Locate equipment labels where accessible and visible.
- .2 Pipe Labels
 - .1 Piping Color-Coding: Painting of piping is specified in Division 09 Section "Interior Painting"
 - .2 Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels with painted, color-coded bands or rectangles on each piping system.
 - .1 Identification Paint: Use for contrasting background.
 - .2 Stencil Paint: Use for pipe marking.
 - .3 Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - .1 Near each valve and control device.
 - .2 Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - .3 Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 - .4 At access doors, manholes, and similar access points that permit view of concealed piping.
 - .5 Near major equipment items and other points of origination and termination.

- .6 Spaced at maximum intervals of 50 feet (15 m) along each run. Reduce intervals to 25 feet (7.6 m) in areas of congested piping and equipment.
- .7 On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- .4 Pipe Label Color Schedule:
 - .1 Fire Protection:
 - .1 Background Color: Red.
 - .2 Letter Color: White.
 - .2 Low-Pressure, Compressed-Air Piping:
 - .1 Background Color: Black
 - .2 Letter Color: Black
 - .3 Medium-Pressure, Compressed-Air Piping:
 - .1 Background Color: Black
 - .2 Letter Color: Black
 - .4 Domestic Water Piping:
 - .1 Background Color: Black
 - .2 Letter Color: Black
 - .5 Sanitary Waste Piping:
 - .1 Background Color: Black
 - .2 Letter Color: Black
 - .6 Natural Gas Piping:
 - .1 Background Color: Yellow.
 - .2 Letter Color: Black.
 - .7 Chilled-Water Piping:
 - .1 Background Color: Black
 - .2 Letter Color: Black
 - .8 Condenser-Water Piping:
 - .1 Background Color: Black
 - .2 Letter Color: Black
 - .9 Heating Water Piping:
 - .1 Background Color: Black
 - .2 Letter Color: Black
 - .10 Refrigerant Piping:
 - .1 Background Color: Black
 - .2 Letter Color: Black
 - .11 Low-Pressure Steam Piping:
 - .1 Background Color: Black
 - .2 Letter Color: Black
 - .12 High-Pressure Steam Piping:
 - .1 Background Color: Black
 - .2 Letter Color: Black
 - .13 Steam Condensate Piping:
 - .1 Background Color: Black

- .2 Letter Color: Black
- .3 Duct Labels
 - .1 Install plastic-laminated duct labels with permanent adhesive on air ducts in the following color codes:
 - .1 Blue: For cold-air supply ducts.
 - .2 Yellow: For hot-air supply ducts.
 - .3 Green: For exhaust-, outside-, relief-, return-, and mixed-air ducts.
 - .4 ASME A13.1 Colors and Designs: For hazardous material exhaust.
 - .2 Stenciled Duct Label Option: Stenciled labels, showing service and flow direction, may be provided instead of plastic-laminated duct labels, at Installer's option, if lettering larger than 1 inch (25 mm) high is needed for proper identification because of distance from normal location of required identification.
 - .3 Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 50 feet (15 m) in each space where ducts are exposed or concealed by removable ceiling system.
- .4 Valve Tags
 - .1 Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
 - .2 Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
 - .1 Valve-Tag Size and Shape:
 - .1 1-1/2 inches (38 mm) , round
 - .2 Domestic Cold Water: 1-1/2 inches (38 mm) round
 - .3 Domestic Hot Water: 1-1/2 inches (38 mm) , round
 - .4 Chilled Water: 1-1/2 inches (38 mm) round
 - .5 Hot Water: 1-1/2 inches (38 mm) , .round
 - .2 Valve-Tag Color:
 - .1 Fire Protection: Red.
 - .2 Domestic Cold Water: Natural
 - .3 Domestic Hot Water: Natural
 - .4 Chilled Water: Natural
 - .5 Hot Water: Natural
 - .3 Letter Color:
 - .1 Fire Protection: White
 - .2 Domestic Cold Water: White
 - .3 Domestic Hot Water: White
 - .4 Chilled Water: White
 - .5 Hot Water: White
 - .5 Warning Tags
 - .1 Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION

PART 1 GENERAL

1.1 GENERAL REFERENCES

- .1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.
- .2 Division 20, including all Common Mechanical Requirements in Section 20 00 00, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.

1.2 RELATED REQUIREMENTS

- .1 Section 01 40 00 - Quality Requirements: Employment of testing agency and payment for services.
- .2 Section 01 91 13 - General Commissioning Requirements: Commissioning requirements that apply to all types of work.
- .3 Section 23 08 00 - Commissioning of HVAC.

1.3 SUBMITTALS

- .1 Action Submittals
 - .1 TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.
 - .1 Submit to Architect.
 - .2 Submit to the Commissioning Authority.
 - .3 Submit six weeks prior to starting the testing, adjusting, and balancing work.
 - .4 Include certification that the plan developer has reviewed Contract Documents, the equipment and systems, and the control system with the Architect and other installers to sufficiently understand the design intent for each system.
 - .5 Include at least the following in the plan:
 - .1 Preface: An explanation of the intended use of the control system.
 - .2 List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
 - .3 Copy of field checkout sheets and logs to be used, listing each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.
 - .4 Identification and types of measurement instruments to be used and their most recent calibration date.
 - .5 Discussion of what notations and markings will be made on the duct and piping drawings during the process.
 - .6 Final test report forms to be used.
 - .7 Detailed step-by-step procedures for TAB work for each system and issue, including:
 - .1 Terminal flow calibration (for each terminal type).
 - .2 Diffuser proportioning.
 - .3 Branch/submain proportioning.
 - .4 Total flow calculations.
 - .5 Rechecking.

- .6 Diversity issues.
- .8 Expected problems and solutions, etc.
- .9 Criteria for using air flow straighteners or relocating flow stations and sensors; analogous explanations for the water side.
- .10 Details of how TOTAL flow will be determined; for example:
 - .1 Air: Sum of terminal flows via control system calibrated readings or via hood readings of all terminals, supply (SA) and return air (RA) pitot traverse, SA or RA flow stations.
 - .2 Water: Pump curves, circuit setter, flow station, ultrasonic, etc.
- .11 Specific procedures that will ensure that both air and water side are operating at the lowest possible pressures and methods to verify this.
- .12 Confirmation of understanding of the outside air ventilation criteria under all conditions.
- .13 Method of verifying and setting minimum outside air flow rate will be verified and set and for what level (total building, zone, etc.).
- .14 Method of checking building static and exhaust fan and/or relief damper capacity.
- .15 Proposed selection points for sound measurements and sound measurement methods.
- .16 Methods for making coil or other system plant capacity measurements, if specified.
- .17 Time schedule for TAB work to be done in phases (by floor, etc.).
- .18 Description of TAB work for areas to be built out later, if any.
- .19 Time schedule for deferred or seasonal TAB work, if specified.
- .20 False loading of systems to complete TAB work, if specified.
- .21 Exhaust fan balancing and capacity verifications, including any required room pressure differentials.
- .22 Interstitial cavity differential pressure measurements and calculations, if specified.
- .23 Procedures for field technician logs of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests (scope and frequency).
- .24 Procedures for formal progress reports, including scope and frequency.
- .25 Procedures for formal deficiency reports, including scope, frequency and distribution.
- .2 Field Quality-control Testing of Laboratory Fume Hoods:
 - .1 Product Data sheets for all equipment proposed for use in on-site as-installed testing.
 - .2 Sample Test Report.
 - .3 List of laboratory fume hoods to be tested. Submit a minimum of one week prior to commencement of testing.
 - .4 Test data demonstrating that each type of fume hood provided for the project has been successfully tested in the factory as per requirements of Section 11 53 13.
- .3 Field Logs: Submit at least twice a week to the Commissioning Authority.
- .4 Control System Coordination Reports: Communicate in writing to the controls installer all setpoint and parameter changes made or problems and discrepancies identified

during TAB that affect, or could affect, the control system setup and operation.

- .5 Progress Reports.
- .6 Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
 - .1 Submit under provisions of Section 01 40 00.
 - .2 Submit to the the Commissioning Authority within two weeks after completion of testing, adjusting, and balancing.
 - .3 Revise TAB plan to reflect actual procedures and submit as part of final report.
 - .4 Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect and for inclusion in operating and maintenance manuals.
 - .5 Provide reports in soft cover, letter size, 3-ring binder manuals, complete with index page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.
 - .6 Include actual instrument list, with manufacturer name, serial number, and date of calibration.
 - .7 Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.
 - .8 Units of Measure: Report data in both I-P (inch-pound) and SI (metric) units.
 - .9 Include the following on the title page of each report:
 - .1 Name of Testing, Adjusting, and Balancing Agency.
 - .2 Address of Testing, Adjusting, and Balancing Agency.
 - .3 Telephone number of Testing, Adjusting, and Balancing Agency.
 - .4 Project name.
 - .5 Project location.
 - .6 Project Architect.
 - .7 Project Engineer.
 - .8 Project Contractor.
 - .9 Project altitude.
 - .10 Report date.
- .2 Record Documents
 - .1 Record actual locations of flow measuring stations and balancing valves and rough setting.

1.4 QUALITY ASSURANCE

- .1 Installer Qualifications: Submit name of adjusting and balancing agency and TAB supervisor for approval within 30 days after award of Contract.

1.5 SUMMARY DESCRIPTION

- .1 Testing, adjustment, and balancing of air systems.
 - .1 Constant-Volume Air Systems
 - .2 Dual-Duct Systems
 - .3 Variable-Air-Volume Systems
 - .4 Multizone Systems
 - .5 Procedures for Testing, Adjusting, and Balancing Existing Air Systems
- .2 Testing, adjustment, and balancing of hydronic, steam, and refrigerating systems.

- .1 Variable-Flow Hydronic Systems
- .2 Primary-Secondary-Flow Hydronic Systems
- .3 Domestic Hot Water Recirculation Plumbing Systems
- .4 Procedures for Testing, Adjusting, and Balancing Existing Hydronic Systems
- .3 Testing, Adjusting, and Balancing of Equipment.
 - .1 Heat Exchangers
 - .2 Motors
 - .3 Condensing Units
 - .4 Heat-Transfer Coils
- .4 Field quality-control testing of Laboratory fume hoods.
- .5 Measurement of final operating condition of HVAC systems.
- .6 Sound measurement of equipment operating conditions.
- .7 Vibration measurement of equipment operating conditions.
- .8 Procedures for Exhaust Hoods
- .9 Procedures for Space Pressurization Measurements and Adjustments
- .10 Procedures for Stair-Tower Pressurization System Measurements and Adjustments
- .11 Procedures for Smoke-Control System Testing
- .12 Procedures for Indoor-Air Quality Measurements
- .13 Commissioning activities.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.1 EXAMINATION

- .1 Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
 - .1 Contract Documents are defined in the General and Supplementary Conditions of Contract.
 - .2 Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- .2 Examine approved submittal data of systems and equipment.
- .3 Examine Project Record Documents described in Division 01 Section "Project Record Documents."
- .4 Examine design data, including system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about system and equipment controls.
- .5 Examine equipment performance data including fan and pump curves. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system. Calculate system effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in

- SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.
- .6 Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.
 - .7 Examine system and equipment test reports.
 - .8 Examine system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.
 - .9 Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.
 - .10 Examine equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
 - .11 Examine terminal units, such as variable-air-volume boxes, to verify that they are accessible and their controls are connected and functioning.
 - .12 Examine plenum ceilings used for supply air to verify that they are airtight. Verify that pipe penetrations and other holes are sealed.
 - .13 Examine strainers for clean screens and proper perforations.
 - .14 Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.
 - .15 Examine heat-transfer coils for correct piping connections and for clean and straight fins.
 - .16 Examine system pumps to ensure absence of entrained air in the suction piping.
 - .17 Examine equipment for installation and for properly operating safety interlocks and controls.
 - .18 Examine automatic temperature system components to verify the following:
 - .1 Dampers, valves, and other controlled devices are operated by the intended controller.
 - .2 Dampers and valves are in the position indicated by the controller.
 - .3 Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units, mixing boxes, and variable-air-volume terminals.
 - .4 Automatic modulating and shutoff valves, including two-way valves and three-way mixing and diverting valves, are properly connected.
 - .5 Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
 - .6 Sensors are located to sense only the intended conditions.
 - .7 Sequence of operation for control modes is according to the Contract Documents.
 - .8 Controller set points are set at indicated values.
 - .9 Interlocked systems are operating.
 - .10 Changeover from heating to cooling mode occurs according to indicated values.
 - .19 Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

- .1 Prepare a TAB plan that includes strategies and step-by-step procedures.

- .2 Complete system readiness checks and prepare system readiness reports. Verify the following:
 - .1 Permanent electrical power wiring is complete.
 - .2 Hydronic systems are filled, clean, and free of air.
 - .3 Automatic temperature-control systems are operational.
 - .4 Equipment and duct access doors are securely closed.
 - .5 Balance, smoke, and fire dampers are open.
 - .6 Isolating and balancing valves are open and control valves are operational.
 - .7 Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
 - .8 Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 CONNECTIONS

3.4 GENERAL PROCEDURES FOR TESTING AND BALANCING

- .1 Perform testing and balancing procedures on each system according to the procedures contained in ASHRAE Std 111 and this Section.
 - .1 Comply with requirements in ASHRAE Std 62.1-2019, Section 7.2.2 - "Air Balancing."
- .2 Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.
- .3 Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, to show final settings.
- .4 Take and report testing and balancing measurements in inch-pound (IP) metric (SI) units.

3.5 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- .1 Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- .2 Prepare schematic diagrams of systems' "as-built" duct layouts.
- .3 For variable-air-volume systems, develop a plan to simulate diversity.
- .4 Determine the best locations in main and branch ducts for accurate duct airflow measurements.
- .5 Check airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.
- .6 Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- .7 Verify that motor starters are equipped with properly sized thermal protection.
- .8 Check dampers for proper position to achieve desired airflow path.
- .9 Check for airflow blockages.
- .10 Check condensate drains for proper connections and functioning.
- .11 Check for proper sealing of air-handling unit components.
- .12 Check for proper sealing of air duct system.

3.6 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- .1 Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 - .1 Measure fan static pressures to determine actual static pressure as follows:
 - .1 Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
 - .2 Measure static pressure directly at the fan outlet or through the flexible connection.
 - .3 Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
 - .4 Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
 - .2 Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
 - .1 Simulate dirty filter operation and record the point at which maintenance personnel must change filters.
 - .3 Measure static pressures entering and leaving other devices such as sound traps, heat recovery equipment, and air washers, under final balanced conditions.
 - .4 Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.
 - .5 Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.
 - .6 Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full cooling, full heating, economizer, and any other operating modes to determine the maximum required brake horsepower.
- .2 Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
 - .1 Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.
 - .1 Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
 - .2 Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.
- .3 Measure terminal outlets and inlets without making adjustments.
 - .1 Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.
- .4 Adjust terminal outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using volume dampers rather than extractors and the dampers at air terminals.
 - .1 Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
 - .2 Adjust patterns of adjustable outlets for proper distribution without drafts.

3.7 PROCEDURES FOR DUAL-DUCT SYSTEMS

- .1 Verify that the cooling coil is capable of full-system airflow, and set mixing boxes at full-cold airflow position for fan volume.
- .2 Measure static pressure in both hot and cold ducts at the end of the longest duct run to determine that sufficient static pressure exists to operate mixing-box controls and to overcome resistance in the ducts and outlets downstream from mixing box.
 - .1 If insufficient static pressure exists, increase the airflow at the fan.
- .3 Test and adjust the constant-volume mixing boxes as follows:
 - .1 Verify both hot and cold operations by adjusting the thermostat and observing the air temperature and volume changes.
 - .2 Verify sufficient inlet static pressure before making volume adjustments.
 - .3 Adjust mixing box to indicated airflows within specified tolerances. Measure the airflow by Pitot-tube traverse readings, totaling the airflow of the outlets; or by measuring static pressure at mixing-box taps if provided by box manufacturer.
- .4 Remeasure static pressure in both hot and cold ducts at the end of the longest duct run to determine that sufficient static pressure exists to operate mixing-box controls and to overcome resistance in the ducts and outlets downstream from mixing box.
- .5 Adjust variable-air-volume, dual-duct systems in the same way as constant-volume dual-duct systems, and adjust each mixing-box maximum- and minimum-airflow settings.

3.8 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

- .1 Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a maximum set-point airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced airflow terminal units so they are distributed evenly among the branch ducts.
- .2 Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
 - .1 Set outside-air dampers at minimum, and return- and exhaust-air dampers at a position that simulates full-cooling load.
 - .2 Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
 - .3 Measure total system airflow. Adjust to within indicated airflow.
 - .4 Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.
 - .5 Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow as described for constant-volume air systems.
 - .1 If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.
 - .6 Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.

- .7 Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.
- .8 Record the final fan performance data.
- .3 Pressure-Dependent, Variable-Air-Volume Systems without Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
 - .1 Balance systems similar to constant-volume air systems.
 - .2 Set terminal units and supply fan at full-airflow condition.
 - .3 Adjust inlet dampers of each terminal unit to indicated airflow and verify operation of the static-pressure controller. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.
 - .4 Readjust fan airflow for final maximum readings.
 - .5 Measure operating static pressure at the sensor that controls the supply fan, if one is installed, and verify operation of the static-pressure controller.
 - .6 Set supply fan at minimum airflow if minimum airflow is indicated. Measure static pressure to verify that it is being maintained by the controller.
 - .7 Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow as described for constant-volume air systems.
 - .1 If air outlets are out of balance at minimum airflow, report the condition but leave the outlets balanced for maximum airflow.
 - .8 Measure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.
- .4 Pressure-Dependent, Variable-Air-Volume Systems with Diversity: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
 - .1 Set system at maximum indicated airflow by setting the required number of terminal units at minimum airflow. Select the reduced airflow terminal units so they are distributed evenly among the branch ducts.
 - .2 Adjust supply fan to maximum indicated airflow with the variable-airflow controller set at maximum airflow.
 - .3 Set terminal units at full-airflow condition.
 - .4 Adjust terminal units starting at the supply-fan end of the system and continuing progressively to the end of the system. Adjust inlet dampers of each terminal unit to indicated airflow. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.
 - .5 Adjust terminal units for minimum airflow.
 - .6 Measure static pressure at the sensor.
 - .7 Measure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.

3.9 PROCEDURES FOR MULTIZONE SYSTEMS

- .1 Set unit at full flow through the cooling coil if coil has that capacity.
- .2 Adjust each zone damper to indicated airflow.

3.10 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

- .1 Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate.

- Correct variations that exceed plus or minus 5 percent.
- .2 Prepare schematic diagrams of systems' "as-built" piping layouts.
- .3 Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:
 - .1 Open all manual valves for maximum flow.
 - .2 Check expansion tank liquid level.
 - .3 Check makeup-water-station pressure gage for adequate pressure for highest vent.
 - .4 Check flow-control valves for specified sequence of operation and set at indicated flow.
 - .5 Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
 - .6 Set system controls so automatic valves are wide open to heat exchangers.
 - .7 Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
 - .8 Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.11 PROCEDURES FOR HYDRONIC SYSTEMS

- .1 Measure water flow at pumps. Use the following procedures, except for positive-displacement pumps:
 - .1 Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
 - .2 Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.
 - .3 Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
 - .4 Report flow rates that are not within plus or minus 5 percent of design.
- .2 Set calibrated balancing valves, if installed, at calculated presettings.
- .3 Measure flow at all stations and adjust, where necessary, to obtain first balance.
 - .1 System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.
- .4 Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.
- .5 Adjust balancing stations to within specified tolerances of indicated flow rate as follows:
 - .1 Determine the balancing station with the highest percentage over indicated flow.
 - .2 Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
 - .3 Record settings and mark balancing devices.
- .6 Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.
- .7 Measure the differential-pressure control valve settings existing at the conclusions of balancing.

3.12 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

- .1 Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

3.13 PROCEDURES FOR PRIMARY-SECONDARY-FLOW HYDRONIC SYSTEMS

- .1 Balance the primary system crossover flow first, then balance the secondary system.

3.14 PROCEDURES FOR DOMESTIC HOT WATER RECIRCULATION PLUMBING SYSTEMS

- .1 Set calibrated balancing valves at calculated presettings.
- .2 Measure flow at all stations and adjust, where necessary, to obtain first balance
- .3 Adjust balancing stations to within specified tolerances of indicated recirculation flow rate.
- .4 Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
- .5 Record settings and mark balancing devices.

3.15 PROCEDURES FOR HEAT EXCHANGERS

- .1 Measure water flow through all circuits.
- .2 Adjust water flow to within specified tolerances.
- .3 Measure inlet and outlet water temperatures.
- .4 Measure inlet steam pressure.
- .5 Check the setting and operation of safety and relief valves. Record settings.

3.16 PROCEDURES FOR MOTORS

- .1 Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 - .1 Manufacturer, model, and serial numbers.
 - .2 Motor horsepower rating.
 - .3 Motor rpm.
 - .4 Efficiency rating.
 - .5 Nameplate and measured voltage, each phase.
 - .6 Nameplate and measured amperage, each phase.
 - .7 Starter thermal-protection-element rating.
- .2 Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass for the controller to prove proper operation. Record observations, including controller manufacturer, model and serial numbers, and nameplate data.
 - .1 Measurements at each location.

3.17 PROCEDURES FOR CONDENSING UNITS

- .1 Verify proper rotation of fans.
- .2 Measure entering- and leaving-air temperatures.
- .3 Record compressor data.

3.18 PROCEDURES FOR HEAT-TRANSFER COILS

- .1 Water Coils: Measure the following data for each coil:
 - .1 Entering- and leaving-water temperature.
 - .2 Water flow rate.

- .3 Water pressure drop.
- .4 Dry-bulb temperature of entering and leaving air.
- .5 Wet-bulb temperature of entering and leaving air for cooling coils.
- .6 Airflow.
- .7 Air pressure drop.
- .2 Electric-Heating Coils: Measure the following data for each coil:
 - .1 Nameplate data.
 - .2 Airflow.
 - .3 Entering- and leaving-air temperature at full load.
 - .4 Voltage and amperage input of each phase at full load and at each incremental stage.
 - .5 Calculated kilowatt at full load.
 - .6 Fuse or circuit-breaker rating for overload protection.

3.19 PROCEDURES FOR TEMPERATURE MEASUREMENTS

- .1 During TAB, report the need for adjustment in temperature regulation within the automatic temperature-control system.
- .2 Measure indoor wet- and dry-bulb temperatures every other hour for a period of two successive eight-hour days, in each separately controlled zone, to prove correctness of final temperature settings. Measure when the building or zone is occupied.

3.20 PROCEDURES FOR SPACE PRESSURIZATION MEASUREMENTS AND ADJUSTMENTS

- .1 Before testing for space pressurization, observe the space to verify the integrity of the space boundaries. Verify that windows and doors are closed and applicable safing, gaskets, and sealants are installed. Report deficiencies and postpone testing until after the reported deficiencies are corrected.
- .2 Measure, adjust, and record the pressurization of each room, each zone, and each building by adjusting the supply, return, and exhaust airflows to achieve the indicated conditions.
- .3 Measure space pressure differential where pressure is used as the design criteria, and measure airflow differential where differential airflow is used as the design criteria for space pressurization.
 - .1 For pressure measurements, measure and record the pressure difference between the intended spaces at the door with all doors in the space closed. Record the high-pressure side, low-pressure side, and pressure difference between each adjacent space.
 - .2 For applications with cascading levels of space pressurization, begin in the most critical space and work to the least critical space.
 - .3 Test room pressurization first, then zones, and finish with building pressurization.
- .4 To achieve indicated pressurization, set the supply airflow to the indicated conditions and adjust the exhaust and return airflow to achieve the indicated pressure or airflow difference.
- .5 For spaces with pressurization being monitored and controlled automatically, observe and adjust the controls to achieve the desired set point.
 - .1 Compare the values of the measurements taken to the measured values of the control system instruments and report findings.
 - .2 Check the repeatability of the controls by successive tests designed to temporarily alter the ability to achieve space pressurization. Test overpressurization and underpressurization, and observe and report on the system's ability to revert to the set point.

- .3 For spaces served by variable-air-volume supply and exhaust systems, measure space pressurization at indicated airflow and minimum airflow conditions.
- .6 In spaces that employ multiple modes of operation, such as normal mode and emergency mode or occupied mode and unoccupied mode, measure, adjust, and record data for each operating mode.
- .7 Record indicated conditions and corresponding initial and final measurements. Report deficiencies.

3.21 PROCEDURES FOR VIBRATION MEASUREMENTS

- .1 Use a vibration meter meeting the following criteria:
 - .1 Solid-state circuitry with a piezoelectric accelerometer.
 - .2 Velocity range of 0.1 to 10 inches per second (2.5 to 254 mm/s).
 - .3 Displacement range of 1 to 100 mils (0.0254 to 2.54 mm).
 - .4 Frequency range of at least 0 to 1000 Hz.
 - .5 Capable of filtering unwanted frequencies.
- .2 Calibrate the vibration meter before each day of testing.
 - .1 Use a calibrator provided with the vibration meter.
 - .2 Follow vibration meter and calibrator manufacturer's calibration procedures.
- .3 Perform vibration measurements when other building and outdoor vibration sources are at a minimum level and will not influence measurements of equipment being tested.
 - .1 Turn off equipment in the building that might interfere with testing.
 - .2 Clear the space of people.
- .4 Perform vibration measurements after air and water balancing and equipment testing is complete.
- .5 Clean equipment surfaces in contact with the vibration transducer.
- .6 Position the vibration transducer according to manufacturer's written instructions and to avoid interference with the operation of the equipment being tested.
- .7 Measure and record vibration on rotating equipment over 3 hp.
- .8 Measure and record equipment vibration, bearing vibration, equipment base vibration, and building structure vibration. Record velocity and displacement readings in the horizontal, vertical, and axial planes.
- .9 For equipment with vibration isolation, take floor measurements with the vibration isolation blocked solid to the floor and with the vibration isolation floating. Calculate and report the differences.
- .10 Inspect, measure, and record vibration isolation.
 - .1 Verify that vibration isolation is installed in the required locations.
 - .2 Verify that installation is level and plumb.
 - .3 Verify that isolators are properly anchored.
 - .4 For spring isolators, measure the compressed spring height, the spring OD, and the travel-to-solid distance.
 - .5 Measure the operating clearance between each inertia base and the floor or concrete base below. Verify that there is unobstructed clearance between the bottom of the inertia base and the floor.

3.22 PROCEDURES FOR SOUND-LEVEL MEASUREMENTS

- .1 Perform sound-pressure-level measurements with an octave-band analyzer complying with ANSI S1.4 for Type 1 sound-level meters and ANSI S1.11 for octave-band filters. Comply with requirements in ANSI S1.13, unless otherwise indicated.

- .2 Calibrate sound meters before each day of testing. Use a calibrator provided with the sound meter complying with ANSI S1.40 and that has NIST certification.
- .3 Use a microphone that is suitable for the type of sound levels measured. For areas where air velocities exceed 100 fpm (0.51 m/s), use a windscreen on the microphone.
- .4 Perform sound-level testing after air and water balancing and equipment testing are complete.
- .5 Close windows and doors to the space.
- .6 Perform measurements when the space is not occupied and when the occupant noise level from other spaces in the building and outside are at a minimum.
- .7 Clear the space of temporary sound sources so unrelated disturbances will not be measured. Position testing personnel during measurements to achieve a direct line-of-sight between the sound source and the sound-level meter.
- .8 Take sound measurements at a height approximately 48 inches (1200 mm) above the floor and at least 36 inches (900 mm) from a wall, column, and other large surface capable of altering the measurements.
- .9 Take sound measurements in dBA and in each of the 8 unweighted octave bands in the frequency range of 63 to 8000 Hz.
- .10 Take sound measurements with the HVAC systems off to establish the background sound levels and take sound measurements with the HVAC systems operating.
 - .1 Calculate the difference between measurements. Apply a correction factor depending on the difference and adjust measurements.
- .11 Perform sound testing at locations on Project for each of the following space types. For each space type tested, select a measurement location that has the greatest sound level. If testing multiple locations for each space type, select at least one location that is near and at least one location that is remote from the predominant sound source.
 - .1 Private office.
 - .2 Open office area.
 - .3 Conference room.
 - .4 Auditorium/large meeting room/lecture hall.
 - .5 Classroom/training room.
 - .6 Patient room/exam room.
 - .7 Sound or vibration sensitive laboratory.
 - .8 Hotel room/apartment.
 - .9 Each space with a noise criterion of RC or NC 25 or lower.
 - .10 Each space with an indicated noise criterion of RC or NC 35 and lower that is adjacent to a mechanical equipment room or roof mounted equipment.
 - .11 Inside each mechanical equipment room.

3.23 PROCEDURES FOR INDOOR-AIR QUALITY MEASUREMENTS

- .1 After air balancing is complete and with HVAC systems operating at indicated conditions, perform indoor-air quality testing.
- .2 Observe and record the following conditions for each HVAC system:
 - .1 The distance between the outside-air intake and the closest exhaust fan discharge, cooling tower, flue termination, or vent termination.
 - .2 Specified filters are installed. Check for leakage around filters.
 - .3 Cooling coil drain pans have a positive slope to drain.
 - .4 Cooling coil condensate drain trap maintains an air seal.

- .5 Evidence of water damage.
- .6 Insulation in contact with the supply, return, and outside air is dry and clean.
- .3 Measure and record indoor conditions served by each HVAC system. Make measurements at multiple locations served by the system if required to satisfy the following:
 - .1 Most remote area.
 - .2 One location per floor.
 - .3 One location for every 5000 sq. ft..
- .4 Measure and record the following indoor conditions for each location two times at two-hour intervals, and in accordance with ASHRAE 113:
 - .1 Temperature.
 - .2 Relative humidity.
 - .3 Air velocity.
 - .4 Concentration of carbon dioxide (ppm).
 - .5 Concentration of carbon monoxide (ppm).
 - .6 Nitrogen oxides (ppm).
 - .7 Formaldehyde (ppm).

3.24 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING AIR SYSTEMS

- .1 Perform a preconstruction inspection of existing equipment that is to remain and be reused.
 - .1 Measure and record the operating speed, airflow, and static pressure of each fan. For belt driven devices, identify and record sheave and belt information.
 - .2 Check and record the condition of each motorized damper.
 - .3 Measure and record the motor voltage and amperage. Compare the values to motor nameplate information. Record the motor RPM.
 - .4 Check the refrigerant charge.
 - .5 Check the condition of filters.
 - .6 Check the condition of coils.
 - .7 Check the operation of the drain pan and condensate drain trap.
 - .8 Check bearings and other lubricated parts for proper lubrication.
 - .9 Obtain the appropriate fan curves and plot the operating points.
 - .10 Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies. Submit the report to the engineer prior to demolition or modification.
- .2 Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished.
 - .1 New filters are installed.
 - .2 Coils are clean and fins combed.
 - .3 Drain pans are clean.
 - .4 Fans are clean.
 - .5 Bearings and other parts are properly lubricated.
 - .6 Deficiencies noted in the preconstruction report are corrected.
- .3 Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.

- .1 Compare the indicated airflow of the renovated work to the measured fan airflows and determine the new fan, speed, filter, and coil face velocity.
- .2 Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
- .3 If calculations increase or decrease the airflow by more than 5 percent, make equipment adjustments to achieve the calculated airflow rates. If 5 percent or less, equipment adjustments are not required.
- .4 Air balance each air outlet.

3.25 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING HYDRONIC SYSTEMS

- .1 Perform a preconstruction inspection of existing equipment that is to remain and be reused.
 - .1 Measure and record the operating speed, flow, and pressure of each pump.
 - .2 Measure and record existing balance valve settings on terminal devices.
 - .3 Check the condition of each control valve on terminal devices.
 - .4 Measure and record the motor voltage and amperage. Compare the values to motor nameplate information. Record the motor RPM.
 - .5 Check bearings and other lubricated parts for proper lubrication.
 - .6 Obtain the appropriate pump curves and plot the operating points.
 - .7 Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies. Submit the report to the engineer prior to demolition or modification.
- .2 Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished.
 - .1 Bearings and other parts are properly lubricated.
 - .2 Deficiencies noted in the preconstruction report are corrected.
- .3 Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.
 - .1 Compare the indicated flow of the renovated work to the measured pump flows and determine the new pump speed.
 - .2 If calculations increase or decrease the water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated water flow rates. If 5 percent or less, equipment adjustments are not required.
 - .3 Water balance each terminal device.

3.26 TEMPERATURE-CONTROL VERIFICATION

- .1 Verify that controllers are calibrated and commissioned.
- .2 Check transmitter and controller locations and note conditions that would adversely affect control functions.
- .3 Record controller settings and note variances between set points and actual measurements.
- .4 Check the operation of limiting controllers (i.e., high- and low-temperature controllers).
- .5 Check free travel and proper operation of control devices such as damper and valve operators.
- .6 Check the sequence of operation of control devices. Note air pressures and device positions and correlate with airflow and water flow measurements. Note the speed of response to input changes.

- .7 Check the interaction of electrically operated switch transducers.
- .8 Check the interaction of interlock and lockout systems.
- .9 Check main control supply-air pressure and observe compressor and dryer operations.
- .10 Record voltages of power supply and controller output. Determine whether the system operates on a grounded or nongrounded power supply.
- .11 Note operation of electric actuators using spring return for proper fail-safe operations.

3.27 TOLERANCES

- .1 Set HVAC system airflow and water flow rates within the following tolerances:
 - .1 Supply, Return, and Exhaust Fans and Equipment with Fans: 0 to +10%.
 - .2 Air Outlets and Inlets: -5% to +5%.
 - .3 Heating-Water Flow Rate: 0 to +10%.
 - .4 Cooling-Water Flow Rate: 0 to +5%.
 - .5 Domestic Hot Water Recirculation Flow Rate: 0 to +10%.
- .2 Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.28 REPORTING

- .1 Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.
- .2 Status Reports: As Work progresses, prepare reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.29 FINAL REPORT

- .1 General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.
- .2 Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.
 - .1 Include a list of instruments used for procedures, along with proof of calibration.
- .3 Final Report Contents: In addition to certified field report data, include the following:
 - .1 Pump curves.
 - .2 Fan curves.
 - .3 Manufacturers' test data.
 - .4 Field test reports prepared by system and equipment installers.
 - .5 Other information relative to equipment performance, but do not include Shop Drawings and Product Data.
- .4 General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:
 - .1 Title page.
 - .2 Name and address of TAB firm.
 - .3 Project name.
 - .4 Project location.

- .5 Architect's name and address.
- .6 Engineer's name and address.
- .7 Contractor's name and address.
- .8 Report date.
- .9 Signature of TAB firm who certifies the report.
- .10 Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
- .11 Summary of contents including the following:
 - .1 Indicated versus final performance.
 - .2 Notable characteristics of systems.
 - .3 Description of system operation sequence if it varies from the Contract Documents.
- .12 Nomenclature sheets for each item of equipment.
- .13 Data for terminal units, including manufacturer, type size, and fittings.
- .14 Notes to explain why certain final data in the body of reports varies from indicated values.
- .15 Test conditions for fans and pump performance forms including the following:
 - .1 Settings for outside-, return-, and exhaust-air dampers.
 - .2 Conditions of filters.
 - .3 Cooling coil, wet- and dry-bulb conditions.
 - .4 Face and bypass damper settings at coils.
 - .5 Fan drive settings including settings and percentage of maximum pitch diameter.
 - .6 Inlet vane settings for variable-air-volume systems.
 - .7 Settings for supply-air, static-pressure controller.
 - .8 Other system operating conditions that affect performance.
- .5 System Diagrams: Include schematic layouts of air and hydronic distribution systems and domestic hot water recirculation systems. Present each system with single-line diagram and include the following as applicable:
 - .1 Quantities of outside, supply, return, and exhaust airflows.
 - .2 Water flow rates.
 - .3 Duct, outlet, and inlet sizes.
 - .4 Pipe and valve sizes and locations.
 - .5 Terminal units.
 - .6 Balancing stations.
 - .7 Position of balancing devices.
- .6 Air-Handling Unit Test Reports: For air-handling units with coils, include the following:
 - .1 Unit Data: Include the following:
 - .1 Unit identification.
 - .2 Location.
 - .3 Make and type.
 - .2 Model number and unit size.
 - .1 Manufacturer's serial number.
 - .2 Unit arrangement and class.

- .3 Discharge arrangement.
 - .4 Sheave make, size in inches, and bore.
 - .5 Sheave dimensions, center-to-center, and amount of adjustments in inches.
 - .6 Number of belts, make, and size.
 - .7 Number of filters, type, and size.
 - .3 Motor Data:
 - .1 Make and frame type and size.
 - .2 Horsepower and rpm.
 - .3 Volts, phase, and hertz.
 - .4 Full-load amperage and service factor.
 - .5 Sheave make, size in inches, and bore.
 - .6 Sheave dimensions, center-to-center, and amount of adjustments in inches.
 - .4 Refrigerant expansion valve and refrigerant types.
 - .5 Test Data (Indicated and Actual Values):
 - .1 Total airflow rate in cfm.
 - .2 Total system static pressure in inches wg.
 - .3 Fan rpm.
 - .4 Discharge static pressure in inches wg.
 - .5 Filter static-pressure differential in inches wg.
 - .6 Preheat coil static-pressure differential in inches wg.
 - .7 Cooling coil static-pressure differential in inches wg.
 - .8 Heating coil static-pressure differential in inches wg.
 - .9 Outside airflow in cfm.
 - .10 Return airflow in cfm.
 - .11 Outside-air damper position.
 - .12 Return-air damper position.
 - .13 Vortex damper position.
- .7 Apparatus-Coil Test Reports:
 - .1 Coil Data:
 - .1 System identification.
 - .2 Location.
 - .3 Coil type.
 - .4 Number of rows.
 - .5 Fin spacing in fins per inch o.c.
 - .6 Make and model number.
 - .7 Face area in sq. ft..
 - .8 Tube size in NPS.
 - .9 Tube and fin materials.
 - .10 Circuiting arrangement.
 - .2 Test Data (Indicated and Actual Values):
 - .1 Airflow rate in cfm.
 - .2 Average face velocity in fpm.
 - .3 Air pressure drop in inches wg.

- .4 Outside-air, wet- and dry-bulb temperatures in deg F.
 - .5 Return-air, wet- and dry-bulb temperatures in deg F.
 - .6 Entering-air, wet- and dry-bulb temperatures in deg F.
 - .3 Leaving-air, wet- and dry-bulb temperatures in deg F.
 - .1 Water flow rate in gpm.
 - .2 Water pressure differential in feet of head or psig.
 - .3 Entering-water temperature in deg F.
 - .4 Leaving-water temperature in deg F.
 - .5 Refrigerant expansion valve and refrigerant types.
 - .6 Refrigerant suction pressure in psig.
 - .7 Refrigerant suction temperature in deg F.
 - .8 Inlet steam pressure in psig.
- .8 Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:
 - .1 Unit Data:
 - .1 System identification.
 - .2 Location.
 - .3 Coil identification.
 - .2 Capacity in Btuh.
 - .1 Number of stages.
 - .2 Connected volts, phase, and hertz.
 - .3 Rated amperage.
 - .4 Airflow rate in cfm.
 - .5 Face area in sq. ft..
 - .6 Minimum face velocity in fpm.
 - .3 Test Data (Indicated and Actual Values):
 - .1 Heat output in Btuh.
 - .2 Airflow rate in cfm.
 - .3 Air velocity in fpm.
 - .4 Entering-air temperature in deg F.
 - .5 Leaving-air temperature in deg F.
 - .6 Voltage at each connection.
 - .7 Amperage for each phase.
- .9 Fan Test Reports: For supply, return, and exhaust fans, include the following:
 - .1 Fan Data:
 - .1 System identification.
 - .2 Location.
 - .3 Make and type.
 - .4 Model number and size.
 - .5 Manufacturer's serial number.
 - .6 Arrangement and class.
 - .7 Sheave make, size in inches, and bore.
 - .8 Sheave dimensions, center-to-center, and amount of adjustments in inches.

- .2 Motor Data:
 - .1 Make and frame type and size.
 - .2 Horsepower and rpm.
 - .3 Volts, phase, and hertz.
 - .4 Full-load amperage and service factor.
 - .5 Sheave make, size in inches, and bore.
 - .6 Sheave dimensions, center-to-center, and amount of adjustments in inches.
 - .7 Number of belts, make, and size.
- .3 Test Data (Indicated and Actual Values):
 - .1 Total airflow rate in cfm.
 - .2 Total system static pressure in inches wg.
 - .3 Fan rpm.
 - .4 Discharge static pressure in inches wg.
 - .5 Suction static pressure in inches wg.
- .10 Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
 - .1 Report Data:
 - .1 System and air-handling unit number.
 - .2 Location and zone.
 - .3 Traverse air temperature in deg F.
 - .4 Duct static pressure in inches wg.
 - .5 Duct size in inches.
 - .6 Duct area in sq. ft..
 - .7 Indicated airflow rate in cfm.
 - .8 Indicated velocity in fpm.
 - .9 Actual airflow rate in cfm.
 - .10 Actual average velocity in fpm.
 - .11 Barometric pressure in psig.
- .11 Air-Terminal-Device Reports:
 - .1 Unit Data:
 - .1 System and air-handling unit identification.
 - .2 Location and zone.
 - .3 Test apparatus used.
 - .4 Area served.
 - .5 Air-terminal-device make.
 - .6 Air-terminal-device number from system diagram.
 - .7 Air-terminal-device type and model number.
 - .8 Air-terminal-device size.
 - .9 Air-terminal-device effective area in sq. ft..
 - .2 Test Data (Indicated and Actual Values):
 - .1 Airflow rate in cfm.
 - .2 Air velocity in fpm.
 - .3 Preliminary airflow rate as needed in cfm.

- .1 Preliminary velocity as needed in fpm.
 - .2 Final airflow rate in cfm.
 - .3 Final velocity in fpm.
- .4 Space temperature in deg F.
- .5 System-Coil Reports: For reheat coils and water coils of terminal units, include the following:
 - .1 Unit Data:
 - .2 System and air-handling unit identification.
 - .3 Location and zone.
 - .4 Room or riser served.
 - .5 Coil make and size.
 - .6 Flowmeter type.
 - .6 Test Data (Indicated and Actual Values):
 - .1 Airflow rate in cfm.
 - .2 Entering-water temperature in deg F.
 - .3 Leaving-water temperature in deg F.
 - .4 Water pressure drop in feet of head or psig.
 - .5 Entering-air temperature in deg F.
 - .6 Leaving-air temperature in deg F.
- .12 Packaged Chiller Reports:
 - .1 Unit Data:
 - .1 Unit identification.
 - .2 Make and model number.
 - .3 Manufacturer's serial number.
 - .4 Refrigerant type and capacity in gal..
 - .5 Starter type and size.
 - .6 Starter thermal protection size.
 - .7 Compressor make and model number.
 - .8 Compressor manufacturer's serial number.
 - .2 Water-Cooled Condenser Test Data (Indicated and Actual Values):
 - .1 Refrigerant pressure in psig.
 - .2 Refrigerant temperature in deg F.
 - .3 Entering-water temperature in deg F.
 - .4 Leaving-water temperature in deg F.
 - .5 Entering-water pressure in feet of head or psig.
 - .6 Water pressure differential in feet of head or psig.
 - .3 Air-Cooled Condenser Test Data (Indicated and Actual Values):
 - .1 Refrigerant pressure in psig.
 - .2 Refrigerant temperature in deg F.
 - .3 Entering- and leaving-air temperature in deg F.
 - .4 Evaporator Test Reports (Indicated and Actual Values):
 - .1 Refrigerant pressure in psig.
 - .2 Refrigerant temperature in deg F.

- .3 Entering-water temperature in deg F.
 - .4 Leaving-water temperature in deg F.
 - .5 Entering-water pressure in feet of head or psig.
 - .6 Water pressure differential in feet of head or psig.
- .5 Compressor Test Data (Indicated and Actual Values):
- .6 Suction pressure in psig.
 - .1 Suction temperature in deg F.
 - .2 Discharge pressure in psig.
 - .3 Discharge temperature in deg F.
 - .4 Oil pressure in psig.
 - .5 Oil temperature in deg F.
 - .6 Voltage at each connection.
 - .7 Amperage for each phase.
 - .8 Kilowatt input.
 - .9 Crankcase heater kilowatt.
 - .10 Chilled-water control set point in deg F.
 - .11 Condenser-water control set point in deg F.
 - .12 Refrigerant low-pressure-cutoff set point in psig.
 - .13 Refrigerant high-pressure-cutoff set point in psig.
- .7 Refrigerant Test Data (Indicated and Actual Values):
 - .1 Oil level.
 - .2 Refrigerant level.
 - .3 Relief valve setting in psig.
 - .4 Unloader set points in psig.
 - .5 Percentage of cylinders unloaded.
 - .6 Bearing temperatures in deg F.
 - .7 Vane position.
 - .8 Low-temperature-cutoff set point in deg F.
- .13 Condenser Reports: For air-cooled condensing units, or water-cooled condensing units, include the following:
 - .1 Unit Data:
 - .1 Unit identification.
 - .2 Location.
 - .3 Unit make and model number.
 - .4 Condenser make.
 - .5 Condenser model and serial numbers.
 - .6 Water weight in lb.
 - .7 Low ambient temperature cutoff in deg F.
 - .2 Test Data (Indicated and Actual Values):
 - .1 Inlet-duct static pressure in inches wg.
 - .2 Outlet-duct static pressure in inches wg.
 - .3 Entering-air, dry-bulb temperature in deg F.
 - .4 Leaving-air, dry-bulb temperature in deg F.

- .3 Condenser entering-water temperature in deg F.
 - .1 Condenser leaving-water temperature in deg F.
 - .2 Condenser-water temperature differential in deg F.
 - .3 Condenser entering-water pressure in feet of head or psig.
 - .4 Condenser leaving-water pressure in feet of head or psig.
 - .5 Condenser-water pressure differential in feet of head or psig.
 - .6 Control settings.
 - .7 Unloader set points.
 - .8 Low-pressure-cutout set point in psig.
 - .9 High-pressure-cutout set point in psig.
 - .10 Suction pressure in psig.
 - .11 Suction temperature in deg F.
 - .12 Condenser refrigerant pressure in psig.
 - .13 Condenser refrigerant temperature in deg F.
 - .14 Oil pressure in psig.
 - .15 Oil temperature in deg F.
 - .16 Voltage at each connection.
 - .17 Amperage for each phase.
 - .18 Kilowatt input.
 - .19 Crankcase heater kilowatt.
 - .20 Number of fans.
 - .21 Condenser fan rpm.
 - .22 Condenser fan airflow rate in cfm.
 - .23 Condenser fan motor make, frame size, rpm, and horsepower.
 - .24 Condenser fan motor voltage at each connection.
 - .25 Condenser fan motor amperage for each phase.
- .14 Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:
 - .1 Unit Data:
 - .1 Unit identification.
 - .2 Location.
 - .3 Service.
 - .4 Make and size.
 - .2 Model and serial numbers.
 - .1 Water flow rate in gpm.
 - .2 Water pressure differential in feet of head or psig.
 - .3 Required net positive suction head in feet of head or psig.
 - .4 Pump rpm.
 - .5 Impeller diameter in inches.
 - .6 Motor make and frame size.
 - .7 Motor horsepower and rpm.
 - .8 Voltage at each connection.
 - .9 Amperage for each phase.

- .10 Full-load amperage and service factor.
 - .11 Seal type.
 - .3 Test Data (Indicated and Actual Values):
 - .1 Static head in feet of head or psig.
 - .2 Pump shutoff pressure in feet of head or psig.
 - .3 Actual impeller size in inches.
 - .4 Full-open flow rate in gpm.
 - .5 Full-open pressure in feet of head or psig.
 - .6 Final discharge pressure in feet of head or psig.
 - .7 Final suction pressure in feet of head or psig.
 - .8 Final total pressure in feet of head or psig.
 - .9 Final water flow rate in gpm.
 - .10 Voltage at each connection.
 - .11 Amperage for each phase.
- .15 Air-to-Air Heat-Recovery Unit Reports:
 - .1 Unit Data:
 - .1 Unit identification.
 - .2 Location.
 - .3 Service.
 - .4 Make and type.
 - .5 Model and serial numbers.
 - .2 Motor Data:
 - .1 Make and frame type and size.
 - .2 Horsepower and rpm.
 - .3 Volts, phase, and hertz.
 - .4 Full load amperage and service factor.
 - .5 Sheave make, size in inches, and bore.
 - .6 Sheave dimensions, center-to-center, and amount of adjustments in inches.
 - .3 If fans are an integral part of the unit, include the following for each fan:
 - .1 Make and type.
 - .2 Arrangement and size.
 - .3 Sheave make, size in inches, and bore.
 - .4 Sheave dimensions, center-to-center, and amount of adjustments in inches.
 - .4 Test Data (Indicated and Actual Values):
 - .1 Total exhaust airflow rate in cfm.
 - .2 Purge exhaust airflow rate in cfm.
 - .3 Outside airflow rate in cfm.
 - .4 Total exhaust fan static pressure in inches wg.
 - .5 Total outside-air fan static pressure in inches wg.
 - .6 Pressure drop on each side of recovery wheel in inches wg.
 - .7 Exhaust air temperature entering in deg F.
 - .8 Exhaust air temperature leaving in deg F.
 - .9 Outside-air temperature entering in deg F.

- .10 Outside-air temperature leaving in deg F.
 - .11 Calculate sensible and total heat capacity of each airstream in MBh.
- .16 Vibration Measurement Reports:
 - .1 Date and time of test.
 - .2 Vibration meter manufacturer, model number, and serial number.
 - .3 Equipment designation, location, equipment, speed, motor speed, and motor horsepower.
 - .4 Diagram of equipment showing the vibration measurement locations.
 - .5 Measurement readings for each measurement location.
 - .6 Calculate isolator efficiency using measurements taken.
 - .7 Description of predominant vibration source.
- .17 Sound Measurement Reports: Record sound measurements on octave band and dBA test forms and on an NC or RC chart indicating the decibel level measured in each frequency band for both "background" and "HVAC system operating" readings. Record each tested location on a separate NC or RC chart. Record the following on the forms:
 - .1 Date and time of test. Record each tested location on its own NC curve.
 - .2 Sound meter manufacturer, model number, and serial number.
 - .3 Space location within the building including floor level and room number.
 - .4 Diagram or color photograph of the space showing the measurement location.
 - .5 Time weighting of measurements, either fast or slow.
 - .6 Description of the measured sound: steady, transient, or tonal.
 - .7 Description of predominant sound source.
- .18 Indoor-Air Quality Measurement Reports for Each HVAC System:
 - .1 HVAC system designation.
 - .2 Date and time of test.
 - .3 Outdoor temperature, relative humidity, wind speed, and wind direction at start of test.
 - .4 Room number or similar description for each location.
 - .5 Measurements at each location.
 - .6 Observed deficiencies.
- .19 Instrument Calibration Reports:
 - .1 Report Data:
 - .1 Instrument type and make.
 - .2 Serial number.
 - .1 Application.
 - .2 Dates of use.
 - .3 Dates of calibration.

3.30 INSPECTIONS

- .1 Initial Inspection:
 - .1 After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the Final Report.
 - .2 Randomly check the following for each system:
 - .1 Measure airflow of at least 10 percent of air outlets.
 - .2 Measure water flow of at least 5 percent of terminals.

- .3 Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
- .4 Measure sound levels at two locations.
- .5 Measure space pressure of at least 10 percent of locations.
- .6 Verify that balancing devices are marked with final balance position.
- .7 Note deviations to the Contract Documents in the Final Report.
- .2 Final Inspection:
 - .1 After initial inspection is complete and evidence by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Owner.
 - .2 TAB firm test and balance engineer shall conduct the inspection in the presence of Owner.
 - .3 Owner shall randomly select measurements documented in the final report to be rechecked. The rechecking shall be limited to either 10 percent of the total measurements recorded, or the extent of measurements that can be accomplished in a normal 8-hour business day.
 - .4 If the rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
 - .5 If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
 - .6 TAB firm shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes and resubmit the final report.
 - .7 Request a second final inspection. If the second final inspection also fails, Owner shall contract the services of another TAB firm to complete the testing and balancing in accordance with the Contract Documents and deduct the cost of the services from the final payment.

3.31 ADDITIONAL TESTS

- .1 Within 90 days of completing TAB, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- .2 Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional testing, inspecting, and adjusting during near-peak summer and winter conditions.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- .1 Insulation Materials:
 - .1 Calcium silicate.
 - .2 Cellular glass.
 - .3 Flexible elastomeric.
 - .4 Mineral fiber.
 - .5 Phenolic.
 - .6 Polyisocyanurate.
 - .7 Polyolefin.
 - .8 Polystyrene.
- .2 Fire-rated insulation systems.
- .3 Insulating cements.
- .4 Adhesives.
- .5 Mastics.
- .6 Lagging adhesives.
- .7 Sealants.
- .8 Factory-applied jackets.
- .9 Field-applied fabric-reinforcing mesh.
- .10 Field-applied cloths.
 - .1 Field-applied jackets.
- .11 Tapes.
- .12 Securements.
- .13 Corner angles.
- .14 Protective shielding guards

1.2 GENERAL REFERENCES

- .1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.
- .2 Division 20, including all Common Mechanical Requirements in Section 20 00 00, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.

1.3 RELATED REQUIREMENTS

1.4 SUBMITTALS

- .1 Action Submittals
 - .1 Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).
 - .2 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 of field-applied jackets.
- .7 Detail application at linkages of control devices.
- .8 Detail field application for each equipment type.
- .3 LEED Submittals

1.5 QUALITY ASSURANCE

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

1.6 PRE-INSTALLATION TESTING

- .1 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.

1.7 COORDINATION

- .1 Coordinate size and location of supports, hangers, and insulation shields specified in Division 20 Section 20 05 29 "Hangers and Supports."
- .2 Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- .3 Coordinate installation and testing of heat tracing.

1.8 DELIVERY, STORAGE AND HANDLING

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

PART 2 PRODUCTS

2.1 INSULATION MATERIALS

- .1 General
 - .1 Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.
 - .2 Products shall not contain asbestos, lead, mercury, or mercury compounds.

- .3 Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C871.
- .4 Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C795.
- .5 Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- .2 Calcium Silicate:
 - .1 Products:
 - .1 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 C533, Type I.
 - .3 Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C533, Type I.
 - .4 Prefabricated Fitting Covers: Comply with ASTM C450 and ASTM C585 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.
- .3 Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - .1 Products:
 - .1 Pittsburgh Corning Corporation; Foamglas.
 - .2 Block Insulation: {RS#745}, Type I.
 - .3 Special-Shaped Insulation: {RS#745}, Type III.
 - .4 Board Insulation: {RS#745}, Type IV.
 - .5 Preformed Pipe Insulation without Jacket: Comply with {RS#745}, Type II, Class 1.
 - .6 Preformed Pipe Insulation with Factory-Applied ASJ: Comply with {RS#745}, Type II, Class 2.
 - .7 Factory fabricate shapes according to ASTM C450 and ASTM C585.
- .4 Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C534/C534M, Type I for tubular materials and Type II for sheet materials.
 - .1 Products: Subject to compliance with requirements, provide one of the following:
 - .1 Aeroflex USA, Inc.; Aerocel.
 - .2 Armacell LLC; AP Armaflex.
 - .3 K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.
- .5 Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C533, Type II and ASTM C1290, Type I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - .1 Products:
 - .1 CertainTeed Corp.; SoftTouch Duct Wrap.
 - .2 Johns Manville; Microlite.
 - .3 Knauf Insulation; Atmosphere Duct Wrap.
 - .4 Manson Insulation Inc.; Alley Wrap.
 - .5 Owens Corning; SOFTR All-Service Duct Wrap.

- .6 High-Temperature, Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C533, Type V, without factory-applied jacket.
 - .1 Products:
 - .1 Industrial Insulation Group (IIG); MinWool-1200 Flexible Batt.
 - .2 Johns Manville; HTB 26 Spin-Glas.
 - .3 Roxul Inc.; Roxul RW.
- .7 Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C612, Type IA or Type IB. For duct and plenum applications, provide insulation without factory-applied jacket. For equipment applications, provide insulation without factory-applied jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - .1 Products:
 - .1 CertainTeed Corp.; CertaPro Commercial Board.
 - .2 Fibrex Insulations Inc.; FBX.
 - .3 Johns Manville; 800 Series Spin-Glas.
 - .4 Knauf Insulation; Earthwool Insulation Board.
 - .5 Manson Insulation Inc.; AK Board.
 - .6 Owens Corning; Fiberglas 700 Series.
- .8 High-Temperature, Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C612, Type III, without factory-applied jacket.
 - .1 Products:
 - .1 Fibrex Insulations Inc.; FBX. Industrial Insulation Group (IIG); MinWool-1200 Industrial Board.
 - .2 Rock Wool; Delta Board.
 - .3 Roxul Inc.; RHT and RockBoard.
 - .4 Thermafiber, Inc.; Thermafiber Industrial Felt.
- .9 Mineral-Fiber, Preformed Pipe Insulation:
 - .1 Products:
 - .1 Fibrex Insulations Inc.; Coreplus 1200.
 - .2 Johns Manville; Micro-Lok.
 - .3 Knauf Insulation; Earthwool 1000° Pipe Insulation.
 - .4 Manson Insulation Inc.; Alley-K.
 - .5 Owens Corning; Fiberglas Pipe Insulation.
 - .2 Type I, 850 deg F (454 deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C547, Type I, Grade A, without factory-applied jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - .3 Type II, 1200 deg F (649 deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C547, Type II, Grade A, without factory-applied jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- .10 Mineral-Fiber, Pipe Insulation Wicking System: Preformed pipe insulation complying with ASTM C547, Type I, Grade A, with absorbent cloth factory applied to the entire inside surface of preformed pipe insulation and extended through the longitudinal joint to outside surface of insulation under insulation jacket. Factory apply a white, polymer, vapor-retarder jacket with self-sealing adhesive tape seam and evaporation holes running continuously along the longitudinal seam, exposing the absorbent cloth.

- .1 Products:
 - .1 Knauf Insulation; Permawick Pipe Insulation.
 - .2 Owens Corning; VaporWick Pipe Insulation.
- .11 Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C612, Type IB. Nominal density is 2.5 lb./cu. ft (40 kg/cu. m) or more. Thermal conductivity (k-value) at 100 deg F (55 deg C) is 0.29 Btu x in./h x sq. ft. x deg F (0.042 W/m x K) or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - .1 Products:
 - .1 CertainTeed Corp.; CrimpWrap.
 - .2 Johns Manville; MicroFlex.
 - .3 Knauf Insulation; Earthwool Pipe & Tank Insulation.
 - .4 Manson Insulation Inc.; AK Flex.
 - .5 Owens Corning; Fiberglas Pipe and Tank Insulation.
- .12 Phenolic:
 - .1 Products:
 - .1 Kingspan Tarec Industrial Insulation NV; Koolphen K.
 - .2 Resolco International BV; Insul-phen.
 - .2 Preformed pipe insulation of rigid, expanded, closed-cell structure. Comply with ASTM C1126, Type III, Grade 1.
 - .3 Block insulation of rigid, expanded, closed-cell structure. Comply with ASTM C1126, Type II, Grade 1.
 - .4 Factory fabricate shapes according to ASTM C450 and ASTM C585.
 - .5 Factory-Applied Jacket: Requirements are specified in "Factory-Applied Jackets" Article.
 - .1 Preformed Pipe Insulation: None.
 - .2 Board for Duct and Plenum Applications: None.
 - .3 Board for Equipment Applications: None.
- .13 Polyisocyanurate: Unfaced, preformed, rigid cellular Polyisocyanurate material intended for use as thermal insulation.
 - .1 Products:
 - .1 Dow Chemical Company (The); Trymer 2000 XP.
 - .2 Duna USA Inc.; Corafoam.
 - .3 Dyplast Products; ISO-25.
 - .4 Elliott Company of Indianapolis; Elfoam.
 - .2 Comply with {RS#756}, Type I or Type IV, except thermal conductivity (k-value) shall not exceed 0.19 Btu x in./h x sq. ft. x deg F (0.027 W/m x K) at 75 deg F (24 deg C) after 180 days of aging.
 - .3 Flame-spread index shall be 25 or less and smoke-developed index shall be 50 or less for thickness up to 1 inch (25 mm) as tested by ASTM E84.
 - .4 Fabricate shapes according to ASTM C450 and ASTM C585 ASTM C585.
 - .5 Factory-Applied Jacket: Requirements are specified in "Factory-Applied Jackets" Article.
 - .1 Pipe Applications: None.
 - .2 Equipment Applications: None.

- .14 Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C534/C534M or ASTM C1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials.
 - .1 Products:
 - .1 Armacell LLC; Tubolit.
 - .2 Nomaco Insulation; IMCOLOCK, IMCOSHEET, NOMALOCK, and NOMAPLY.
- .15 Polystyrene: Rigid, extruded cellular polystyrene intended for use as thermal insulation. Comply with ASTM C578, Type IV or Type XIII, except thermal conductivity (k-value) shall not exceed 0.26 Btu x in./h x sq. ft. x deg F (0.038 W/m x K) after 180 days of aging. Fabricate shapes according to ASTM C450 and ASTM C585.
 - .1 Products:
 - .1 Dow Chemical Company (The); Styrofoam.

2.2 FIRE-RATED INSULATION SYSTEMS

- .1 Fire-Rated Board: Structural-grade, press-molded, xonolite calcium silicate, fireproofing board suitable for operating temperatures up to 1700 deg F (927 deg C). Comply with ASTM C656, Type II, Grade 6. tested and certified to provide a 1-hour fire rating by a NRTL acceptable to authority having jurisdiction.
 - .1 Products:
 - .1 Johns Manville; Super Firetemp M.
- .2 Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a 1-hour fire rating by a NRTL acceptable to authority having jurisdiction.
 - .1 Products:
 - .1 CertainTeed Corp.; FlameChek.
 - .2 Johns Manville; Firetemp Wrap.
 - .3 Nelson Fire Stop Products; Nelson FSB Flameshield Blanket.
 - .4 Thermal Ceramics; FireMaster Duct Wrap.
 - .5 3M; Fire Barrier Wrap Products.
 - .6 Unifrax Corporation; FyreWrap.

2.3 INSULATING CEMENTS

- .1 Mineral-Fiber Insulating Cement: Comply with ASTM C195.
 - .1 Products:
 - .1 Ramco Insulation, Inc.; Super-Stik.
- .2 Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C196.
 - .1 Products: Subject to compliance with requirements, provide one of the following:
 - .1 Ramco Insulation, Inc.; Thermokote V.
- .3 Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C449.
 - .1 Products:
 - .1 Ramco Insulation, Inc.; Ramcote 1200 and Quik-Cote.

2.4 ADHESIVES

- .1 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 Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F (10 to 427 deg C).

- .1 Products: Subject to compliance with requirements, provide one of the following:
 - .1 Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-97.
 - .2 Eagle Bridges - Marathon Industries; 290.
 - .3 Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 81-27.
 - .4 Mon-Eco Industries, Inc.; 22-30.
 - .5 Vimasco Corporation; 760.
- .2 For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- .3 Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- .3 Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F (minus 73 to plus 93 deg C).
 - .1 Products:
 - .1 Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 81-84.
 - .2 For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - .3 Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- .4 Phenolic and Polyisocyanurate Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F (minus 59 to plus 149 deg C).
 - .1 Products:
 - .1 Childers Products, Division of ITW; CP-96.
 - .2 Foster Products Corporation, H. B. Fuller Company; 81-33.
 - .2 For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - .3 Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- .5 Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179, Type II, Class I.
 - .1 Products:
 - .1 Aeroflex USA, Inc.; Aero seal.
 - .2 Armacell LLC; Armaflex 520 Adhesive.
 - .3 Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
 - .4 K-Flex USA; R-373 Contact Adhesive.
 - .2 For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - .3 Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- .6 Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

- .1 Products:
 - .1 Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
 - .2 Eagle Bridges - Marathon Industries; 225.
 - .3 Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
 - .4 Mon-Eco Industries, Inc.; 22-25.
- .2 For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- .3 Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- .7 Polystyrene Adhesive: Solvent- or water-based, synthetic resin adhesive with a service temperature range of minus 20 to plus 140 deg F (29 to plus 60 deg C).
 - .1 Products:
 - .1 Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-96.
 - .2 Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60.
- .8 ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
 - .1 Products:
 - .1 Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
 - .2 Eagle Bridges - Marathon Industries; 225.
 - .3 Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.
 - .4 Mon-Eco Industries, Inc.; 22-25.
 - .2 For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - .3 Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- .9 PVC Jacket Adhesive: Compatible with PVC jacket.
 - .1 Products:
 - .1 Dow Corning Corporation; 739, Dow Silicone.
 - .2 Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
 - .3 P.I.C. Plastics, Inc.; Welding Adhesive.
 - .4 Speedline Corporation; Polyco VP Adhesive.
 - .2 For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - .3 Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.5 MASTICS

- .1 Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.
 - .1 For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- .2 Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
 - .1 Products:
 - .1 Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
 - .2 Vimasco Corporation; 749.
 - .2 Water-Vapor Permeance: ASTM E96/E96M, Procedure B, 0.013 perm (0.009 metric perm) at 43 mil (1.09 mm) dry film thickness.
 - .3 Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
 - .4 Solids Content: ASTM D1644, 58 percent by volume and 70 percent by weight.
 - .5 Color: White.
- .3 Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below ambient services.
 - .1 Products:
 - .1 Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-30.
 - .2 Eagle Bridges - Marathon Industries; 501.
 - .3 Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-35.
 - .4 Mon-Eco Industries, Inc.; 55-10.
 - .2 Water-Vapor Permeance: ASTM F1249, 0.05 perm (0.03 metric perm) at 35 mil (0.9 mm) dry film thickness.
 - .3 Service Temperature Range: 0 to plus 180 deg F (Minus 18 to plus 82 deg C).
 - .4 Solids Content: ASTM D1644, 44 percent by volume and 62 percent by weight.
 - .5 Color: White.
- .4 Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.
 - .1 Products:
 - .1 Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Encacel.
 - .2 Eagle Bridges - Marathon Industries; 570.
 - .3 Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 60-95/60-96.
 - .2 Water-Vapor Permeance: ASTM F1249, 0.05 perm (0.033 metric perm) at 30 mil (0.8 mm) dry film thickness.
 - .3 Service Temperature Range: Minus 50 to plus 220 deg F (Minus 46 to plus 104 deg C).
 - .4 Solids Content: ASTM D1644, 33 percent by volume and 46 percent by weight.
 - .5 Color: White.
- .5 Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
 - .1 Products:
 - .1 Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.

- .2 Eagle Bridges - Marathon Industries; 550.
- .3 Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.
- .4 Mon-Eco Industries, Inc.; 55-50.
- .5 Vimasco Corporation; WC-1/WC-5.
- .2 Water-Vapor Permeance: ASTM F1249, 1.8 perms (1.2 metric perms) at 0.0625 inch (1.6 mm) dry film thickness.
- .3 Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
- .4 Solids Content: 60 percent by volume and 66 percent by weight.
- .5 Color: White.

2.6 LAGGING ADHESIVES

- .1 Description: Comply with MIL-A-3316C Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
 - .1 For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - .2 Products:
 - .1 Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-50 AHV2.
 - .2 Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-36.
 - .3 Vimasco Corporation; 713 and 714.
 - .3 Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct, equipment, and pipe insulation.
 - .4 Service Temperature Range: 0 to plus 180 deg F (Minus 18 to plus 82 deg C).
 - .5 Color: White.

2.7 SEALANTS

- .1 Joint Sealants:
 - .1 Joint Sealants for Cellular-Glass, Phenolic, and Polyisocyanurate Products: Subject to compliance with requirements, provide one of the following:
 - .1 Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
 - .2 Eagle Bridges - Marathon Industries; 405.
 - .3 Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-45.
 - .4 Mon-Eco Industries, Inc.; 44-05.
 - .5 Pittsburgh Corning Corporation; Pittseal 444.
 - .2 Joint Sealants for Polystyrene Products: Subject to compliance with requirements, provide one of the following:
 - .1 Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-70.
 - .2 Eagle Bridges - Marathon Industries; 405.
 - .3 Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-45.
 - .4 Mon-Eco Industries, Inc.; 44-05.
- .3 Materials shall be compatible with insulation materials, jackets, and substrates.

- .4 Permanently flexible, elastomeric sealant.
- .5 Service Temperature Range: Minus 100 to plus 300 deg F (Minus 73 to plus 149 deg C).
- .6 Color: White or gray.
- .7 For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- .8 Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- .2 FSK and Metal Jacket Flashing Sealants:
 - .1 Products:
 - .1 Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
 - .2 Eagle Bridges - Marathon Industries; 405.
 - .3 Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
 - .4 Mon-Eco Industries, Inc.; 44-05.
 - .2 Materials shall be compatible with insulation materials, jackets, and substrates.
 - .3 Fire- and water-resistant, flexible, elastomeric sealant.
 - .4 Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
 - .5 Color: Aluminum.
 - .6 For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - .7 Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- .3 ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
 - .1 Products:
 - .1 Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
 - .2 Materials shall be compatible with insulation materials, jackets, and substrates.
 - .3 Fire- and water-resistant, flexible, elastomeric sealant.
 - .4 Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
 - .5 Color: White.
 - .6 For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - .7 Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.8 FACTORY-APPLIED JACKETS

- .1 Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
 - .1 ASJ: White, Kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.

- .2 ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
- .3 FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with Kraft-paper backing; complying with ASTM C1136, Type II.
- .4 FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type II.
- .5 PVDC Jacket for Indoor Applications: 4 mil (0.10 mm) thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms (0.013 metric perms) when tested according to ASTM E96/E96M and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E84.
 - .1 Products:
 - .1 Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
- .6 PVDC Jacket for Outdoor Applications: 6 mil (0.15 mm) thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms (0.007 metric perms) when tested according to ASTM E96/E96M and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E84.
 - .1 Products: Subject to compliance with requirements, provide one of the following:
 - .1 Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
- .7 PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.
 - .1 Products:
 - .1 Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
- .8 Vinyl Jacket: White vinyl with a permeance of 1.3 perms (0.86 metric perms) when tested according to ASTM E96/E96M , Procedure A, and complying with NFPA 90A and NFPA 90B.

2.9 FIELD-APPLIED FABRIC-REINFORCING MESH

- .1 Woven Glass-Fiber Fabric for Pipe Insulation: Approximately 2 oz/sq. yd (68 g/sq. m) with a thread count of 10 strands by 10 strands/sq. inch (4 strands by 4 strands/sq. mm) for covering pipe and pipe fittings.
 - .1 Products:
 - .1 Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Chil-Glas Number 10.
- .2 Woven Glass-Fiber Fabric for Duct and Equipment Insulation: Approximately 6 oz/sq. yd (203 g/sq. m) with a thread count of 5 strands by 5 strands/sq. inch (2 strands by 2 strands/sq. mm) for covering equipment.
 - .1 Products:
 - .1 Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Chil-Glas No. 5.
- .3 Woven Polyester Fabric: Approximately 1 oz/sq. yd (34 g/sq. m) with a thread count of 10 strands by 10 strands/sq. inch (4 strands by 4 strands/sq. mm), in a Leno weave, for duct, equipment, and pipe.
 - .1 Products:
 - .1 Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Mast-A-Fab.

.2 Vimasco Corporation; Elastafab 894.

2.10 FIELD-APPLIED CLOTHS

- .1 Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz/sq. yd (271 g/sq. m).
 - .1 Products:
 - .1 Alpha Associates, Inc.; Alpha-Maritex 84215 and 84217/9485RW, Luben 59.

2.11 FIELD-APPLIED JACKETS

- .1 Field-applied jackets shall comply with ASTM C921, Type I, unless otherwise indicated.
- .2 FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with Kraft-paper backing.
- .3 PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
 - .1 Products:
 - .1 Johns Manville; Zeston.
 - .2 P.I.C. Plastics, Inc.; FG Series.
 - .3 Proto Corporation; LoSmoke.
 - .4 Speedline Corporation; SmokeSafe.
 - .2 Adhesive: As recommended by jacket material manufacturer.
 - .3 Color: White.
 - .4 Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
 - .1 Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
 - .5 Factory-fabricated tank heads and tank side panels.
- .4 Metal Jacket:
 - .1 Products:
 - .1 Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.
 - .2 ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
 - .3 RPR Products, Inc.; Insul-Mate.
 - .2 Aluminum Jacket: Comply with ASTM B209/B209M, Alloy 3003, 3005, 3105 or 5005, Temper H-14.
 - .1 Sheet and roll stock ready for shop or field sizing.
 - .2 Finish and thickness are indicated in field-applied jacket schedules.
 - .3 Moisture Barrier for Indoor Applications: 1 mil (0.025 mm) thick, heat-bonded polyethylene and Kraft paper.
 - .4 Moisture Barrier for Outdoor Applications: 3 mil (0.075 mm) thick, heat-bonded polyethylene and Kraft paper.
 - .5 Factory-Fabricated Fitting Covers:
 - .1 Same material, finish, and thickness as jacket.
 - .2 Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - .3 Tee covers.
 - .4 Flange and union covers.

- .5 End caps.
 - .6 Beveled collars.
 - .7 Valve covers.
 - .8 Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
- .3 Stainless-Steel Jacket: ASTM A167 or ASTM A240/A240M.
 - .1 Sheet and roll stock ready for shop or field sizing.
 - .2 Material, finish, and thickness are indicated in field-applied jacket schedules.
 - .3 Moisture Barrier for Indoor Applications: 1 mil (0.025 mm) thick, heat-bonded polyethylene and Kraft paper.
 - .4 Moisture Barrier for Outdoor Applications: 3 mil (0.075 mm) thick, heat-bonded polyethylene and Kraft paper.
 - .5 Factory-Fabricated Fitting Covers:
 - .1 Same material, finish, and thickness as jacket.
 - .2 Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - .3 Tee covers.
 - .4 Flange and union covers.
 - .5 End caps.
 - .6 Beveled collars.
 - .7 Valve covers.
 - .8 Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
- .5 Underground Direct-Buried Jacket: 125 mil (3.2 mm) thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.
 - .1 Products:
 - .1 Pittsburgh Corning Corporation; Pittwrap.
 - .2 Polyguard Products, Inc.; Insulrap No Torch 125.
- .6 Self-Adhesive Outdoor Jacket: 60 mil (1.5 mm) thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a cross laminated polyethylene film covered with white aluminum-foil facing.
 - .1 Products:
 - .1 Polyguard Products, Inc.; Alumaguard 60.
- .7 PVDC Jacket for Indoor Applications: 4 mil (0.10 mm) thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms (0.013 metric perms) when tested according to ASTM E96/E96M and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E84.
 - .1 Products:
 - .1 Dow Chemical Company (The); Saran 540 Vapor Retarder Film.
- .8 PVDC Jacket for Outdoor Applications: 6 mil (0.15 mm) thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms (0.007 metric perms) when tested according to ASTM E96/E96M and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E84.
 - .1 Products:

- .1 Dow Chemical Company (The); Saran 560 Vapor Retarder Film.
- .9 PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.
 - .1 Products:
 - .1 Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.

2.12 TAPES

- .1 ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.
 - .1 Products:
 - .1 ABI, Ideal Tape Division; 428 AWF ASJ.
 - .2 Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
 - .3 Compac Corporation; 104 and 105.
 - .4 Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
 - .2 Width: 3 inches (75 mm).
 - .3 Thickness: 11.5 mils (0.29 mm).
 - .4 Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
 - .5 Elongation: 2 percent.
 - .6 Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
 - .7 ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- .2 FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.
 - .1 Products:
 - .1 ABI, Ideal Tape Division; 491 AWF FSK.
 - .2 Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
 - .3 Compac Corporation; 110 and 111.
 - .4 Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.
 - .2 Width: 3 inches (75 mm).
 - .3 Thickness: 6.5 mils (0.16 mm).
 - .4 Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
 - .5 Elongation: 2 percent.
 - .6 Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
 - .7 FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- .3 PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.
 - .1 Products:
 - .1 ABI, Ideal Tape Division; 370 White PVC tape.
 - .2 Compac Corporation; 130.
 - .3 Venture Tape; 1506 CW NS.
 - .2 Width: 2 inches (50 mm).
 - .3 Thickness: 6 mils (0.15 mm).
 - .4 Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
 - .5 Elongation: 500 percent.
 - .6 Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.

- .4 Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
 - .1 Products:
 - .1 ABI, Ideal Tape Division; 488 AWF.
 - .2 Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
 - .3 Compac Corporation; 120.
 - .4 Venture Tape; 3520 CW.
 - .2 Width: 2 inches (50 mm).
 - .3 Thickness: 3.7 mils (0.093 mm).
 - .4 Adhesion: 100 ounces force/inch (1.1 N/mm) in width.
 - .5 Elongation: 5 percent.
 - .6 Tensile Strength: 34 lbf/inch (6.2 N/mm) in width.
- .5 PVDC Tape for Indoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
 - .1 Products:
 - .1 Dow Chemical Company (The); Saran 540 Vapor Retarder Tape.
 - .2 Width: 3 inches (75 mm).
 - .3 Film Thickness: 4 mils (0.10 mm).
 - .4 Adhesive Thickness: 1.5 mils (0.04 mm).
 - .5 Elongation at Break: 145 percent.
 - .6 Tensile Strength: 55 lbf/inch (10.1 N/mm) in width.
- .6 PVDC Tape for Outdoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
 - .1 Products:
 - .1 Dow Chemical Company (The); Saran 560 Vapor Retarder Tape.
 - .2 Width: 3 inches (75 mm).
 - .3 Film Thickness: 6 mils (0.15 mm).
 - .4 Adhesive Thickness: 1.5 mils (0.04 mm).
 - .5 Elongation at Break: 145 percent.
 - .6 Tensile Strength: 55 lbf/inch (10.1 N/mm) in width.

2.13 SECUREMENTS

- .1 Bands:
 - .1 Products:
 - .1 ITW Insulation Systems; Gerrard Strapping and Seals.
 - .2 RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs
 - .2 Stainless Steel: ASTM A167 or ASTM A240/A240M, Type 304; 0.015 inch (0.38 mm) thick, 1/2 inch (13 mm) wide with wing seal.
 - .3 Aluminum: ASTM B209/B209M, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, 1/2 inch (13 mm) wide with wing seal.
 - .4 Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.
- .2 Insulation Pins and Hangers:
 - .1 Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106 inch (2.6 mm) diameter shank, length to suit depth of insulation indicated.
 - .1 Products:

- .1 AGM Industries, Inc.; CWP-1.
 - .2 GEMCO; CD.
 - .3 Midwest Fasteners, Inc.; CD.
 - .4 Nelson Stud Welding; TPA, TPC, and TPS.
- .2 Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106 inch (2.6 mm) diameter shank, length to suit depth of insulation indicated with integral 1-1/2 inches (38 mm) galvanized carbon-steel washer.
 - .1 Products:
 - .1 AGM Industries, Inc.; CHP-1.
 - .2 GEMCO; Cupped Head Weld Pin.
 - .3 Midwest Fasteners, Inc.; Cupped Head.
 - .4 Nelson Stud Welding; CHP.
- .3 Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - .1 Products:
 - .1 AGM Industries, Inc.; Tactoo Perforated Base Insul-Hangers.
 - .2 GEMCO; Perforated Base.
 - .3 Midwest Fasteners, Inc.; Spindle.
 - .2 Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
 - .3 Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106 inch (2.6 mm) diameter shank, length to suit depth of insulation indicated.
 - .4 Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
- .4 Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - .1 Products:
 - .1 GEMCO; Nylon Hangers.
 - .2 Midwest Fasteners, Inc.; Nylon Insulation Hangers.
 - .2 Baseplate: Perforated, nylon sheet, 0.030 inch (0.76 mm) thick by 1-1/2 inches (38 mm) in diameter.
 - .3 Spindle: Nylon, 0.106 inch (2.6 mm) diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches (63 mm).
 - .4 Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
- .5 Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - .1 Products:
 - .1 AGM Industries, Inc.; Tactoo Self-Adhering Insul-Hangers.

- .2 GEMCO; Peel & Press.
- .3 Midwest Fasteners, Inc.; Self Stick.
- .2 Baseplate: Galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
- .3 Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106 inch (2.6 mm) diameter shank, length to suit depth of insulation indicated.
- .4 Adhesive-backed base with a peel-off protective cover.
- .6 Insulation-Retaining Washers: Self-locking washers formed from 0.016 inch (0.41 mm) thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.
 - .1 Products:
 - .1 AGM Industries, Inc.; RC-150.
 - .2 GEMCO; R-150.
 - .3 Midwest Fasteners, Inc.; WA-150.
 - .4 Nelson Stud Welding; Speed Clips.
 - .2 Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
- .7 Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016 inch (0.41 mm) thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.
 - .1 Products:
 - .1 GEMCO.
 - .2 Midwest Fasteners, Inc.
- .3 Staples: Outward-clinching insulation staples, nominal 3/4 inch (19 mm) wide, stainless steel or Monel.
- .4 Wire: 0.080 inch (2.0 mm) nickel-copper alloy.
 - .1 Manufacturers:
 - .1 C & F Wire.

2.14 CORNER ANGLES

- .1 PVC Corner Angles: 30 mils (0.8 mm) thick, minimum 1 by 1 inch (25 by 25 mm), PVC according to ASTM D1784, Class 16354-C. White or color-coded to match adjacent surface.
- .2 Aluminum Corner Angles: 0.040 inch (1.0 mm) thick, minimum 1 by 1 inch (25 by 25 mm), aluminum according to ASTM B209/B209M, Alloy 3003, 3005, 3105 or 5005; Temper H-14.
- .3 Stainless-Steel Corner Angles: 0.024 inch (0.61 mm) thick, minimum 1 by 1 inch (25 by 25 mm), stainless steel according to ASTM A167 or ASTM A240/A240M, Type 304.

2.15 PROTECTIVE SHIELDING GUARDS

- .1 Protective Shielding Pipe Covers:
 - .1 Manufacturers:
 - .1 Truebro; a brand of IPS Corporation.
 - .2 Zurn Industries, LLC; Tubular Brass Plumbing Products Operation.
 - .3 Engineered Brass Company.
 - .4 Insul-Tect Products Co.; a subsidiary of MVG Molded Products.
 - .5 McGuire Manufacturing.
 - .6 Plumberex.

- .2 Description: Manufactured plastic wraps for covering plumbing fixture hot-water supply and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.
- .2 Protective Shielding Piping Enclosures:
 - .1 Manufacturers:
 - .1 Truebro; a brand of IPS Corporation.
 - .2 Zurn Industries, LLC; Tubular Brass Plumbing Products Operation.
 - .2 Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

PART 3 EXECUTION

3.1 EXAMINATION

- .1 Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
 - .1 Verify that systems and equipment to be insulated have been tested and are free of defects.
 - .2 Verify that surfaces to be insulated are clean and dry.
 - .3 Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- .1 Surface Preparation (Conditioned Spaces): Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- .2 Surface Preparation (Unconditioned Spaces and Exposed to Weather): Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
 - .1 Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils (0.127 mm) thick and an epoxy finish 5 mils (0.127 mm) thick if operating in a temperature range between 140 and 300 deg F (60 and 149 deg C). Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
 - .2 Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F (0 and 149 deg C) with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- .3 Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- .4 Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 INSTALLATION

- .1 General
 - .1 Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.
 - .2 Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.
 - .3 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.
- .4 Install insulation with longitudinal seams at top and bottom of horizontal runs.
 - .5 Install multiple layers of insulation with longitudinal and end seams staggered.
 - .6 Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
 - .7 Keep insulation materials dry during application and finishing.
 - .8 Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
 - .9 Install insulation with least number of joints practical.
 - .10 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.
 - .11 Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
 - .12 Install insulation with factory-applied jackets as follows:
 - .1 Draw jacket tight and smooth.
 - .2 Cover circumferential joints with 3 inch (75 mm) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
 - .3 Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches (50 mm) o.c.
 - .1 For below ambient services, apply vapor-barrier mastic over staples.
 - .4 Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
 - .5 Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.
 - .13 Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
 - .14 Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
 - .15 Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
 - .16 For above ambient services, do not install insulation to the following:
 - .1 Vibration-control devices.
 - .2 Testing agency labels and stamps.

- .3 Nameplates and data plates.
- .4 Manholes.
- .5 Handholes.
- .6 Cleanouts.
- .2 Penetrations
 - .1 Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 - .1 Seal penetrations with flashing sealant.
 - .2 For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - .3 Extend jacket of outdoor insulation outside roof flashing at least 2 inches (50 mm) below top of roof flashing.
 - .4 Seal jacket to roof flashing with flashing sealant.
 - .2 Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
 - .3 Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
 - .1 Seal penetrations with flashing sealant.
 - .2 For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - .3 Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches (50 mm).
 - .4 Seal jacket to wall flashing with flashing sealant.
 - .4 Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
 - .5 Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches (50 mm).
 - .1 Comply with requirements in Division 07 Section 07 84 13 "Penetration Firestopping" and fire-resistive joint sealers.
 - .6 Insulation Installation at Floor Penetrations:
 - .1 Duct: Install insulation continuously through floor penetrations that are not fire rated. For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches (50 mm).
 - .2 Pipe: Install insulation continuously through floor penetrations.
 - .3 Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 07 84 13 Section "Penetration Firestopping."
- .3 Equipment, Tank, and Vessel Installation
 - .1 Mineral Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.

- .1 Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.
- .2 Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
- .3 Protect exposed corners with secured corner angles.
- .4 Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
 - .1 Do not weld anchor pins to ASME-labeled pressure vessels.
 - .2 Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
 - .3 On tanks and vessels, maximum anchor-pin spacing is 3 inches (75 mm) from insulation end joints, and 16 inches (400 mm) o.c. in both directions.
 - .4 Do not overcompress insulation during installation.
 - .5 Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
 - .6 Impale insulation over anchor pins and attach speed washers.
 - .7 Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
- .5 Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
- .6 Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches (150 mm) from each end. Install wire or cable between two circumferential girdles 12 inches (300 mm) o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches (1200 mm) o.c. Use this network for securing insulation with tie wire or bands.
- .7 Stagger joints between insulation layers at least 3 inches (75 mm).
- .8 Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
- .9 Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
- .10 For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.
- .2 Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.
 - .1 Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
 - .2 Seal longitudinal seams and end joints.
- .3 Insulation Installation on Pumps:

- .1 Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6 inch (150 mm) centers, starting at corners. Install 3/8 inch (10 mm) diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
- .2 Fabricate boxes from galvanized steel, at least 0.040 inch (1.0 mm) thick.
- .3 For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.
- .4 General Pipe Insulation Installation
 - .1 Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
 - .2 Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
 - .1 On tanks and vessels, maximum anchor-pin spacing is 3 inches (75 mm) from insulation end joints, and 16 inches (400 mm) o.c. in both directions.
 - .2 Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
 - .3 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.
 - .4 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.
 - .5 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.
 - .6 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.
 - .7 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.
 - .8 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.

- .9 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.
- .10 Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.
- .3 Provide protective shielding guards on exposed piping serving barrier free sinks and lavatories.
- .4 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.
- .5 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 (50 mm) over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
 - .5 Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.
- .5 Calcium Silicate
 - .1 Insulation Installation on Boiler Breechings and Ducts:
 - .1 Secure single-layer insulation with stainless-steel bands at 12 inch (300 mm) intervals and tighten bands without deforming insulation material.
 - .2 Install 2-layer insulation with joints tightly butted and staggered at least 3 inches (75 mm). Secure inner layer with wire spaced at 12 inch (300 mm) intervals. Secure outer layer with stainless-steel bands at 12 inch (300 mm) intervals.
 - .3 On exposed applications without metal jacket, finish insulation surface with a skim coat of mineral-fiber, hydraulic-setting cement. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth. Overlap edges at least 1 inch (25 mm). Apply finish coat of lagging adhesive over glass cloth. Thin finish coat to achieve smooth, uniform finish.
 - .2 Insulation Installation on Straight Pipes and Tubes:
 - .1 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 (25 mm). Apply

- finish coat of lagging adhesive over glass cloth or tape. Thin finish coat to achieve smooth, uniform finish.
- .3 Insulation Installation on Pipe Flanges:
 - .1 Install preformed pipe insulation to outer diameter of pipe flange.
 - .2 Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 - .3 Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation.
 - .4 Finish flange insulation same as pipe insulation.
 - .4 Insulation Installation on Pipe Fittings and Elbows:
 - .1 Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
 - .2 When preformed insulation sections of insulation are not available, install mitered sections of calcium silicate insulation. Secure insulation materials with wire or bands.
 - .3 Finish fittings insulation same as pipe insulation.
 - .5 Insulation Installation on Valves and Pipe Specialties:
 - .1 Install mitered segments of calcium silicate insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 - .2 Install insulation to flanges as specified for flange insulation application.
 - .3 Finish valve and specialty insulation same as pipe insulation.
 - .6 Cellular Glass Insulation Installation
 - .1 Insulation Installation on Straight Pipes and Tubes:
 - .1 Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
 - .2 Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
 - .3 For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches (150 mm) o.c.
 - .4 For insulation with factory-applied jackets on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
 - .2 Insulation Installation on Pipe Flanges:
 - .1 Install preformed pipe insulation to outer diameter of pipe flange.
 - .2 Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 - .3 Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
 - .4 Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm) 1 inch (25 mm), and seal joints with flashing sealant.
 - .3 Insulation Installation on Pipe Fittings and Elbows:

- .1 Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
- .2 When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.
- .4 Insulation Installation on Valves and Pipe Specialties:
 - .1 Install preformed sections of cellular-glass insulation to valve body.
 - .2 Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 - .3 Install insulation to flanges as specified for flange insulation application.
- .7 Flexible Elastomeric Insulation Installation
 - .1 Seal longitudinal seams and end joints with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
 - .2 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 manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
 - .3 Insulation Installation on Pipe Fittings and Elbows:
 - .1 Install mitered sections of pipe insulation.
 - .2 Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
 - .4 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.
- .8 Mineral-Fiber Insulation Installation
 - .1 Insulation Installation on Straight Pipes and Tubes:
 - .1 Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
 - .2 Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
 - .3 For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches (150 mm) o.c.

- .4 For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
- .2 Insulation Installation on Pipe Flanges:
 - .1 Install preformed pipe insulation to outer diameter of pipe flange.
 - .2 Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 - .3 Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
 - .4 Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.
- .3 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.
- .4 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.
- .5 Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
 - .1 Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
 - .2 Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 - .3 Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - .1 On duct sides with dimensions 18 inches (450 mm) and smaller, place pins along longitudinal centerline of duct. Space 3 inches (75 mm) maximum from insulation end joints, and 16 inches (400 mm) o.c.
 - .2 On duct sides with dimensions larger than 18 inches (450 mm), place pins 16 inches (400 mm) o.c. each way, and 3 inches (75 mm) maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - .3 Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - .4 Do not overcompress insulation during installation.
 - .5 Impale insulation over pins and attach speed washers.

- .6 Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
- .4 For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2 inch (13 mm) outward-clinching staples, 1 inch (25 mm) o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - .1 Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - .2 Install vapor stops for ductwork and plenums operating below 50 deg F (10 deg C) at 18 foot (5.5 m) intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches (75 mm).
- .5 Overlap unfaced blankets a minimum of 2 inches (50 mm) on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches (450 mm) o.c.
- .6 Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
- .7 Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6 inch (150 mm) wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches (150 mm) o.c.
- .6 Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
 - .1 Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
 - .2 Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 - .3 Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - .1 On duct sides with dimensions 18 inches (450 mm) and smaller, place pins along longitudinal centerline of duct. Space 3 inches (75 mm) maximum from insulation end joints, and 16 inches (400 mm) o.c.
 - .2 On duct sides with dimensions larger than 18 inches (450 mm), space pins 16 inches (400 mm) o.c. each way, and 3 inches (75 mm) maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - .3 Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - .4 Do not overcompress insulation during installation.
 - .5 Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

- .4 For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2 inch (13 mm) outward-clinching staples, 1 inch (25 mm) o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - .1 Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - .2 Install vapor stops for ductwork and plenums operating below 50 deg F (10 deg C) at 18 foot (5.5 m) intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches (75 mm).
- .5 Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
- .6 Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6 inch (150 mm) wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches (150 mm) o.c.
- .9 External Acoustical Duct Lagging System Installation
 - .1 Board Insulation Installation for external ductwork lagging:
 - .1 Provide lagging system where indicated on drawings.
 - .2 For Mineral-Fiber Board lagging:
 - .1 Secure a single layer of 1 inch mineral-fiber board with minimum 4 lb/cu. ft (96 kg/cu. m) density with lagging adhesive. Provide reinforcement angles two feet on center. Mineral-fiber board shall extend edges up to seams and reinforcements.
 - .3 For Gypsum lagging for duct rumble:
 - .1 Secure a single layer of 5/8 inch fire-rated gypsum board with adhesive and sheet metal screws. Provide sheet metal screws with washer in head 18 inches on center. Provide reinforcement angles two feet on center. Gypsum shall extend edges up to seams and reinforcements.
 - .2 Secure dual layers of 5/8 inch fire-rated gypsum board with adhesive and sheet metal screws. Provide sheet metal screws with washer in head 18 inches on center. Provide reinforcement angles two feet on center. Overlap layers so joints are staggered. Seal joints with sealant. Gypsum shall extend edges up to seams and reinforcements.
 - .3 Secure dual layers of 5/8 inch fire-rated gypsum board with adhesive and sheet metal screws to metal stud framing. Provide 6 inches of air space around duct between the duct and metal framing to decouple the system. Overlap layers so joints are staggered. Seal joints with sealant. Gypsum shall extend edges up to seams and reinforcements.
- .10 Penolic Insulation Installation
 - .1 General Installation Requirements:
 - .1 Secure single-layer insulation with stainless-steel bands at 12 inch (300 mm) intervals and tighten bands without deforming insulation materials.

- .2 Install 2-layer insulation with joints tightly butted and staggered at least 3 inches (75 mm). Secure inner layer with 0.062 inch (1.6 mm) wire spaced at 12 inch (300 mm) intervals. Secure outer layer with stainless-steel bands at 12 inch (300 mm) intervals.
- .2 Insulation Installation on Straight Pipes and Tubes:
 - .1 Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
 - .2 Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
 - .3 For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches (150 mm) o.c.
 - .4 For insulation with factory-applied jackets with vapor retarders on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
- .3 Insulation Installation on Pipe Flanges:
 - .1 Install preformed pipe insulation to outer diameter of pipe flange.
 - .2 Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
 - .3 Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation.
 - .4 Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.
- .4 Insulation Installation on Valves and Pipe Specialties:
 - .1 Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.
 - .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.
- .11 Polyisocyanurate Insulation Installation
 - .1 Insulation Installation on Straight Pipes and Tubes:
 - .1 Secure each layer of insulation to pipe with tape or bands and tighten without deforming insulation materials. Orient longitudinal joints between half sections in 3 and 9 o'clock positions on the pipe.
 - .2 For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs but secure tabs with additional adhesive or tape as recommended by insulation material manufacturer and seal with vapor-barrier mastic.
 - .3 All insulation shall be tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.
 - .2 Insulation Installation on Pipe Flanges:
 - .1 Install preformed pipe insulation to outer diameter of pipe flange.
 - .2 Make width of insulation section same as overall width of flange and bolts, same thickness of adjacent pipe insulation, not to exceed 1-1/2 inch (38 mm) thickness.

- .3 Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of Polyisocyanurate block insulation of same thickness as pipe insulation.
- .3 Insulation Installation on Fittings and Elbows:
 - .1 Install preformed sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.
- .4 Insulation Installation on Valves and Pipe Specialties:
 - .1 Install preformed sections of Polyisocyanurate insulation to valve body.
 - .2 Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 - .3 Install insulation to flanges as specified for flange insulation application.
- .12 Polyolefin Insulation Installation
 - .1 Insulation Installation on Straight Pipes and Tubes:
 - .1 Seal split-tube longitudinal seams and end joints with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
 - .2 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 manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
 - .3 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.
 - .4 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.
- .13 Polystyrene Insulation Installation
 - .1 Insulation Installation on Straight Pipes and Tubes:
 - .1 Secure each layer of insulation with tape or bands and tighten bands without deforming insulation materials. Orient longitudinal joints between half sections in 3 and 9 o'clock positions on the pipe.
 - .2 For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs but secure tabs with additional adhesive or tape as recommended by insulation material manufacturer and seal with vapor-barrier

- mastic.
- .3 All insulation shall be tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.
- .2 Insulation Installation on Pipe Flanges:
 - .1 Install preformed pipe insulation to outer diameter of pipe flange.
 - .2 Make width of insulation section same as overall width of flange and bolts, same thickness of adjacent pipe insulation, not to exceed 1-1/2 inch (38 mm) thickness.
 - .3 Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polystyrene block insulation of same thickness as pipe insulation.
- .3 Insulation Installation on Pipe Fittings and Elbows:
 - .1 Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.
- .4 Insulation Installation on Valves and Pipe Specialties:
 - .1 Install preformed section of polystyrene 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.
- .14 Field-Applied Jacket Installation
 - .1 Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
 - .1 Draw jacket smooth and tight to surface with 2 inch (50 mm) overlap at seams and joints.
 - .2 Embed glass cloth between two 0.062 inch (1.6 mm) thick coats of lagging adhesive.
 - .3 Completely encapsulate insulation with coating, leaving no exposed insulation.
 - .2 Where FSK jackets are indicated, install as follows:
 - .1 Draw jacket material smooth and tight.
 - .2 Install lap or joint strips with same material as jacket.
 - .3 Secure jacket to insulation with manufacturer's recommended adhesive.
 - .4 Install jacket with 1-1/2 inch (38 mm) laps at longitudinal seams and 3 inch (75 mm) wide joint strips at end joints.
 - .5 Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
 - .3 Where PVC jackets are indicated, install with 1 inch (25 mm) overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturers recommended adhesive.
 - .1 Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
 - .4 Where metal jackets are indicated, install with 2 inch (50 mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches (300 mm) o.c. and at end joints.
 - .5 Where PVDC jackets are indicated, install as follows:

- .1 Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
 - .2 Wrap factory-presizes jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install presized jacket with an approximate overlap at butt joint of 2 inches (50 mm) over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.
 - .3 Continuous jacket can be spiral wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.
 - .4 Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches (850 mm) or less. The 33-1/2 inch (850 mm) circumference limit allows for 2 inch (50 mm) overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
 - .5 Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.
- .15 Fire-Rated Insulation System Installation
- .1 Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating. Install insulation system per manufacturer's recommendations, free of voids throughout the length of piping including fittings, valves, and specialties.
 - .2 Insulation system installation instructions and testing compliance information shall be maintained onsite for code official.
 - .3 Insulate duct access panels and doors to achieve same fire rating as duct.
 - .4 Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Division 07 Section 07 84 13 "Penetration Firestopping."
- .16 Finishes
- .1 Duct, Equipment, and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.
 - .1 Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - .1 Finish Coat Material: Interior, flat, latex-emulsion size.
 - .2 Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
 - .3 Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
 - .4 Do not field paint aluminum or stainless-steel jackets.

3.4 FIELD QUALITY CONTROL

- .1 Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- .2 Perform tests and inspections.
- .3 Tests and Inspections:

- .1 Inspect ductwork, 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 for each duct system defined in the "Duct Insulation Schedule, General" Article.
- .2 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 for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
- .3 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 threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.
- .4 All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

INSULATION SCHEDULE

4.1 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

- .1 Refer to "Duct Application Schedule" in the drawings.
- .2 Concealed, round and flat-oval, supply-air/return-air/outdoor-air duct insulation shall be one of the following:
 - .1 Flexible Elastomeric: 1 inch (25 mm) thick.
 - .2 Mineral-Fiber Blanket: 1-1/2 inches (38 mm) thick and 0.75 lb/cu. ft (12 kg/cu. m) nominal density.
 - .3 Mineral-Fiber Board: 1-1/2 inches (38 mm) thick and 2 lb/cu. ft (32 kg/cu. m) nominal density.
 - .4 Phenolic: 1 inch (25 mm) thick.
 - .5 Polyolefin: 1 inch (25 mm) thick.
- .3 Concealed, round and flat-oval, exhaust-air duct insulation shall be one of the following:
 - .1 Flexible Elastomeric: 1 inch (25 mm) thick.
 - .2 Mineral-Fiber Blanket: 1-1/2 inches (38 mm) thick and 0.75 lb/cu. ft (12 kg/cu. m) nominal density.
 - .3 Mineral-Fiber Board: 1-1/2 inches (38 mm) thick and 2 lb/cu. ft (32 kg/cu. m) nominal density.
 - .4 Phenolic: 1 inch (25 mm) thick.
 - .5 Polyolefin: 1 inch (25 mm) thick.
- .4 Concealed, rectangular, supply-air/return-air/outdoor-air duct insulation shall be one of the following:
 - .1 Flexible Elastomeric: 1 inch (25 mm) thick.
 - .2 Mineral-Fiber Blanket: 1-1/2 inches (38 mm) thick and 0.75 lb/cu. ft (12 kg/cu. m) nominal density.
 - .3 Mineral-Fiber Board: 1-1/2 inches (38 mm) thick and 2 lb/cu. ft (32 kg/cu. m) nominal density.
 - .4 Phenolic: 1 inch (25 mm) thick.
 - .5 Polyolefin: 1 inch (25 mm) thick.

- .5 Concealed, rectangular, exhaust-air duct insulation between isolation damper and penetration of building exterior shall be one of the following:
 - .1 Flexible Elastomeric: 1 inch (25 mm) thick.
 - .2 Mineral-Fiber Blanket: 1-1/2 inches (38 mm) thick and 0.75 lb/cu. ft (12 kg/cu. m) nominal density.
 - .3 Mineral-Fiber Board: 1-1/2 inches (38 mm) thick and 2 lb/cu. ft (32 kg/cu. m) nominal density.
 - .4 Phenolic: 1 inch (25 mm) thick.
 - .5 Polyolefin: 1 inch (25 mm) thick.
- .6 Concealed, supply-air/return-air/outdoor-air plenum insulation shall be one of the following:
 - .1 Flexible Elastomeric: 1 inch (25 mm) thick.
 - .2 Mineral-Fiber Blanket: 1-1/2 inches (38 mm) thick and 0.75 lb/cu. ft (12 kg/cu. m) nominal density.
 - .3 Mineral-Fiber Board: 1-1/2 inches (38 mm) thick and 2 lb/cu. ft (32 kg/cu. m) nominal density.
 - .4 Phenolic: 1 inch (25 mm) thick.
 - .5 Polyolefin: 1 inch (25 mm) thick.
- .7 Concealed, exhaust-air plenum insulation shall be one of the following:
 - .1 Mineral-Fiber Blanket: 1-1/2 inches (38 mm) thick and 0.75 lb/cu. ft (12 kg/cu. m) nominal density.
 - .2 Mineral-Fiber Board: 1-1/2 inches (38 mm) thick and 2 lb/cu. ft (32 kg/cu. m) nominal density.
 - .3 Phenolic: 1 inch (25 mm) thick.
- .8 Exposed, round and flat-oval, supply-air/return-air/outdoor-air duct insulation shall be one of the following:
 - .1 Flexible Elastomeric: 1 inch (25 mm) thick.
 - .2 Mineral-Fiber Blanket: 1-1/2 inches (38 mm) thick and 0.75 lb/cu. ft (12 kg/cu. m) nominal density.
 - .3 Mineral-Fiber Board: 1-1/2 inches (38 mm) thick and 2 lb/cu. ft (32 kg/cu. m) nominal density.
 - .4 Phenolic: 1 inch (25 mm) thick.
 - .5 Polyolefin: 1 inch (25 mm) thick.
- .9 Exposed, round and flat-oval, exhaust-air duct insulation shall be one of the following:
 - .1 Flexible Elastomeric: 1 inch (25 mm) thick.
 - .2 Mineral-Fiber Blanket: 1-1/2 inches (38 mm) thick and 0.75 lb/cu. ft (12 kg/cu. m) nominal density.
 - .3 Mineral-Fiber Board: 1-1/2 inches (38 mm) thick and 2 lb/cu. ft (32 kg/cu. m) nominal density.
 - .4 Phenolic: 1 inch (25 mm) thick.
 - .5 Polyolefin: 1 inch (25 mm) thick.
- .10 Exposed, rectangular, supply-air/return-air/outdoor-air duct insulation shall be one of the following:
 - .1 Flexible Elastomeric: 1 inch (25 mm) thick.
 - .2 Mineral-Fiber Blanket: 1-1/2 inches (38 mm) thick and 0.75 lb/cu. ft (12 kg/cu. m) density.

- .3 Mineral-Fiber Board: 1-1/2 inches (38 mm) thick and 2 lb/cu. ft (32 kg/cu. m) nominal density.
- .4 Phenolic: 1 inch (25 mm) thick.
- .5 Polyolefin: 1 inch (25 mm) thick.
- .11 Exposed, rectangular, exhaust-air duct insulation shall be one of the following:
 - .1 Flexible Elastomeric: 1 inch (25 mm) thick.
 - .2 Mineral-Fiber Blanket: 1-1/2 inches (38 mm) thick and 0.75 lb/cu. ft (12 kg/cu. m) nominal density.
 - .3 Mineral-Fiber Board: 1-1/2 inches (38 mm) thick and 2 lb/cu. ft (32 kg/cu. m) nominal density.
 - .4 Phenolic: 1 inch (25 mm) thick.
 - .5 Polyolefin: 1 inch (25 mm) thick.
- .12 Exposed, supply-air plenum insulation shall be one of the following:
 - .1 Flexible Elastomeric: 1 inch (25 mm) thick.
 - .2 Mineral-Fiber Blanket: 1-1/2 inches (38 mm) thick and 0.75 lb/cu. ft (12 kg/cu. m) nominal density.
 - .3 Mineral-Fiber Board: 1-1/2 inches (38 mm) thick and 2 lb/cu. ft (32 kg/cu. m) nominal density.
 - .4 Phenolic: 1 inch (25 mm) thick.
 - .5 Polyolefin: 1 inch (25 mm) thick.
- .13 Exposed, return-air plenum insulation shall be one of the following:
 - .1 Flexible Elastomeric: 1 inch (25 mm) thick.
 - .2 Mineral-Fiber Blanket: 1-1/2 inches (38 mm) thick and 0.75 lb/cu. ft (12 kg/cu. m) nominal density.
 - .3 Mineral-Fiber Board: 1-1/2 inches (38 mm) thick and 2 lb/cu. ft (32 kg/cu. m) nominal density.
 - .4 Phenolic: 1 inch (25 mm) thick.
 - .5 Polyolefin: 1 inch (25 mm) thick.
- .14 Exposed, outdoor-air plenum insulation shall be one of the following:
 - .1 Mineral-Fiber Blanket: 1-1/2 inches (38 mm) thick and 0.75 lb/cu. ft (12 kg/cu. m) nominal density.
 - .2 Mineral-Fiber Board: 1-1/2 inches (38 mm) thick and 2 lb/cu. ft (32 kg/cu. m) nominal density.
 - .3 Phenolic: 1 inch (25 mm) thick.
- .15 Exposed, exhaust-air plenum insulation shall be one of the following:
 - .1 Mineral-Fiber Blanket: 1-1/2 inches (38 mm) thick and 0.75 lb/cu. ft (12 kg/cu. m) nominal density.
 - .2 Mineral-Fiber Board: 1-1/2 inches (38 mm) thick and 2 lb/cu. ft (32 kg/cu. m) nominal density.
 - .3 Phenolic: 1 inch (25 mm) thick.

4.2 ABOVEGROUND, OUTDOOR DUCT AND PLENUM INSULATION SCHEDULE

- .1 Refer to "Duct Application Schedule" in the drawings.
- .2 Insulation materials and thicknesses are identified below. If more than one material is listed for a duct system, selection from materials listed is Contractor's option.

- .3 Concealed, round and flat-oval, supply-air/return-air/outdoor-air duct insulation shall be one of the following:
 - .1 Mineral-Fiber Blanket: 2 inches (50 mm) and 0.75 lb/cu. ft (12 kg/cu. m) nominal density.
 - .2 Mineral-Fiber Board: 2 inches (50 mm) thick and 2 lb/cu. ft (32 kg/cu. m) nominal density.
 - .3 Phenolic: 1-1/2 inches (38 mm) thick.
- .4 Concealed, rectangular, supply-air/return-air duct insulation shall be one of the following:
 - .1 Mineral-Fiber Blanket: 2 inches (50 mm) and 0.75 lb/cu. ft (12 kg/cu. m) nominal density.
 - .2 Mineral-Fiber Board: 2 inches (50 mm) thick and 2 lb/cu. ft (32 kg/cu. m) nominal density.
 - .3 Phenolic: 1-1/2 inches (38 mm) thick.
- .5 Concealed, supply-air/return-air plenum insulation shall be one of the following:
 - .1 Mineral-Fiber Blanket: 2 inches (50 mm) and 0.75 lb/cu. ft (12 kg/cu. m) nominal density.
 - .2 Mineral-Fiber Board: 2 inches (50 mm) thick and 2 lb/cu. ft (32 kg/cu. m) nominal density.
 - .3 Phenolic: 1-1/2 inches (38 mm) thick.
- .6 Exposed, round and flat-oval, supply-air/return-air duct insulation shall be one of the following:
 - .1 Mineral-Fiber Blanket: 2 inches (50 mm) and 0.75 lb/cu. ft (12 kg/cu. m) nominal density.
 - .2 Mineral-Fiber Board: 2 inches (50 mm) thick and 2 lb/cu. ft (32 kg/cu. m) nominal density.
 - .3 Phenolic: 1-1/2 inches (38 mm) thick.
- .7 Exposed, rectangular, supply-air/return-air duct insulation shall be one of the following:
 - .1 Mineral-Fiber Blanket: 2 inches (50 mm) and 0.75 lb/cu. ft (12 kg/cu. m) nominal density.
 - .2 Mineral-Fiber Board: 2 inches (50 mm) thick and 2 lb/cu. ft (32 kg/cu. m) nominal density.
 - .3 Phenolic: 1-1/2 inches (38 mm) thick.
- .8 Exposed, supply-air/return-air plenum insulation shall be one of the following:
 - .1 Mineral-Fiber Blanket: 2 inches (50 mm) and 0.75 lb/cu. ft (12 kg/cu. m) nominal density.
 - .2 Mineral-Fiber Board: 2 inches (50 mm) thick and 2 lb/cu. ft (32 kg/cu. m) nominal density.
 - .3 Phenolic: 1-1/2 inches (38 mm) thick.

4.3 EXTERNAL ACOUSTICAL DUCT LAGGING SCHEDULE

- .1 System for prevention of sound transmission through metal ductwork in noise sensitive areas.
 - .1 Mineral-Fiber Board: Single layer 1 inch (25 mm) thick and 6 lb/cu. ft (96 kg/cu. m) density.
 - .2 Gypsum Board: Two layers 1/2 inch (13 mm) thick.

4.4 EQUIPMENT INSULATION SCHEDULE

- .1 Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.
- .2 Insulate indoor and outdoor equipment in paragraphs below that is not factory insulated.
- .3 Heat-exchanger (water-to-water for cooling service) insulation shall be one of the following:
 - .1 Cellular Glass: 2 inches (50 mm) thick.
 - .2 Flexible Elastomeric: 1 inch (25 mm) thick.
 - .3 Mineral-Fiber Board: 1 inch (25 mm) thick and 2 lb/cu. ft (32 kg/cu. m) nominal density.
 - .4 Mineral-Fiber Pipe and Tank: 1 inch (25 mm) thick.
 - .5 Phenolic: 1 inch (25 mm) thick.
 - .6 Polyisocyanurate: 1 inch (25 mm) thick.
 - .7 Polyolefin: 1 inch (25 mm) thick.
- .4 Chilled-water expansion/compression tank insulation shall be one of the following:
 - .1 Cellular Glass: 1-1/2 inches (38 mm) thick.
 - .2 Flexible Elastomeric: 1 inch (25 mm) thick.
 - .3 Mineral-Fiber Board: 1 inch (25 mm) thick and 2 lb/cu. ft (32 kg/cu. m) nominal density.
 - .4 Mineral-Fiber Pipe and Tank: 1 inch (25 mm) thick.
 - .5 Phenolic: 1 inch (25 mm) thick.
 - .6 Polyisocyanurate: 1 inch (25 mm) thick.
 - .7 Polyolefin: 1 inch (25 mm) thick.
- .5 Condenser-water expansion/compression tank insulation shall be one of the following:
 - .1 Cellular Glass: 1-1/2 inches (38 mm) thick.
 - .2 Flexible Elastomeric: 1 inch (25 mm) thick.
 - .3 Mineral-Fiber Board: 1 inch (25 mm) thick and 2 lb/cu. ft (32 kg/cu. m) nominal density.
 - .4 Mineral-Fiber Pipe and Tank: 1 inch (25 mm) thick.
 - .5 Phenolic: 1 inch (25 mm) thick.
 - .6 Polyisocyanurate: 1 inch (25 mm) thick.
 - .7 Polyolefin: 1 inch (25 mm) thick.
- .6 Heating-hot-water expansion/compression tank insulation shall be one of the following:
 - .1 Calcium Silicate: 2 inches (50 mm) thick.
 - .2 Cellular Glass: 1-1/2 inches (38 mm) thick.
 - .3 Mineral-Fiber Board: 1 inch (25 mm) thick and 2 lb/cu. ft (32 kg/cu. m) nominal density.
 - .4 Mineral-Fiber Pipe and Tank: 1 inch (25 mm) thick.
- .7 Heat-recovery expansion/compression tank insulation shall be one of the following:
 - .1 Cellular Glass: 1-1/2 inches (38 mm) thick.
 - .2 Flexible Elastomeric: 1 inch (25 mm) thick.
 - .3 Mineral-Fiber Board: 1 inch (25 mm) thick and 2 lb/cu. ft (32 kg/cu. m) nominal density.
 - .4 Mineral-Fiber Pipe and Tank: 1 inch (25 mm) thick.
 - .5 Phenolic: 1 inch (25 mm) thick.
 - .6 Polyisocyanurate: 1 inch (25 mm) thick.

- .7 Polyolefin: 1 inch (25 mm) thick.
- .8 Chilled-water air-separator insulation shall be one of the following:
 - .1 Cellular Glass: 2 inches (50 mm) thick.
 - .2 Flexible Elastomeric: 1 inch (25 mm) thick.
 - .3 Mineral-Fiber Board: 1 inch (25 mm) thick and 2 lb/cu. ft (32 kg/cu. m) nominal density.
 - .4 Mineral-Fiber Pipe and Tank: 1 inch (25 mm) thick.
 - .5 Phenolic: 1 inch (25 mm) thick.
 - .6 Polyisocyanurate: 1 inch (25 mm) thick.
 - .7 Polyolefin: 1 inch (25 mm) thick.
- .9 Condenser-water air-separator insulation shall be one of the following:
 - .1 Cellular Glass: 2 inches (50 mm) thick.
 - .2 Flexible Elastomeric: 1 inch (25 mm) thick.
 - .3 Mineral-Fiber Board: 1 inch (25 mm) thick and 2 lb/cu. ft (32 kg/cu. m) nominal density.
 - .4 Mineral-Fiber Pipe and Tank: 1 inch (25 mm) thick.
 - .5 Phenolic: 1 inch (25 mm) thick.
 - .6 Polyisocyanurate: 1 inch (25 mm) thick.
 - .7 Polyolefin: 1 inch (25 mm) thick.
- .10 Heating-hot-water air-separator insulation shall be one of the following:
 - .1 Calcium Silicate: 3 inches (75 mm) thick.
 - .2 Cellular Glass: 3 inches (75 mm) thick.
 - .3 Mineral-Fiber Board: 2 inches (50 mm) thick and 2 lb/cu. ft (32 kg/cu. m) nominal density.
 - .4 Mineral-Fiber Pipe and Tank: 2 inches (50 mm) thick.

4.5 PIPING INSULATION SCHEDULE, GENERAL

- .1 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.
- .2 Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 - .1 Drainage piping located in crawl spaces.
 - .2 Underground piping.
 - .3 Chrome-plated pipes and fittings unless there is a potential for personnel injury.

4.6 INDOOR PIPING INSULATION SCHEDULE

- .1 Refer to "Piping Application Schedule" and "Plumbing Application Schedule" in the drawings.
- .2 Domestic Cold Water and Non Potable Cold Water:
 - .1 NPS 1 (DN 25) and Smaller: Insulation shall be one of the following:
 - .1 Cellular Glass: 1-1/2 inches (38 mm) thick.
 - .2 Flexible Elastomeric: 1/2 inch (13 mm) thick.
 - .3 Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch (13 mm) thick.
 - .4 Phenolic: 1 inch (25 mm) thick.
 - .5 Polyolefin: 1/2 inch (13 mm) thick.
 - .2 NPS 1-1/4 (DN 32) and Larger: Insulation shall be one of the following:

- .1 Cellular Glass: 1-1/2 inches (38 mm) thick.
 - .2 Flexible Elastomeric: 1 inch (25 mm) thick.
 - .3 Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.
 - .4 Phenolic: 1 inch (25 mm) thick.
 - .5 Polyolefin: 1 inch (25 mm) thick.
- .3 Domestic Hot and Recirculated Hot Water:
- .1 NPS 1-1/4 (DN 32) and Smaller: Insulation shall be one of the following:
 - .1 Cellular Glass: 1-1/2 inches (38 mm) thick.
 - .2 Flexible Elastomeric: 3/4 inch (19 mm) thick.
 - .3 Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch (13 mm) thick.
 - .4 Phenolic: 1 inch (25 mm) thick.
 - .5 Polyolefin: 3/4 inch (19 mm) thick.
 - .2 NPS 1-1/2 (DN 40) and Larger: Insulation shall be one of the following:
 - .1 Cellular Glass: 1-1/2 inches (38 mm) thick.
 - .2 Flexible Elastomeric: 1 inch (25 mm) thick.
 - .3 Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.
 - .4 Phenolic: 1 inch (25 mm) thick.
 - .5 Polyolefin: 1 inch (25 mm) thick.
- .4 Stormwater and Overflow:
- .1 All Pipe Sizes: Insulation shall be one of the following:
 - .1 Cellular Glass: 1-1/2 inches (38 mm) thick.
 - .2 Flexible Elastomeric: 1 inch (25 mm) thick.
 - .3 Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.
 - .4 Phenolic: 1 inch (25 mm) thick.
 - .5 Polyolefin: 1 inch (25 mm) thick.
- .5 Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:
- .1 All Pipe Sizes: Insulation shall be one of the following:
 - .1 Flexible Elastomeric: 1/2 inch (13 mm) thick.
 - .2 Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch (13 mm) thick.
 - .3 Polyolefin: 1/2 inch (13 mm) thick.
- .6 Sanitary Waste Piping Where Heat Tracing Is Installed:
- .1 All Pipe Sizes: Insulation shall be one of the following:
 - .1 Cellular Glass: 2 inches (50 mm) thick.
 - .2 Mineral-Fiber, Preformed Pipe Insulation, Type I: 1-1/2 inches (38 mm) thick.
 - .3 Phenolic: 1-1/2 inches (38 mm) thick.
- .7 Floor Drains, Traps, and Sanitary Drain Piping within 10 feet (3 m) of Drain Receiving Condensate and Equipment Drain Water below 60 deg F (16 deg C):
- .1 All Pipe Sizes: Insulation shall be one of the following:
 - .1 Cellular Glass: 1-1/2 inches (38 mm) thick.
 - .2 Flexible Elastomeric: 3/4 inch (19 mm) thick.
 - .3 Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch (13 mm) thick.
 - .4 Phenolic: 1 inch (25 mm) thick.

- .5 Polyolefin: 3/4 inch (19 mm) thick.
- .8 Chilled Water, 40 deg F (5 deg C) and below:
 - .1 NPS 6 (DN 150) and Smaller: Insulation shall be one of the following:
 - .1 Cellular Glass: 1-1/2 inches (38 mm) thick.
 - .2 Mineral-Fiber, Preformed Pipe, Type I or Pipe Insulation Wicking System: 1 inch (25 mm) thick.
 - .3 Phenolic: 1 inch (25 mm) thick.
 - .4 Polyisocyanurate: 1 inch (25 mm) thick.
 - .2 NPS 8 (DN 200) and Larger: Insulation shall be one of the following:
 - .1 Cellular Glass: 1-1/2 inches (38 mm) thick.
 - .2 Mineral-Fiber, Preformed Pipe, Type I or Pipe Insulation Wicking System: 1-1/2 inches (38 mm) thick.
 - .3 Phenolic: 1-1/2 inches (38 mm) thick.
 - .4 Polyisocyanurate: 1 inch (25 mm) thick.
- .9 Chilled Water, above 40 deg F (5 deg C):
 - .1 NPS 12 (DN 300) and Smaller: Insulation shall be one of the following:
 - .1 Cellular Glass: 1-1/2 inches (38 mm) thick.
 - .2 Flexible Elastomeric: 1 inch (25 mm) thick.
 - .3 Mineral-Fiber, Preformed Pipe, Type I or Pipe Insulation Wicking System: 1 inch (25 mm) thick.
 - .4 Phenolic: 1 inch (25 mm) thick.
 - .5 Polyisocyanurate: 1 inch (25 mm) thick.
 - .6 Polyolefin: 1 inch (25 mm) thick.
 - .2 NPS 14 (DN 350) and Larger: Insulation shall be one of the following:
 - .1 Cellular Glass: 2 inches (50 mm) thick.
 - .2 Mineral-Fiber Preformed Pipe, Type I or Pipe Insulation Wicking System: 1-1/2 inches (38 mm) thick.
 - .3 Phenolic: 1-1/2 inches (38 mm) thick.
 - .4 Polyisocyanurate: 1-1/2 inches (38 mm) thick.
- .10 Condenser-Water Supply and Return:
 - .1 NPS 12 (DN 300) and Smaller: Insulation shall be one of the following:
 - .1 Cellular Glass: 1-1/2 inches (38 mm) thick.
 - .2 Flexible Elastomeric: 1 inch (25 mm) thick.
 - .3 Mineral-Fiber, Preformed Pipe, Type I: 1 inch (25 mm) thick.
 - .4 Phenolic: 1 inch (25 mm) thick.
 - .5 Polyisocyanurate: 1 inch (25 mm) thick.
 - .6 Polyolefin: 1 inch (25 mm) thick.
 - .2 NPS 14 (DN 350) and Larger: Insulation shall be one of the following:
 - .1 Cellular Glass: 2 inches (50 mm) thick.
 - .2 Mineral-Fiber, Preformed Pipe, Type I: 1-1/2 inches (38 mm) thick.
 - .3 Phenolic: 1-1/2 inches (38 mm) thick.
 - .4 Polyisocyanurate: 1-1/2 inches (38 mm) thick.
- .11 Heating-Hot-Water Supply and Return, 200 deg F (93 deg C) and below:
 - .1 NPS 12 (DN 300) and Smaller: Insulation shall be one of the following:

- .1 Cellular Glass: 1-1/2 inches (38 mm) thick.
 - .2 Mineral-Fiber, Preformed Pipe, Type I: 1 inch (25 mm) thick.
 - .3 Phenolic: 1 inch (25 mm) thick.
 - .4 Polyisocyanurate: 1 inch (25 mm) thick.
- .2 NPS 14 (DN 350) and Larger: Insulation shall be one of the following:
 - .1 Cellular Glass: 2 inches (50 mm) thick.
 - .2 Mineral-Fiber, Preformed Pipe, Type I: 1-1/2 inches (38 mm) thick.
 - .3 Phenolic: 1-1/2 inches (38 mm) thick.
 - .4 Polyisocyanurate: 1-1/2 inches (38 mm) thick.
- .12 Heating-Hot-Water Supply and Return, above 200 deg F (93 deg C):
 - .1 NPS 3/4 (DN 20) and Smaller: Insulation shall be one of the following:
 - .1 Calcium Silicate: 2 inches (50 mm) thick.
 - .2 Cellular Glass: 2 inches (50 mm) thick.
 - .3 Mineral-Fiber, Preformed Pipe, Type I or II: 1-1/2 inches (38 mm) thick.
 - .2 NPS 1 (DN 25) and Larger: Insulation shall be one of the following:
 - .1 Calcium Silicate: 3 inches (75 mm) thick.
 - .2 Cellular Glass: 3 inches (75 mm) thick.
 - .3 Mineral-Fiber, Preformed Pipe, Type I or II: 3 inches (75 mm) thick.
- .13 Hot Service Drains:
 - .1 All Pipe Sizes: Insulation shall be one of the following:
 - .1 Calcium Silicate: 1-1/2 inches (38 mm) thick.
 - .2 Cellular Glass: 1-1/2 inches (38 mm) thick.
 - .3 Mineral-Fiber, Preformed Pipe, Type I or II: 1 inch (25 mm) thick.
- .14 Hot Service Vents:
 - .1 All Pipe Sizes: Insulation shall be one of the following:
 - .1 Calcium Silicate: 1-1/2 inches (38 mm) thick.
 - .2 Cellular Glass: 1-1/2 inches (38 mm) thick.
 - .3 Mineral-Fiber, Preformed Pipe, Type I or II: 1 inch (25 mm) thick.

4.7 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

- .1 Refer to "Piping Application Schedule" and "Plumbing Application Schedule" in the drawings.
- .2 Sanitary Waste Piping Where Heat Tracing Is Installed:
 - .1 All Pipe Sizes: Insulation shall be one of the following:
 - .1 Cellular Glass: 2 inches (50 mm) thick.
 - .2 Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches (50 mm) thick.
 - .3 Phenolic: 2 inches (50 mm) thick.
- .3 Chilled Water:
 - .1 All Pipe Sizes: Insulation shall be one of the following:
 - .1 Cellular Glass: 3 inches (75 mm) thick.
 - .2 Flexible Elastomeric: 3 inches (75 mm) thick.
 - .3 Mineral-Fiber, Preformed Pipe Insulation, Type I: 3 inches (75 mm) thick.
 - .4 Phenolic: 2 inches (50 mm) thick.
 - .5 Polyisocyanurate: 2 inches (50 mm) thick.
 - .6 Polyolefin: 3 inches (75 mm) thick.

- .7 Polystyrene: 2 inches (50 mm) thick.
- .4 Condenser-Water Supply and Return:
 - .1 All Pipe Sizes: Insulation shall be one of the following:
 - .1 Cellular Glass: 2 inches (50 mm) thick.
 - .2 Flexible Elastomeric: 2 inches (50 mm) thick.
 - .3 Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches (50 mm) thick.
 - .4 Phenolic: 2 inches (50 mm) thick.
 - .5 Polyisocyanurate: 2 inches (50 mm) thick.
 - .6 Polyolefin: 2 inches (50 mm) thick.
 - .7 Polystyrene: 2 inches (50 mm) thick.
- .5 Hot Service Drains:
 - .1 All Pipe Sizes: Insulation shall be one of the following:
 - .1 Calcium Silicate: 1-1/2 inches (38 mm) thick.
 - .2 Cellular Glass: 1-1/2 inches (38 mm) thick.
 - .3 Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.
- .6 Hot Service Vents:
 - .1 All Pipe Sizes: Insulation shall be one of the following:
 - .1 Calcium Silicate: 1-1/2 inches (38 mm) thick.
 - .2 Cellular Glass: 1-1/2 inches (38 mm) thick.
 - .3 Mineral-Fiber, Preformed Pipe Insulation, Type II: 1 inch (25 mm) thick.

4.8 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- .1 Refer to "Duct Application Schedule", "Piping Application Schedule" and "Plumbing Application Schedule" in the drawings.
- .2 Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- .3 If more than one material is listed, selection from materials listed is Contractor's option.
- .4 Ducts and Plenums, Concealed:
 - .1 None.
 - .2 PVC: 20 mils (0.5 mm) thick.
 - .3 Aluminum, Smooth: 0.016 inch (0.41 mm) thick.
 - .4 Painted Aluminum, Smooth: 0.016 inch (0.41 mm) thick.
 - .5 Stainless Steel, Type 304 or 316, Smooth 2B Finish: 0.010 inch (0.25 mm) thick.
- .5 Ducts and Plenums, Exposed:
 - .1 None.
 - .2 PVC: 20 mils (0.5 mm) thick.
 - .3 Aluminum, Smooth: 0.016 inch (0.41 mm) thick.
 - .4 Painted Aluminum, Smooth: 0.016 inch (0.41 mm) thick.
 - .5 Stainless Steel, Type 304 or 316, Smooth 2B Finish: 0.010 inch (0.25 mm) thick.
- .6 Equipment, Concealed:
 - .1 None.
 - .2 PVC: 20 mils (0.5 mm) thick.
 - .3 Aluminum, Smooth: 0.016 inch (0.41 mm) thick.
 - .4 Painted Aluminum, Smooth: 0.016 inch (0.41 mm) thick.

- .5 Stainless Steel, Type 304 or 316, Smooth 2B Finish: 0.010 inch (0.25 mm) thick.
- .7 Equipment, Exposed, up to 48 inches (1200 mm) in Diameter or with Flat Surfaces up to 72 inches (1800 mm):
 - .1 None.
 - .2 PVC: 20 mils (0.5 mm) thick.
 - .3 Aluminum, Smooth: 0.016 inch (0.41 mm) thick.
 - .4 Painted Aluminum, Smooth: 0.016 inch (0.41 mm) thick.
 - .5 Stainless Steel, Type 304 or 316, Smooth 2B Finish: 0.010 inch (0.25 mm) thick.
- .8 Equipment, Exposed, Larger Than 48 inches (1200 mm) in Diameter or with Flat Surfaces Larger Than 72 inches (1800 mm):
 - .1 None.
 - .2 Painted Aluminum, Smooth with 1-1/4 inch (32 mm) Deep Corrugations: 0.032 inch (0.81 mm) thick.
 - .3 Stainless Steel, Type 304 or 316, Smooth, with 1-1/4 inch (32 mm) Deep Corrugations: 0.020 inch (0.51 mm) thick.
- .9 Piping, Concealed:
 - .1 None.
 - .2 PVC: 20 mils (0.5 mm) thick.
 - .3 Aluminum, Smooth: 0.016 inch (0.41 mm) thick.
 - .4 Painted Aluminum, Smooth: 0.016 inch (0.41 mm) thick.
 - .5 Stainless Steel, Type 304 or 316, Smooth 2B Finish: 0.010 inch (0.25 mm) thick.
- .10 Piping, Exposed:
 - .1 None.
 - .2 PVC: 20 mils (0.5 mm) thick.
 - .3 Aluminum, Smooth: 0.016 inch (0.41 mm) thick.
 - .4 Painted Aluminum, Smooth: 0.016 inch (0.41 mm) thick.
 - .5 Stainless Steel, Type 304 or 316, Smooth 2B Finish: 0.010 inch (0.25 mm) thick.

4.9 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

- .1 Refer to "Duct Application Schedule", "Piping Application Schedule" and "Plumbing Application Schedule" in the drawings.
- .2 Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- .3 If more than one material is listed, selection from materials listed is Contractor's option.
- .4 Ducts and Plenums, Concealed:
 - .1 None.
 - .2 PVC: 20 mils (0.5 mm) thick.
 - .3 Aluminum, Smooth: 0.016 inch (0.41 mm) thick.
 - .4 Painted Aluminum, Smooth: 0.016 inch (0.41 mm) thick.
 - .5 Stainless Steel, Type 304 or 316, Smooth 2B Finish: 0.010 inch (0.25 mm) thick.
- .5 Ducts and Plenums, Exposed, up to 48 inches (1200 mm) in Diameter or with Flat Surfaces up to 72 inches (1800 mm):
 - .1 Aluminum, Smooth: 0.016 inch (0.41 mm) thick.
 - .2 Painted Aluminum, Smooth: 0.016 inch (0.41 mm) thick.
 - .3 Stainless Steel, Type 304 or 316, Smooth 2B Finish: 0.010 inch (0.25 mm) thick.

- .6 Ducts and Plenums, Exposed, Larger Than 48 inches (1200 mm) in Diameter or with Flat Surfaces Larger Than 72 inches (1800 mm):
 - .1 Painted Aluminum, Smooth with 1-1/4 inch (32 mm) Deep Corrugations: 0.032 inch (0.81 mm) thick.
 - .2 Stainless Steel, Type 304 or 316, Smooth, with 1-1/4 inch (32 mm) Deep Corrugations: 0.020 inch (0.51 mm) thick.
- .7 Equipment, Concealed:
 - .1 None.
 - .2 PVC: 20 mils (0.5 mm) thick.
 - .3 Aluminum, Smooth: 0.016 inch (0.41 mm) thick.
 - .4 Painted Aluminum, Smooth: 0.016 inch (0.41 mm) thick.
 - .5 Stainless Steel, Type 304 or 316, Smooth 2B Finish: 0.010 inch (0.25 mm) thick.
- .8 Equipment, Exposed, up to 48 inches (1200 mm) in Diameter or with Flat Surfaces up to 72 inches (1800 mm):
 - .1 Painted Aluminum, Smooth: 0.016 inch (0.41 mm) thick.
 - .2 Stainless Steel, Type 304 or 316, Smooth 2B Finish: 0.010 inch (0.25 mm) thick.
- .9 Equipment, Exposed, Larger Than 48 inches (1200 mm) in Diameter or with Flat Surfaces Larger Than 72 inches (1800 mm):
 - .1 Painted Aluminum, Smooth with 1-1/4 inch (32 mm) Deep Corrugations: 0.032 inch (0.81 mm) thick.
 - .2 Stainless Steel, Type 304 or 316, Smooth, with 1-1/4 inch (32 mm) Deep Corrugations: 0.020 inch (0.51 mm) thick.
- .10 Piping, Concealed:
 - .1 None.
 - .2 PVC: 20 mils (0.5 mm) thick.
 - .3 Aluminum, Smooth: 0.016 inch (0.41 mm) thick.
 - .4 Painted Aluminum, Smooth: 0.016 inch (0.41 mm) thick.
 - .5 Stainless Steel, Type 304 or 316, Smooth 2B Finish: 0.010 inch (0.25 mm) thick.
- .11 Piping, Exposed:
 - .1 PVC: 20 mils (0.5 mm) thick.
 - .2 Painted Aluminum, Smooth: 0.016 inch (0.41 mm) thick.
 - .3 Stainless Steel, Type 304 or 316, Smooth 2B Finish: 0.010 inch (0.25 mm) thick.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- .1 Hangers and supports.
- .2 General Duty Valves for Water-Based Fire-Protection Systems.
- .3 Backflow Prevention Assemblies.
- .4 Identification for fire-protection piping and equipment.

1.2 GENERAL REFERENCES

- .1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.
- .2 Division 20, including all Common Mechanical Requirements in Section 20 00 00, apply to this Section. Requirements noted in this section are supplemental to the requirements of these General References.

1.3 RELATED REQUIREMENTS

- .1 Contract Documents: Refer to complete set of Contract Documents for requirements that are related to or may affect the work described in this Section.
- .2 Section 20 05 00 "Common Mechanical Work Results" for sleeves, stack-sleeve fittings, sleeve-seal systems, escutcheons, floor plates, grout, and silicone sealants.
- .3 Section 20 05 13 "Common Mechanical Motor Requirements" for general motor requirements, motor characteristics, polyphase motors (1/2 HP and larger), polyphase motors with additional requirements, and single-phase motors (less than 1/2 HP).
- .4 Section 20 05 33 "Heat Tracing" for heat tracing used on fire protection piping.
- .5 Section 20 05 48 "Vibration and Seismic Controls".
- .6 Section 20 07 00 "Mechanical Insulation" for insulation used on fire protection piping and equipment.
- .7 Section 20 08 00 "Mechanical Commissioning" for fire protection system and equipment commissioning requirements.

1.4 ABBREVIATIONS AND ACRONYMS

- .1 EPDM: Ethylene propylene diene monomer.
- .2 FM: Factory Mutual Global.
- .3 GPM: Gallons (U.S.) per minute.
- .4 NFPA: National Fire Protection Association.
- .5 NPS: Nominal pipe size.
- .6 NRS: Non-rising stem.
- .7 OS&Y: Outside screw and yoke.
- .8 PSIG: Pounds per square inch gauge.
- .9 SBR: Styrene-butadiene rubber.
- .10 UL: Underwriter's Laboratories.

1.5 DEFINITIONS

- .1 Standard-Pressure Valves: Valves designed and listed to operate at a working pressure of 175 psi maximum.
- .2 High-Pressure Valves: Valves designed and listed to operate at a working pressure higher than standard 175 psig (1200 kPa), but not higher than 300 psig as required by maximum

local system pressure where installed.

1.6 PERFORMANCE REQUIREMENTS

- .1 Hangers and Supports:
 - .1 Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design seismic bracing, trapeze pipe hangers and equipment supports, including comprehensive engineering analysis.
 - .2 Structural Performance: Hangers and supports for fire-suppression piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
 - .1 Design supports for multiple pipes, including pipe stands, capable of supporting 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.
 - .3 Design seismic-restraint hangers and supports for piping and equipment meeting requirements of NFPA 13 and ASCE/SEI 7. Obtain approval from authorities having jurisdiction.
 - .3 NFPA Compliance: Comply with NFPA 13.
 - .4 UL Compliance: Comply with UL 203.
- .2 General Duty Valves for Water-Based Fire Protection Systems:
 - .1 UL Listed: Valves shall be listed in UL's "Online Certifications Directory" under the headings listed below and shall bear UL mark.
 - .1 Fire Main Equipment: HAMV - Main Level
 - .1 Indicator Posts, Gate Valve: HCBZ - Level 1
 - .2 Ball Valves, System Control: HLUG - Level 3
 - .3 Butterfly Valves: HLXS - Level 3
 - .4 Check Valves: HMER - Level 3
 - .5 Gate Valves: HMRZ - Level 3
 - .2 Sprinkler System & Water Spray System Devices: VDGT – Main Level
 - .1 Valves, Trim and Drain: VQGU – Level 1
 - .2 FM Global Approved: Valves shall be listed in its "Approval Guide," under the headings listed below:
 - .1 Automated Sprinkler Systems:
 - .1 Indicator posts.
 - .2 Valves.
 - .1 Gate valves.
 - .2 Check valves.
 - .3 Miscellaneous valves.
 - .3 ASME Compliance:
 - .1 ASME B16.1 for flanges on iron valves.
 - .2 ASME B1.20.1 for threads for threaded-end valves.
 - .3 ASME B31.9 for building services piping valves.
 - .4 AWWA Compliance: Comply with AWWA C606 for grooved-end connections.
 - .5 NFPA Compliance for valves:
 - .1 Comply with NFPA 13, NFPA 14, NFPA 20 and NFPA 24.

- .6 Valve Pressure Ratings: Not less than the minimum pressure rating as required by the maximum system pressure at location of valve.
- .7 Valve Sizes: Same as upstream piping unless otherwise indicated.
- .8 Valve Actuator Types:
 - .1 Worm-gear actuator with handwheel for quarter-turn valves, except for trim and drain valves.
 - .2 Handwheel: For other than quarter-turn trim and drain valves.
 - .3 Hand lever: For quarter-turn trim and drain valves NPS 2 (DN 50) and smaller.

1.7 SUBMITTALS

- .1 Action Submittals
 - .1 Product Data:
 - .1 For each type of product, excluding motors which are included in Part 1 of the fire-protection equipment Sections.
 - .1 Include construction details, material descriptions, and dimensions of components.
 - .2 Include operating characteristics and furnished accessories.
 - .2 Shop Drawings: Signed and sealed by a qualified professional engineer. All hanger types and locations shall be indicated on the shop drawings. Provide Product Data for components and show fabrication and installation details and include calculations for the following:
 - .1 Trapeze pipe hangers.
 - .2 Metal framing systems.
 - .3 Pipe stands.
 - .4 Equipment supports.
 - .5 Seismic supports.
 - .3 Delegated-Design Submittal: For trapeze hangers and seismic bracing required to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - .1 Detail fabrication and assembly of trapeze hangers.
 - .2 Include design calculations for designing trapeze hangers.
 - .4 Equipment-Label Schedule: Include a listing of all equipment to be labeled and the proposed content for each label.
 - .5 Valve numbering scheme.
 - .6 Valve Schedules: Provide for fire-suppression piping systems. Include in operation and maintenance manuals.
- .2 Informational Submittals
 - .1 Field quality-control reports.
 - .2 Welding certificates.
- .3 Closeout Submittals
 - .1 Furnish copy of latest edition of NFPA 25 "Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems."
 - .2 After completing a fire-protection system installation, the Contractor shall submit to the authority having jurisdiction a written certification that the system has been installed in accordance with the approved plans and tested in accordance with NFPA 13 and manufacturer's recommendations.

- .4 Operation and Maintenance Materials
 - .1 Include manufacturer's descriptive literature, operating instructions, cleaning procedures, replacement parts list, maintenance and repair data.
- .5 Record Documents
 - .1 Record As-built drawings.
 - .2 Record digital files.
 - .1 Digital layout models.
 - .2 Product data.
 - .3 Final submittals with responses.

1.8 QUALITY ASSURANCE

- .1 Installer Qualifications: Utilize an installer having demonstrated experience on projects of similar size and complexity and possessing documentation proving successful completion of fire protection systems training.
- .2 Codes and NFPA Standards: Materials, equipment and installation of hangers and supports for fire protection piping shall comply with NFPA 13, local building codes and the requirements of all Authorities Having Jurisdiction.
- .3 Hangers and supports for fire protection piping shall be listed and labeled by Underwriters Laboratories and approved by FM Global.
- .4 Steel pipe hangers and supports shall have the manufacturer's name, part number, and applicable size stamped in the part itself for identification.
- .5 Hangers and supports shall be designed and manufactured in conformance with MSS SP-58.
- .6 Certifications: Provide letters of certification as follows.
 - .1 Installer will utilize skilled workers holding a trade qualification license or equivalent, or apprentices under the supervision of a licensed tradesperson.
- .7 Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M.
- .8 Pipe Welding Qualifications: Qualify procedures and operators according to 2015 ASME Boiler and Pressure Vessel Code, Section IX.

1.9 MOCK-UPS AND SAMPLES

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

1.10 DELIVERY, STORAGE, AND HANDLING

- .1 Prepare valves for shipping as follows:
 - .1 Protect internal parts against rust and corrosion.
 - .2 Protect threads, flange faces, and weld ends.
 - .3 Set valves open to minimize exposure of functional surfaces.
- .2 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.
- .3 Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.
- .4 Protect flanges and specialties from moisture and dirt.

PART 2 PRODUCTS

2.1 HANGERS AND SUPPORTS

- .1 Metal Pipe Hangers and Supports:
 - .1 Manufacturers:
 - .1 Anvil International.
 - .2 Cooper B-Line.
 - .3 Erico.
 - .4 Hilti.
 - .5 Tolco.
 - .2 Carbon-Steel Pipe Hangers and Supports:
 - .1 Description: Factory-fabricated components, NFPA approved, UL listed and FM approved for fire-suppression piping support.
 - .2 Galvanized Metallic Coatings: Pre-galvanized or hot-dip galvanized.
 - .3 Hanger Rods: Continuous-thread rod, nuts, and washer made of electro-galvanized carbon steel.
 - .3 Stainless-Steel Pipe Hangers and Supports:
 - .1 Description: Factory-fabricated components, NFPA approved, UL listed or FM approved for fire-suppression piping support.
 - .2 Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.
 - .4 Copper Pipe Hangers:
 - .1 Description: Copper-coated steel, factory-fabricated components, NFPA approved, UL listed or FM approved for fire-suppression piping support.
 - .2 Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.
- .2 Trapeze Pipe Hangers:
 - .1 Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with NFPA approved, UL listed and FM approved electro-galvanized carbon-steel hanger rods, nuts, saddles, and U-bolts
- .3 Metal Framing Systems:
 - .1 MFMA Manufacturer Metal Framing Systems:
 - .1 Manufacturers:
 - .1 B-line, an Eaton business.
 - .2 Flex-Strut Inc.
 - .3 Unistrut; Part of Atkore International.
 - .2 Description: Shop- or field-fabricated pipe-support assembly, made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
 - .3 Standard: Comply with MFMA-4, factory-fabricated components for field assembly.
 - .4 Channels: Continuous slotted carbon-steel channel with in-turned lips.
 - .5 Channel Width: Selected for applicable load criteria.
 - .6 Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.

- .7 Hanger Rods: Continuous-thread rod, nuts, and washer made of electro-galvanized carbon steel.
 - .8 Metallic Coating: Pre-galvanized G90.
 - .9 Paint Coating: Green epoxy, acrylic, or urethane.
 - .2 Non-MFMA Manufacturer Metal Framing Systems:
 - .1 Manufacturers:
 - .1 Anvil International.
 - .2 ERICO International Corporation.
 - .3 PHD Manufacturing, Inc.
 - .2 Description: Shop- or field-fabricated pipe-support assembly, made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
 - .3 Standard: Comply with MFMA-4, factory-fabricated components for field assembly.
 - .4 Channels: Continuous slotted carbon-steel channel with in-turned lips.
 - .5 Channel Width: Select for applicable load criteria.
 - .6 Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
 - .7 Hanger Rods: Continuous-thread rod, nuts, and washer made of electro-galvanized carbon steel.
 - .8 Metallic Coating: Pre-galvanized G90.
 - .9 Paint Coating: Green epoxy, acrylic, or urethane.
- .4 Thermal Hanger-Shield Inserts:
 - .1 Manufacturers:
 - .1 ERICO International Corporation.
 - .2 National Pipe Hanger Corporation.
 - .3 Pipe Shields Inc.
 - .2 Insulation-Insert Material: Water-repellent-treated, ASTM C533, Type I calcium silicate with 100-psi ASTM C552, Type II cellular glass with 100-psi or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psi minimum compressive strength.
 - .3 For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
 - .4 For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
 - .5 Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.
- .5 Fastener Systems:
 - .1 Powder-Actuated Fasteners: NFPA-approved, UL-listed, and FM-approved threaded-steel stud, for use in hardened portland cement concrete, with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
 - .1 Manufacturers:
 - .1 Hilti, Inc.
 - .2 ITW Ramset/Red Head; Illinois Tool Works, Inc.
 - .3 MKT Fastening, LLC.
 - .4 Simpson Strong-Tie Co., Inc.
 - .2 Mechanical-Expansion Anchors: NFPA-approved, UL-listed, and FM-approved, insert-wedge-type anchors, for use in hardened portland cement concrete; with pull-out,

tension, and shear capacities appropriate for supported loads and building materials where used.

- .1 Manufacturers:
 - .1 B-line, an Eaton business.
 - .2 Hilti, Inc.
 - .3 ITW Ramset/Red Head; Illinois Tool Works, Inc.
 - .4 MKT Fastening, LLC.
- .2 Indoor Applications: Zinc-coated or Stainless steel.
- .3 Outdoor Applications: Stainless steel.
- .6 Pipe Stands:
 - .1 General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured electro-galvanized carbon steel components to support piping
- .7 Equipment Supports:
 - .1 Design Mix: 5000-psi, 28-day compressive strength
- .8 Materials:
 - .1 Carbon Steel: ASTM A1011/A1011M.
 - .2 Structural Steel: ASTM A36/A36M, carbon-steel plates, shapes, and bars; black and galvanized.
 - .3 Stainless Steel: ASTM A240/A240M.
 - .4 Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrinking and nonmetallic grout; suitable for interior and exterior applications.
 - .1 Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrinking and nonmetallic grout; suitable for interior and exterior applications.
 - .2 Design Mix: 5000-psi, 28-day compressive strength.

2.2 GENERAL DUTY VALVES FOR WATER-BASED FIRE-PROTECTION SYSTEMS

- .1 Two-Piece Ball Valves with Indicators:
 - .1 Manufacturers:
 - .1 Ames Fire & Waterworks; A Watts Water Technologies Company.
 - .2 NIBCO INC.
 - .3 Victaulic Company.
 - .2 Description:
 - .1 UL 1091, except with ball instead of disc and FM Global standard for indicating valves (butterfly or ball type), Class Number 1112.
 - .2 Body Design: Two piece.
 - .3 Body Material: Forged brass or bronze.
 - .4 Port Size: Full or standard.
 - .5 Seats: PTFE.
 - .6 Stem: Bronze or stainless steel.
 - .7 Ball: Chrome-plated brass.
 - .8 Actuator: Worm gear or traveling nut.
 - .9 Supervisory Switch: Internal or external.
 - .10 End Connections for Valves NPS 1 (DN 25) through NPS 2 (DN 50): Threaded ends.

- .11 End Connections for Valves NPS 2-1/2 (DN 65): Grooved ends.
- .2 Bronze Butterfly Valves with Indicators:
 - .1 Manufacturers:
 - .1 Milwaukee Valve Company.
 - .2 Description:
 - .1 Standard: UL 1091 and FM Global standard for indicating valves, (butterfly or ball type), Class Number 1112.
 - .2 Body Material: Bronze.
 - .3 Seat Material: EPDM.
 - .4 Stem Material: Bronze or stainless steel.
 - .5 Disc: Bronze with EPDM coating.
 - .6 Actuator: Worm gear or traveling nut.
 - .7 Supervisory Switch: Internal.
 - .8 Ends Connections for Valves NPS 1 (DN 25) through NPS 2 (DN 50): Threaded ends.
 - .9 Ends Connections for Valves NPS 2-1/2 (DN 65): Grooved ends.
- .3 Iron Butterfly Valves with Indicators:
 - .1 Manufacturers:
 - .1 Kennedy Valve Company; a division of McWane, Inc.
 - .2 NIBCO INC.
 - .3 Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.
 - .4 Victaulic Company.
 - .5 Zurn Industries, LLC.
 - .2 Description:
 - .1 Standard: UL 1091 UL 1091 and FM Global standard for indicating valves, (butterfly or ball type), Class Number 112.
 - .2 Body Material: Cast or ductile iron [with nylon, EPDM, epoxy, or polyamide coating].
 - .3 Seat Material: EPDM.
 - .4 Stem: Stainless steel.
 - .5 Disc: Ductile iron, nickel plated and EPDM or SBR coated.
 - .6 Actuator: Worm gear or traveling nut.
 - .7 Supervisory Switch: Internal.
 - .8 Body Design: Grooved-end connections.
- .4 Check Valves:
 - .1 Manufacturers:
 - .1 FEBCO; A WATTS Brand.
 - .2 Fire Protection Products Inc (FPPI); a brand of Anvil International and Smith-Cooper International.
 - .3 Mueller Co. LLC; Mueller Water Products, Inc.
 - .4 NIBCO INC.
 - .5 Reliable Automatic Sprinkler Co., Inc. (The).

- .6 Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.
- .7 United Brass Works, Inc.
- .8 Victaulic Company.
- .9 Viking Group Inc.
- .10 WATTS; A Watts Water Technologies Company.
- .11 Zurn Industries, LLC.
- .2 Description:
 - .1 Standard: UL 312 and FM Global standard for swing check valves, Class Number 1210.
 - .2 Type for fire department connections and general purpose: Single swing check.
 - .3 Type for fire pump discharge: Fire pump discharge check valves shall be FM Global approved as "anti-water hammer" type.
 - .4 Body Material: Cast iron, ductile iron, or bronze.
 - .5 Clapper: Bronze, ductile iron, or stainless steel with elastomeric seal.
 - .6 Clapper Seat: Brass, bronze, or stainless steel.
 - .7 Hinge Shaft: Bronze or stainless steel.
 - .8 Hinge Spring: Stainless steel.
 - .9 End Connections: Flanged, grooved, or threaded.
- .5 Bronze OS&Y Gate Valves:
 - .1 Manufacturers:
 - .1 Milwaukee Valve Company.
 - .2 NIBCO INC.
 - .3 United Brass Works, Inc.
 - .4 Zurn Industries, LLC.
 - .2 Description:
 - .1 Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves).
 - .2 Body and Bonnet Material: Bronze or brass.
 - .3 Wedge: One-piece bronze or brass.
 - .4 Wedge Seat: Bronze.
 - .5 Stem: Bronze or brass.
 - .6 Packing: Non-asbestos PTFE.
 - .7 Supervisory Switch: External.
 - .8 End Connections: Threaded.
- .6 Iron OS&Y Gate Valves:
 - .1 Manufacturers:
 - .1 American Cast Iron Pipe Company.
 - .2 Clow Valve Company; a subsidiary of McWane, Inc.
 - .3 Hammond Valve.
 - .4 Mueller Co. LLC; Mueller Water Products, Inc.
 - .5 NIBCO INC.
 - .6 Victaulic Company.
 - .7 WATTS; A Watts Water Technologies Company.

- .8 Zurn Industries, LLC.
- .2 Description:
 - .1 Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves)
 - .2 Body and Bonnet Material: Cast or ductile iron.
 - .3 Wedge: Cast or ductile iron, or bronze with elastomeric coating.
 - .4 Wedge Seat: Cast or ductile iron, or bronze with elastomeric coating.
 - .5 Stem: Brass or bronze.
 - .6 Packing: Non-asbestos PTFE.
 - .7 Supervisory Switch: External.
 - .8 End Connections: Flanged.
- .7 NRS Gate Valves:
 - .1 Manufacturers:
 - .1 American Cast Iron Pipe Company.
 - .2 Clow Valve Company; a subsidiary of McWane, Inc.
 - .3 Mueller Co. LLC; Mueller Water Products, Inc.
 - .4 NIBCO INC.
 - .5 Victaulic Company.
 - .6 Zurn Industries, LLC.
 - .2 Description:
 - .1 Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves).
 - .2 Body and Bonnet Material: Cast or ductile iron.
 - .3 Wedge: Cast or ductile iron with elastomeric coating.
 - .4 Wedge Seat: Cast or ductile iron, or bronze with elastomeric coating.
 - .5 Stem: Brass or bronze.
 - .6 Packing: Non-asbestos PTFE.
 - .7 Supervisory Switch: External.
 - .8 End Connections: Flanged.
- .8 Indicator Posts:
 - .1 Manufacturers:
 - .1 American Cast Iron Pipe Company.
 - .2 Clow Valve Company; a subsidiary of McWane, Inc.
 - .3 Mueller Co. LLC; Mueller Water Products, Inc.
 - .4 NIBCO INC.
 - .2 Description:
 - .1 Standard: UL 789 and FM Global standard for indicator posts.
 - .2 Type: Underground.
 - .3 Base Barrel Material: Cast or ductile iron.
 - .4 Extension Barrel: Cast or ductile iron.
 - .5 Cap: Cast or ductile iron.
 - .6 Operation: Wrench.
- .9 Trim and Drain Valves:

- .1 Ball Valves:
 - .1 Manufacturers:
 - .1 Fire Protection Products Inc (FPPI); a brand of Anvil International and Smith-Cooper International.
 - .2 Fire-End & Croker Corporation.
 - .3 Milwaukee Valve Company.
 - .4 NIBCO INC.
 - .5 Potter Roemer LLC; a Division of Morris Group International.
 - .6 Red-White Valve Corp.
 - .7 Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.
 - .8 Victaulic Company.
 - .9 WATTS; A Watts Water Technologies Company.
 - .10 Zurn Industries, LLC.
 - .2 Description:
 - .1 Body Design: Two-piece.
 - .2 Body Material: Forged brass or bronze.
 - .3 Port size: Full or standard.
 - .4 Seats: PTFE.
 - .5 Stem: Bronze or stainless steel.
 - .6 Ball: Chrome-plated brass.
 - .7 Actuator: Hand lever.
 - .8 End Connections for Valves NPS 1 (DN 25) through NPS 2-1/2 (DN 65): Threaded ends.
 - .9 End Connections for Valves NPS 1-1/4 and NPS 2-1/2 (DN 65): Grooved ends.
- .2 Angle Valves:
 - .1 Manufacturers:
 - .1 Fire Protection Products Inc (FPPI); a brand of Anvil International and Smith-Cooper International.
 - .2 NIBCO INC.
 - .3 United Brass Works, Inc.
 - .2 Description:
 - .1 Body Material: Brass or bronze.
 - .2 Ends: Threaded.
 - .3 Stem: Bronze.
 - .4 Disc: Bronze.
 - .5 Packing: Asbestos free.
 - .6 Handwheel: Malleable iron, bronze, or aluminum.
- .3 Globe Valves:
 - .1 Manufacturers:
 - .1 NIBCO INC.
 - .2 United Brass Works, Inc.
 - .2 Description:

- .1 Body Material: Bronze with integral seat and screw-in bonnet.
 - .2 Ends: Threaded.
 - .3 Stem: Bronze.
 - .4 Disc Holder and Nut: Bronze.
 - .5 Disc Seat: Nitrile.
 - .6 Packing: Asbestos free.
 - .7 Handwheel: Malleable iron, bronze, or aluminum.
- .10 Pressure Reducing Valves:
- .1 Manufacturers:
 - .1 Bermad Inc.
 - .2 Cla-Val Co.
 - .3 Reliable Automatic Sprinkler Company, Inc.
 - .4 Tyco Fire & Building Products.
 - .5 Victaulic Company.
 - .6 Viking Corporation.
 - .2 Description: Pilot-operation, diaphragm-type, single-seated main water control valve with AWWA C550 or FDA-approved, interior epoxy coating. Include small pilot control valve, restrictor device, specialty fittings, and sensor piping. UL listed and FM Global approved.
 - .3 Main Valve Body: Cast or ductile iron with AWWA C550 or FDA-approved, interior epoxy coating; or stainless-steel body.
 - .1 Pattern: Globe-valve design.
 - .2 Trim: Stainless steel.
 - .4 End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.

2.3 BACKFLOW PREVENTION ASSEMBLIES

2.4 IDENTIFICATION FOR FIRE-PROTECTION PIPING AND EQUIPMENT

- .1 Equipment Labels:
- .1 Metal Labels for Equipment:
 - .1 Manufacturers:
 - .1 Brady Corporation.
 - .2 Carlton Industries, LP.
 - .3 Champion America.
 - .4 Craftmark Pipe Markers.
 - .5 Emedco.
 - .6 Kolbi Pipe Marker Co.
 - .7 LEM Products Inc.
 - .8 Marking Services Inc.
 - .9 Pipemarket.com; Brimar Industries, Inc.
 - .10 Seton Identification Products; a Brady Corporation company.
 - .2 Material and Thickness: Brass, 0.032 inch, stainless steel, 0.025 inch, aluminum, 0.032 inch or anodized aluminum, 0.032 inch thick, with predrilled holes for attachment hardware.
 - .3 Letter and Background Color: As indicated for specific application under Part 3.

- .4 Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 - .5 Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 - .6 Fasteners: Stainless-steel rivets or self-tapping screws.
 - .7 Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
 - .2 Plastic Labels for Equipment:
 - .1 Manufacturers:
 - .1 Brady Corporation.
 - .2 Carlton Industries, LP.
 - .3 Champion America.
 - .4 Craftmark Pipe Markers.
 - .5 Emedco.
 - .6 Kolbi Pipe Marker Co.
 - .7 LEM Products Inc.
 - .8 Marking Services Inc.
 - .9 Pipemarker.com; Brimar Industries, Inc.
 - .10 Seton Identification Products; a Brady Corporation company.
 - .2 Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, with predrilled holes for attachment hardware.
 - .3 Letter and Background Color: As indicated for specific application under Part 3.
 - .4 Maximum Temperature: Able to withstand temperatures up to 160 deg F.
 - .5 Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 - .6 Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 - .7 Fasteners: Stainless-steel rivets or self-tapping screws.
 - .8 Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
 - .3 Label Content: Include equipment's Drawing designation or unique equipment number, drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.
 - .4 Equipment-Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.
- .2 Warning Signs and Labels:
 - .1 Manufacturers:
 - .1 Brady Corporation.
 - .2 Carlton Industries, LP.

- .3 Champion America.
- .4 Craftmark Pipe Markers.
- .5 Emedco.
- .6 LEM Products Inc.
- .7 Marking Services Inc.
- .8 National Marker Company.
- .9 Pipemarker.com; Brimar Industries, Inc.
- .10 Seton Identification Products; a Brady Corporation company.
- .11 Stranco, Inc.
- .2 Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, with predrilled holes for attachment hardware.
- .3 Letter and Background Color: As indicated for specific application under Part 3.
- .4 Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- .5 Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- .6 Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- .7 Fasteners: Stainless-steel rivets or self-tapping screws.
- .8 Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- .9 Label Content: Include caution and warning information, plus emergency notification instructions.
- .3 Warning Tape:
 - .1 Manufacturers:
 - .1 Brady Corporation.
 - .2 Craftmark Pipe Markers.
 - .3 National Marker Company.
 - .4 Pipemarker.com; Brimar Industries, Inc.
 - .5 Seton Identification Products; a Brady Corporation company.
 - .2 Material: Vinyl.
 - .3 Minimum Thickness: 0.005 inch.
 - .4 Letter, Pattern, and Background Color: As indicated for specific application under Part 3.
 - .5 Waterproof Adhesive Backing: Suitable for indoor or outdoor use.
 - .6 Maximum Temperature: 160 deg F.
 - .7 Minimum Width: 4 inches.
- .4 Pipe Labels:
 - .1 Manufacturers: Provide products by one of the following manufacturers:
 - .1 Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.
 - .2 Brady Corporation.
 - .3 Carlton Industries, LP.
 - .4 Champion America.
 - .5 Craftmark Pipe Markers.

- .6 Emedco.
- .7 Kolbi Pipe Marker Co.
- .8 LEM Products Inc.
- .9 Marking Services Inc.
- .10 Pipemarket.com; Brimar Industries, Inc.
- .11 Seton Identification Products; a Brady Corporation company.
- .2 General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service and showing flow direction according to ASME A13.1.
- .3 Letter and Background Color: As indicated for specific application under Part 3.
- .4 Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- .5 Self-adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- .6 Pipe-Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
 - .1 Flow-Direction Arrows: Include flow-direction arrows on main distribution piping. Arrows may be either integral with label or applied separately.
 - .2 Lettering Size: At least 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm) and proportionately larger lettering for greater viewing distances.
- .5 Stencils:
 - .1 Manufacturers: Provide products by one of the following manufacturers:
 - .1 Craftmark Pipe Markers.
 - .2 Kolbi Pipe Marker Co.
 - .3 Marking Services Inc.
 - .4 Pipemarket.com; Brimar Industries, Inc.
 - .2 Lettering Size: At least 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances.
 - .3 Stencil Material: Fiberboard or metal.
 - .4 Stencil Paint: Exterior, gloss, alkyd enamel. Paint may be in pressurized spray-can form.
 - .5 Identification Paint: Exterior, alkyd enamel. Paint may be in pressurized spray-can form.
- .6 Valve Tags:
 - .1 Manufacturers: Provide products by one of the following manufacturers:
 - .1 Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.
 - .2 Brady Corporation.
 - .3 Carlton Industries, LP.
 - .4 Champion America.
 - .5 Craftmark Pipe Markers.
 - .6 Emedco.
 - .7 Kolbi Pipe Marker Co.
 - .8 LEM Products Inc.
 - .9 Marking Services Inc.
 - .10 Pipemarket.com; Brimar Industries, Inc.

- .11 Seton Identification Products; a Brady Corporation company.
- .2 Description: Stamped or engraved with 1/4 inch (6.4 mm) letters for piping-system abbreviation and 1/2 inch (13 mm) numbers.
 - .1 Tag Material: Brass, 0.032 inch, stainless steel, 0.025 inch, aluminum, 0.032 inch or anodized aluminum, 0.032 inch thick, with predrilled holes for attachment hardware.
 - .2 Fasteners: Brass wire-link chain or beaded chain.
- .3 Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
 - .1 Include valve-tag schedule in operation and maintenance data.
- .7 Warning Tags:
 - .1 Manufacturers:
 - .1 Brady Corporation.
 - .2 Champion America.
 - .3 Craftmark Pipe Markers.
 - .4 Emedco.
 - .5 Kolbi Pipe Marker Co.
 - .6 LEM Products Inc.
 - .7 Marking Services Inc.
 - .8 Pipemarker.com; Brimar Industries, Inc.
 - .9 Seton Identification Products; a Brady Corporation company.
 - .2 Description: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
 - .1 Size: 3 by 5-1/4 inches minimum.
 - .2 Fasteners: Reinforced grommet and wire.
 - .3 Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
- .8 Identification Signs:
 - .1 Hydraulic Design Information Sign:
 - .1 Identify all hydraulically designed sprinkler systems, in accordance with NFPA system requirements with a permanently marked (by engraving) weatherproof metal or rigid plastic sign. The signs shall be secured with corrosion resistant wire or chain. Such signs shall be located at the sprinkler system control valve supplying the corresponding hydraulically designed area.
 - .2 The sign shall include the location of the design area, discharge densities over the design area, flow and residual pressure demand at the base of the riser, occupancy classification or commodity classification and maximum permitted storage height and configuration, hose stream allowance included in addition to the sprinkler demand, and the name of the installing contractor.
 - .2 Identification of Valves:
 - .1 All control, drain, and test connection valves shall be provided with a permanently marked (by engraving) weatherproof metal or rigid plastic identification signs. The identification signs shall be secured with corrosion resistant wire or chain.

- .2 The sign shall identify purpose of valve and the portion of the building served.
- .3 General Information Sign:
 - .1 Provide a general information sign, conforming to NFPA 13, used to determine system design basis and information relevant to the inspection, testing, and maintenance requirements required by NFPA 25, "Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems."
- .9 Fire Protection System Diagrams:
 - .1 Provide fire protection system diagrams, drawn to scale, framed and under glass to be permanently posted in a conspicuous location in the fire pump room. Diagrams shall show the water supply, fire pumps, fire department connections, sprinkler and standpipe mains, risers and all valves.

PART 3 EXECUTION

3.1 APPLICATION

- .1 Hangers and Supports:
 - .1 Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 250 lb.
 - .2 Comply with NFPA requirements for pipe-hanger selections and applications that are not specified in piping system Sections.
 - .3 Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
 - .4 Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
 - .5 Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers, and metal framing systems and attachments for general service applications.
 - .6 Use galvanized or stainless-steel pipe hangers and attachments for hostile environment applications, including but not limited to outdoor areas, corrosive areas, high moisture areas, and over pools and in pool equipment rooms.
 - .7 Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.
 - .8 Use thermal hanger-shield inserts for insulated piping and tubing.
 - .9 Horizontal-Piping Hangers and Supports: Comply with NFPA requirements. Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - .1 Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated, stationary pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
 - .2 Steel Pipe Clamps (MSS Type 4): For suspension of NPS 1/2 to NPS 24 (DN 15 to NPS 600) if little or no insulation is required.
 - .3 Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of non-insulated stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
 - .4 Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of non-insulated stationary pipes NPS 3/8 to NPS 8 (DN 10 to DN 200).
 - .5 Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of non-insulated stationary pipes NPS 3/8 to NPS 3 (DN 10 to DN 75).

- .6 U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
- .7 Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
- .8 Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
- .9 Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 (DN 65 to DN 900) if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
- .10 Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - .1 Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24 (DN 20 to DN 600).
 - .2 Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 (DN 20 to DN 600) if longer ends are required for riser clamps.
- .11 Hanger-Rod Attachments: Comply with NFPA requirements.
- .12 Building Attachments: Comply with NFPA requirements. Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - .1 Steel or Malleable-Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 - .2 C-Clamps (MSS Type 23): For structural shapes.
 - .3 Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
- .13 Saddles and Shields: Comply with NFPA requirements. Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - .1 Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 - .2 Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 - .3 Thermal Hanger-Shield Inserts: For supporting insulated pipe.
- .14 Comply with NFPA requirements for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- .15 Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- .16 Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.
- .2 General Duty Valves:
 - .1 Source limitations: Obtain each type of valve from single manufacturer.
 - .2 Control valves on the suction side of fire pumps shall be OS&Y type.
 - .3 Fire pump discharge check valve shall be Factory Mutual approved as an anti-water hammer check valve.

3.2 EXAMINATION

- .1 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.

- .2 Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- .3 Examine threads on valve and mating pipe for form and cleanliness.
- .4 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.
- .5 Do not attempt to repair defective valves; replace with new valves.

3.3 PREPARATION

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

3.4 INSTALLATION

- .1 Hangers and Supports:
 - .1 General:
 - .1 Sprinkler piping shall be supported from the building structure, which must support the added load of the water-filled pipe plus a minimum of 250 lb. applied at the point of hanging.
 - .2 Do not support piping from other pipes, ductwork, other equipment, or anything else that is not part of the building structure.
 - .3 Hanger rod sizes shall be in conformance with the requirements of NFPA 13.
 - .4 Metal Pipe-Hanger Installation: Comply with installation requirements of approvals and listings. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
 - .5 Riser Installation:
 - .1 Risers shall be supported by riser clamps or by hangers located on the horizontal piping connections within 24 inches of the centerline of the riser.
 - .2 Riser clamps supporting risers by means of set screws shall not be used.
 - .3 Riser clamps anchored to walls using hanger rods in the horizontal position shall not be permitted to vertically support risers.
 - .4 In multistory buildings, riser supports shall be provided at the lowest level, at every level above, above and below offsets, and at the top of the riser.
 - .5 Supports above the lowest level shall also restrain the pipe to prevent movement by an upward thrust where flexible fittings are used.
 - .6 Where risers offset, the first ceiling level above the offset shall constitute the first level of riser support.
 - .7 Distance between supports for risers shall not exceed 15 feet.
 - .6 Metal Trapeze Pipe-Hanger Installation: Trapeze hangers shall be used where necessary to transfer loads to appropriate structural members. Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
 - .1 Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 - .2 Field fabricated from ASTM A36/A36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

- .3 The minimum size of steel angle or pipe span between purlins or joists shall be such that section modulus shall not exceed section modulus of trapeze member as shown in the NFPA 13.
- .4 The trapeze member shall be secured to prevent slippage.
- .5 All components of each hanger assembly that attaches to the trapeze member shall be sized to support the suspended sprinkler pipes in accordance with NFPA 13.
- .6 Any other sizes or shapes giving greater section modulus than required by NFPA 13 shall be acceptable.
- .7 Sprinkler piping may be supported from trapeze hangers supporting both sprinkler piping and ductwork or equipment provided such trapeze hangers comply with NFPA 13 requirements for the total supported load of all equipment plus a minimum of 250 lb. and provided such trapeze hangers are supported from the building structure.
- .7 Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal strut systems.
- .8 Thermal Hanger-Shield Installation: Install in pipe hanger or shield for insulated piping.
- .9 Fastener System:
 - .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. Install in accordance with approvals and listings.
 - .2 Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
 - .3 Provide inserts for placement in formwork before concrete is poured.
 - .4 Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 - .5 Where concrete slabs form finished ceilings, provide inserts to be flush with slab surface.
 - .6 Powder-driven studs shall not be used in steel of less than 3/16 inch total thickness.
 - .7 Increaser couplings shall be attached directly to the powder-driven studs.
 - .8 Listed inserts in concrete and listed post-installed anchors to support hangers shall be used for mains and branch lines.
 - .9 Post-installed anchors shall not be used in cinder concrete except for branch lines where the post-installed anchors are alternated with through-bolts or hangers attached to beams.
 - .10 Post-installed anchors shall be installed in a horizontal position in the sides of concrete beams.
 - .11 Holes for post-installed anchors in the side of beams shall be above the centerline of the beam or above the bottom reinforcement steel rods.
 - .12 Holes for post-installed anchors used in the vertical position shall be drilled to provide uniform contact with the shield over its entire circumference.

- .13 The depth of the post-installed anchor hole shall not be less than specified for the type of shield used.
- .14 Welding studs or other hanger parts shall not be attached by welding to steel less than U.S. Standard, 12 gauge.
- .10 Pipe Stands:
 - .1 Pipe stands shall be sized to support a minimum of 5 times the weight of the water-filled pipe, plus 250 lb.
 - .2 Where pipe stands are utilized, they shall be approved.
- .11 Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- .12 Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- .13 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.
- .14 Install lateral bracing with pipe hangers and supports to prevent swaying.
- .15 Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 (DN 65) and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- .16 Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- .17 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.
- .18 Insulated Piping:
 - .1 Attach clamps and spacers to piping.
 - .1 Piping Operating Above Ambient Air Temperature: Clamp may project through insulation.
 - .2 Piping Operating Below Ambient Air Temperature: Use thermal hanger-shield insert with clamp sized to match OD of insert.
 - .3 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.
 - .1 Option: Thermal hanger-shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
 - .3 Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - .4 Shield Dimensions for Pipe: Not less than the following:
 - .1 NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches long and 0.048 inch thick.
 - .2 NPS 4 (DN 100): 12 inches long and 0.06 inch thick.

- .3 NPS 5 and NPS 6 (DN 125 to DN 150): 18 inches long and 0.06 inch thick.
- .4 NPS 8 to NPS 14 (DN 100 to DN 350): 24 inches long and 0.075 inch thick.
- .5 NPS 16 to NPS 24 (DN 400 to DN 600): 24 inches long and 0.105 inch thick.
- .5 Pipes NPS 8 (DN 200) and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
- .6 Thermal Hanger Shields: Install with insulation of same thickness as piping insulation.
- .19 Fasteners used to support sprinkler system piping shall not be attached to a ceiling of gypsum board or other similar soft material.
- .20 Distance between a hanger and the centerline of an upright sprinkler shall not be less than 3 inches.
- .21 The cumulative horizontal length of an unsupported arm-over to a sprinkler, sprinkler drop, or sprig shall not exceed 24 inches for steel pipe or 12 inches for copper pipe.
- .22 The cumulative horizontal length of an unsupported arm-over to a pendent sprinkler below a ceiling supplied from a branch line above the ceiling shall not exceed 12 inches for steel pipe or 6 inches for copper tube where the maximum static or flowing pressure, whichever is greater at the sprinkler exceeds 100 psi.
- .23 Sprigs 4 feet or longer shall be restrained against lateral movement.
- .24 Eye rods shall be secured with lock washers to prevent lateral motion.
- .25 Eye rods shall be backed with a large flat washer bearing directly against the structural member in addition to lock washer where eye rods are fastened to the wood structural member.
- .26 Minimum Coach Screw Rod Size: The size of coach screw rods shall not be less than 3/8 inch for pipe sizes supported up to 4 inches. Coach screw rods are not permitted for support pipes larger than 4 inches.
- .27 The minimum plank thickness and the minimum width of the lower face of beams or joists in which coach screw rods are installed shall be in accordance with NFPA 13.
- .2 Equipment Supports:
 - .1 Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
 - .2 Grouting: Place grout under supports for equipment and make bearing surface smooth.
 - .3 Provide lateral bracing, to prevent swaying, for equipment supports.
- .3 Metal Fabrications:
 - .1 Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
 - .2 Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
 - .3 Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 - .1 Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

- .2 Obtain fusion without undercut or overlap.
 - .3 Remove welding flux immediately.
 - .4 Finish welds at exposed connections, so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.
 - .4 Flexible Sprinkler Hose Fittings:
 - .1 Listed flexible sprinkler hose fittings and their anchoring components intended for use in installations connecting the sprinkler system piping to sprinklers shall be installed in accordance with the requirements of the listing, including any installation instructions.
 - .2 Where flexible hose fittings exceed 6 feet in length and are supported by a suspended ceiling a hanger(s) attached to the structure shall be required to ensure that the maximum unsupported length does not exceed 6 ft.
 - .3 Where flexible sprinkler hose fittings are used to connect sprinklers to branch lines in suspended ceilings, a label limiting relocation of the sprinkler shall be provided on the anchoring component.
- .2 General Duty Valves for Water-Based Fire-Protection Systems:
 - .1 General:
 - .1 Install backflow prevention assemblies in potable-water-supply sources for each fire-protection water supply connection.
 - .2 Install valves having threaded connections with unions at each piece of equipment arranged to allow easy access, service, maintenance, and equipment removal without system shutdown. Provide separate support where necessary.
 - .3 Install valves in horizontal piping with stem at or above the pipe center.
 - .4 Install valves in position to allow full stem movement.
 - .5 Install listed fire-protection shutoff valves supervised-open (except pump test connection valve which shall be supervised-closed), located to control sources of water supply except from fire-department connections.
 - .2 Pressure Reducing Valves:
 - .1 Pressure gauges shall be installed on the inlet and outlet side of each pressure reducing valve.
 - .2 A relief valve of not less than ½ inch in size shall be provided on discharge side of the valve.
 - .3 A listed indicating valve shall be provided on the inlet side of each pressure reducing valve, unless the pressure reducing valve meets the listing requirements for use as an indicating valve.
 - .4 Means shall be provided downstream of all pressure reducing valves for flow tests at system demand.
 - .3 Backflow Prevention Assemblies:
 - .1 Install backflow prevention assemblies of type, size, and capacity indicated. Include valves and test cocks. Install according to requirements of plumbing and health department and authorities having jurisdiction.
 - .2 Do not install backflow preventers that have relief drain in vault or in other spaces subject to flooding.
- .3 Pipe Loops and Swing Connections:
 - .1 Install pipe loops and offsets in accordance with NFPA 13 requirements for expansion and contraction compensation.

3.5 PAINTING

- .1 Hangers and Supports:
 - .1 Touchup:
 - .1 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.
 - .2 Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780/A780M.

3.6 IDENTIFICATION

- .1 General:
 - .1 Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be installed.
 - .2 Coordinate installation of identifying devices with locations of access panels and doors.
 - .3 Install identifying devices before installing acoustical ceilings and similar concealment.
 - .4 Locate identifying devices so that they are readily visible from the point of normal approach.
- .2 Equipment Labels, Warning Signs, and Labels:
 - .1 Permanently fasten labels on each item of fire-suppression equipment.
 - .2 Sign and Label Colors: White letters on an ANSI Z535.1 safety-red background.
 - .3 Locate equipment labels where accessible and visible.
 - .4 Arc-Flash Warning Signs: Provide arc-flash warning signs on electrical disconnects and other equipment where arc-flash hazard exists, as indicated on Drawings, and in accordance with requirements of OSHA and NFPA 70E, and other applicable codes and standards.
- .3 Warning Tape:
 - .1 Warning Tape Color and Pattern: Yellow background with black diagonal stripes.
 - .2 Install warning tape on pipes and ducts, with cross-designated walkways providing less than 6 ft. of clearance.
 - .3 Locate tape so as to be readily visible from the point of normal approach.
- .4 Pipe Labels:
 - .1 Install pipe labels showing service and flow direction with permanent adhesive on pipes.
 - .2 Stenciled Pipe-Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1, with painted, color-coded bands or rectangles on each piping system.
 - .1 Identification Paint: Use for contrasting background.
 - .2 Stencil Paint: Use for pipe marking.
 - .3 Pipe-Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - .1 Within 3 ft. of each valve and control device.

- .2 At access doors, manholes, and similar access points that permit a view of concealed piping.
- .3 Within 3 ft. of equipment items and other points of origination and termination.
- .4 Spaced at maximum intervals of 25 ft. along each run. Reduce intervals to 10 ft. in areas of congested piping and equipment.
- .4 Flow Direction Arrows: Provide arrows to indicate direction of flow in pipes including pipes where flow is allowed in both directions.
- .5 Fire Protection Pipe Label Color: White letters on an ANSI Z535.1 safety-red background.
- .5 Valve Tags:
 - .1 Install tags on valves and control devices in fire protection piping systems. List tagged valves in a valve-tag schedule in the operating and maintenance manual. Include the identification "FPV" on all fire-protection system valve tags.
 - .2 Valve tag size and shape: 2 inches, round.
 - .3 Valve-Tag Color: White letters on an ANSI Z535.1 safety-red background.
- .6 Warning Tags:
 - .1 Warning Tag Color: Black letters on an ANSI Z535.1 safety-yellow background.
 - .2 Attach warning tags, with proper message, to equipment and other items where required by NFPA standards, drawings and/or specifications.

3.7 ADJUSTING

- .1 Hangers:
 - .1 Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
 - .2 Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- .1 Fire-protection piping, fittings, and appurtenances.
 - .1 Steel fire-protection piping, fittings, and appurtenances.
- .2 Fire department connections.
 - .1 Exposed type fire department connections.
 - .2 Flush wall mounted type fire department connections.
 - .3 Yard type fire department connections.
 - .4 Storz type fire department connections.
- .3 Hose connections and hose stations.
 - .1 Hose connections, pressure regulating.
 - .2 Hose connections, non-pressure regulating.
 - .3 Hose stations, rack type, NPS 1-1/2 (DN 40).
 - .4 Hose stations, rack type, NPS 1-1/2 (DN 40) by NPS 2-1/2 (DN 65).
 - .5 Hose stations, reel type, NPS 1-1/2 (DN 40).
- .4 System control valves.
 - .1 Dry pipe valves.
 - .2 Deluge valves.
 - .3 Preaction valves.
- .5 Fire-protection piping specialties.
- .6 Sprinklers.
- .7 Expansion plate.
- .8 Pipe expansion loops and joints.
- .9 Alarm devices.
- .10 Manual control stations.
- .11 Control panels.
- .12 Fire Detection devices.
- .13 Pressure gauges.

1.2 GENERAL REFERENCES

- .1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.
- .2 Division 20, including all Common Mechanical Requirements in Section 20 00 00, apply to this Section. Requirements noted in this section are supplemental to the requirements of these General References.

1.3 RELATED REQUIREMENTS

- .1 Contract Documents: Refer to complete set of Contract Documents for requirements that are related to or may affect the work described in this Section.
- .2 Section 20 05 00 "Common Mechanical Work Results" for sleeves, stack-sleeve fittings, sleeve-seal systems, escutcheons, floor plates, grout, and silicone sealants.
- .3 Section 20 05 13 "Common Mechanical Motor Requirements" for general motor requirements, motor characteristics, polyphase motors (1/2 HP and larger), polyphase motors with additional requirements, and single-phase motors (less than 1/2 HP).

- .4 Section 20 05 33 "Heat Tracing" for heat tracing used on fire protection piping.
- .5 Section 20 05 48 "Vibration and Seismic Controls".
- .6 Section 20 07 00 "Mechanical Insulation" for insulation used on fire protection piping and equipment.
- .7 Section 21 05 00 "Common Work Results for Fire-Protection" for fire protection hangers and supports, general duty valves and identification for fire protection piping and equipment.
- .8 Section 21 31 13 "Fire Pumps, Pressure Maintenance Pumps, and Controllers" for fire pumps, pressure maintenance pumps, and their associated controllers used for water-based fire protection systems.
- .9 Section 28 46 21.11 "Addressable Fire Alarm Systems" for connection to supervisory and alarm devices, and for fire detection devices for fire protection system release.

1.4 REFERENCE STANDARDS

- .1 ANSI/ASA S3.41 - x.
- .2 ASCE/SEI 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures.
- .3 ASME B1.20.1 - Pipe Threads, General Purpose, Inch.
- .4 ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
- .5 ASME B16.4 - Gray Iron Threaded Fittings: Classes 125 and 250; The American Society of Mechanical Engineers.
- .6 ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.
- .7 ASME B16.9 - Factory-Made Wrought Buttwelding Fittings.
- .8 ASME B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges.
- .9 ASME B18.21.1 - Washers: Helical Spring-Lock, Tooth Lock, and Plain Washers (Inch Series).
- .10 ASME B31.9 - Building Services Piping.
- .11 ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings.
- .12 ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
- .13 ASTM A135/A135M - Standard Specification for Electric-Resistance-Welded Steel Pipe.
- .14 ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
- .15 ASTM A449 - Standard Specification for Hex Cap Screws, Bolts and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use.
- .16 ASTM A536 - Standard Specification for Ductile Iron Castings.
- .17 ASTM A733 - Standard Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples.
- .18 ASTM A795/A795M - Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use.
- .19 ASTM A865/A865M - Standard Specification for Threaded Couplings, Steel, Black or Zinc-Coated (Galvanized) Welded or Seamless, for Use in Steel Pipe Joints.
- .20 AWS B2 - x.
- .21 AWS D10.12/D10.12M - GUIDE FOR WELDING MILD STEEL PIPE.
- .22 AWWA C110 - x.
- .23 AWWA C606 - Grooved and Shouldered Joints.
- .24 FM 1637 - x.

- .25 NEMA 4 - x.
- .26 NEMA 6P - x.
- .27 NEMA ICS 6 - Industrial Control and Systems: Enclosures.
- .28 NFPA 13 - Standard for the Installation of Sprinkler Systems.
- .29 NFPA 14 - Standard for the Installation of Standpipe and Hose Systems.
- .30 NFPA 20 - Standard for the Installation of Stationary Pumps for Fire Protection.
- .31 NFPA 25 - Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.
- .32 NFPA 70 - National Electrical Code.
- .33 NFPA 72 - National Fire Alarm and Signaling Code; National Fire Protection Association.
- .34 NFPA 291 - x.
- .35 NFPA 1961 - x.
- .36 NFPA 1963 - Standard for Fire Hose Connections.
- .37 UL 47 - x.
- .38 UL 199 - x.
- .39 UL 213 - x.
- .40 UL 219 - x.
- .41 UL 260 - x.
- .42 UL 346 - x.
- .43 UL 393 - Indicating Pressure Gauges for Fire-Protection Service.
- .44 UL 401 - x.
- .45 UL 405 - Standard for Safety Fire Department Connection Devices.
- .46 UL 464 - Standard for Audible Signaling Devices for Fire Alarm and Signaling Systems, Including Accessories.
- .47 UL 668 - x.
- .48 UL 1468 - x.
- .49 UL 1474 - x.
- .50 UL 1486 - x.
- .51 UL 1626 - x.
- .52 UL 1767 - x.
- .53 UL 2443 - x.

1.5 ABBREVIATIONS AND ACRONYMS

- .1 FM: Factory Mutual Global.
- .2 GPM: Gallons (U.S.) per minute.
- .3 NFPA: National Fire Protection Association.
- .4 NPS: Nominal pipe size.
- .5 PSIG: Pounds per square inch gauge.
- .6 UL: Underwriters Laboratories.

1.6 DEFINITIONS

- .1 Standard-Pressure Fire-Protection System Piping: Piping designed to operate at working pressure of 175 psig (1200 kPa) maximum.
- .2 High-Pressure Fire-Protection System Piping: Piping designed to operate at working pressure higher than standard 175 psig (1200 kPa), but not higher than 250 psig (1725 kPa).

- .3 Standard-Pressure Sprinklers: Sprinklers listed for a maximum system pressure of 175 psig (1200 kPa).
- .4 High-Pressure Sprinklers: Sprinklers listed for a maximum system pressure higher than standard-pressure sprinklers but not higher than 250 psig (1725 kPa).

1.7 PERFORMANCE REQUIREMENTS

- .1 Seismic Performance: Fire-Protection system piping to withstand the effects of earthquake motions determined in accordance with NFPA 13 and ASCE/SEI 7. Refer to Section 20 05 48 "Vibration and Seismic Controls."
- .2 Fire-Protection System Components, Devices, and Accessories: Listed in UL's "Fire Protection Equipment Directory" and FM Globals' "Approval Guide."
- .3 Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- .4 Fire-Protection system equipment, specialties, accessories, installation, and testing to comply with NFPA 13 and NFPA 14.
- .5 Standard-Pressure Piping System Component: Listed for 175 psig (1200 kPa) minimum working pressure.
- .6 High-Pressure Piping System Component: Listed for 250 psig (1725 kPa) working pressure.
- .7 Piping, fittings, valves, and specialty valves shall be rated for the maximum system working pressure. Use of pressure regulating valves (except for individual pressure reducing/restricting fire hose valves) shall not be permissible, unless noted otherwise.
- .8 Delegated Design: Engage a qualified professional engineer or NICET certified technician, "Water-Based Systems Layout" with appropriate certified NICET level as required by the local jurisdiction to design fire-Protection systems.
 - .1 Fire-Hydrant Flow Test:
 - .1 Available fire-hydrant flow test records indicate the following conditions:
 - .1 Date: _____.
 - .2 Time: _____ a.m.
 - .3 Performed by: Insert operator's name of Insert firm.
 - .4 Location of Residual Fire Hydrant R: _____.
 - .5 Location of Flow Fire Hydrant F: _____.
 - .6 Static Pressure at Residual Fire Hydrant R: Insert psig (kPa).
 - .7 Measured Flow at Flow Fire Hydrant F: Insert gpm (L/s).
 - .8 Residual Pressure at Residual Fire Hydrant R: Insert psig (kPa).
 - .2 Perform fire-hydrant flow test and record the following conditions:
 - .1 Date: _____.
 - .2 Time: _____ a.m.
 - .3 Performed by: Insert operator's name of Insert firm.
 - .4 Location of Residual Fire Hydrant R: _____.
 - .5 Location of Flow Fire Hydrant F: _____.
 - .6 Static Pressure at Residual Fire Hydrant R: Insert psig (kPa).
 - .7 Measured Flow at Flow Fire Hydrant F: Insert gpm (L/s).
 - .8 Residual Pressure at Residual Fire Hydrant R: Insert psig (kPa).
 - .3 Fire-hydrant flow test must be performed within previous 12 months prior to completion of design documents and hydraulic calculations.
 - .2 Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.

- .3 Maximum Protection Area per Sprinkler: As noted on drawings and shall not exceed NFPA 13 requirements and limitation indicated on drawings.
- .4 Total Combined Hose-Stream Demand Requirement: As noted on drawings and shall not be less than that required by NFPA 13.
- .5 Minimum residual pressure at each hose-connection outlet is as follows:
 - .1 NPS 1-1/2 (DN 40) Hose Connections: 65 psig (450 kPa).
 - .2 NPS 2-1/2 (DN 65) Hose Connections: 100 psig (690 kPa).
- .6 Maximum residual pressure at each hose-connection outlet is as follows:
 - .1 NPS 1-1/2 (DN 40) Hose Connections: 100 psig (690 kPa).
 - .2 NPS 2-1/2 (DN 65) Hose Connections: 175 psig (1200 kPa).
- .9 Obtain documented approval of Fire-Protection system design from AHJs.
- .10 Pipe, fittings, valves, specialty valves and sprinklers shall be rated and listed for the maximum system working pressure. The use of pressure reducing or regulating valves shall not be permissible unless noted otherwise.
- .11 Each sprinkler outlet located in the most remote area in shell and core office tenant areas shall be calculated to feed two (2) sprinklers from each base building 1" outlet/upright sprinkler location. Install temporary upright sprinklers on one-inch outlets.
- .12 Each sprinkler outlet located in the most remote area in shell and core retail areas shall be calculated to feed one (1) sprinkler from each base building 1" outlet/upright sprinkler location. Sprinkler spacing in shell and core retail areas shall be reduced to 100 sq. feet per sprinkler maximum. Margin of safety between available water flow and pressure and total calculated sprinkler and hose stream shall be increased to a minimum of 25 psi for shell and core retail areas.
- .13 For gridded systems, the designer shall verify that the hydraulically most demanding area is used. A minimum of two additional sets of calculations shall be submitted to demonstrate the most demanding area or hydraulic calculation program used indicating that "auto-peaking" of gridded remote area has been performed..
- .14 The system area of operation shall be increased by 30 percent without revising the density when sprinklers are installed on a sloped ceiling with a pitch exceeding one in six units in non-storage applications.
- .15 Dry Pipe and Preaction Systems:
 - .1 Hydraulic calculations shall utilize a C value (roughness coefficient) of 100 for both black steel and galvanized pipe, regardless of supervisory gas type.
 - .2 The use of gridded and looped systems shall not be allowed.
 - .3 The remote area shall be increased by 30 percent.

1.8 SUBMITTALS

- .1 Action Submittals
 - .1 Product Data:
 - .1 For each type of product.
 - .1 Include construction details, material descriptions, dimensions of individual components and profiles.
 - .2 Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 - .2 Shop Drawings:
 - .1 Prepare in accordance with NFPA 13 and NFPA 14 section "Working Plans."
 - .1 Include plans, elevations, and sections of the system piping and details.

- .2 Include detailed riser diagram and schematic diagram showing system supply, supply connection, devices, valves, pipe, and fittings, as well as the delineation of the standard-pressure and high-pressure portions of the fire-Protection system.
 - .3 Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - .2 Prepare computer-generated hydraulic calculations in accordance with the following:
 - .1 NFPA 13 requirements for sprinkler systems.
 - .2 Factory Mutual requirements for sprinkler systems.
 - .3 NFPA 13 requirements for standpipe systems. Minimum operating pressure at hydraulically most remote fire hose valve is to be 100 psig (690 kPa).
 - .4 Name of hydraulic program used.
 - .5 Water supply information, including fire hydrant flow test data report.
 - .3 Include diagrams for power, signal, and control wiring.
- .3 Delegated Design Submittals: Submit documents and calculations for fire-protection systems indicated to comply with performance requirements and design criteria, including analysis data, signed, and sealed by the qualified professional engineer responsible for their preparation or prepared by NICET certified technician, "Water-Based Systems Layout" with appropriate certified NICET level as required by the local jurisdiction. NICET certified-technician submittals are to include the following information on each drawing title block: technician's name, NICET certification number, and NICET certification specialty area and level.
- .2 Informational Submittals
 - .1 Coordination Drawings: Fire-protection system plans and sections, or Building Information Model (BIM), drawn to scale, showing the items described in this Section and coordinated with all building trades.
 - .2 Seismic Qualification Certificates: For fire-protection equipment, accessories, and components, from manufacturer.
 - .1 Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - .2 Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - .3 Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
 - .3 Qualification Data: For qualified Installer, professional engineer, and NICET-certified technician.
 - .4 Design Data: Approved fire-Protection piping working plans, prepared in accordance with NFPA 13 and NFPA 14, including documented approval by AHJs, and including hydraulic calculations.
 - .5 Welding certificates.
 - .6 Field Test Reports:
 - .1 Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13 and NFPA 14. Include "Contractor's Material and Test Certificate for Aboveground Piping."
 - .2 Fire-hydrant flow test report.
 - .7 Field quality-control reports.

- .3 Closeout Submittals
 - .1 Furnish copy of latest edition of NFPA 25 "Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems."
 - .2 After completing a fire-protection system installation, the Contractor shall submit to the authority having jurisdiction a written certification that the system has been installed in accordance with the approved plans and tested in accordance with NFPA 13 and manufacturer's recommendations.
- .4 Operation and Maintenance Materials
 - .1 Include manufacturer's descriptive literature, operating instructions, cleaning procedures, replacement parts list, maintenance data, and repair data.
- .5 Record Documents
 - .1 Record As-built drawings.
 - .2 Record hydraulic calculations.
 - .3 Record digital files.
 - .1 Digital layout models.
 - .2 Product data.
 - .3 Final submittals with responses.

1.9 QUALITY ASSURANCE

- .1 Installer Qualifications:
 - .1 Installer's responsibilities include designing, fabricating, and installing fire-protection systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
 - .1 Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer or NICET certified technician, "Water-Based Systems Layout" with appropriate certified NICET level as required by the local jurisdiction.
 - .2 An experienced installer who has designed, installed, and obtained approvals for fire-Protection sprinkler systems like that indicated for this Project.
 - .3 Prior to commencing work, submit data showing that the Contractor has successfully installed Fire Protection systems of the same type and design as specified herein, or that they have a firm contractual agreement with a subcontractor having the required experience. Include the names and locations of at least two installations where the Contractor, or the subcontractor referred to above, has installed such systems. Indicate the type and design of each system and certify that the system has performed satisfactorily for a period of at least 18 months.
 - .4 Qualifications of System Technician: Installation drawings, shop drawing and as-built drawings shall be prepared, by or under the supervision of, an individual who is experienced with the types of works specified herein. Contractor shall submit data for approval showing the name and certification of all involved individuals with such qualifications at or prior to submittal of drawings.
- .2 Welding Qualifications: Qualify procedures and operators in accordance with ASME Boiler and Pressure Vessel Code.
- .3 All grooved couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.

- .1 All castings used for couplings housings, fittings, or valve and specialty bodies shall be date stamped for quality assurance and traceability.

1.10 DELIVERY, STORAGE AND HANDLING

- .1 Store products in shipping containers until installation. Provide and maintain temporary inlet and outlet caps until installation.
- .2 Glass bulb sprinklers shall be shipped and stored with protective bulb shields. Bulb shields shall be removed after installation and before placing the system in service.

1.11 EXTRA MATERIALS

- .1 Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - .1 Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.

1.12 FIELD CONDITIONS

- .1 Interruption of Existing Fire Suppression System Service: Do not interrupt fire suppression service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary fire suppression service according to requirements indicated:
- .2 Notify Architect no fewer than two days in advance of proposed interruption of fire suppression service.
- .3 Do not proceed with interruption of fire suppression service without Architect 's written permission.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

- .1 Automatic wet-type, Class I standpipe system.
- .2 Automatic dry-type, Class I standpipe system.
- .3 Semiautomatic dry-type, Class I standpipe system.
- .4 Manual wet-type, Class I standpipe system.
- .5 Manual dry-type, Class I standpipe system.
- .6 Automatic combination wet-type standpipe and sprinkler system.
- .7 Automatic wet-pipe sprinkler system.
- .8 Automatic dry-pipe sprinkler system.
- .9 Automatic deluge sprinkler system.
- .10 Automatic single-interlock preaction sprinkler system.
- .11 Automatic double-interlock preaction sprinkler system.

2.2 FIRE-PROTECTION PIPING, FITTINGS, AND APPURTENANCES

- .1 Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, and fitting materials and for joining methods for specific services, service locations, and pipe sizes.
- .2 Steel Pipe, Fittings, and Appurtenances:
 - .1 Schedule 40 Steel Pipe: Galvanized- and black-steel pipe, ASTM A53/A53M, ASTM A135/A135M, or ASTM A795/A795M, with flanged, threaded, roll grooved, or cut grooved joints. Welded joints are also acceptable for black steel pipe only.

- .1 Factory-applied exterior coating.
- .2 Pipe ends may be factory or field formed to match joining method.
- .2 Schedule 10 Steel Pipe: Galvanized- and black-steel pipe, ASTM A53/A53M, ASTM A135/A135M, or ASTM A795/A795M, with flanged or roll grooved joints. Welded joints are also acceptable for black steel pipe only.
 - .1 Factory-applied exterior coating.
 - .2 Pipe ends may be factory or field formed to match joining method.
- .3 Steel Pipe Nipples: Galvanized and black steel, ASTM A733, made of ASTM A53/A53M, standard-weight, seamless steel pipe with threaded ends.
- .4 Steel Couplings: Galvanized and uncoated steel, ASTM A865/A865M, threaded.
- .5 Cast-Iron, Malleable-Iron and Ductile-Iron Threaded Fittings: Galvanized and uncoated threaded fittings, ASME B16.4, Class 125 and Class 150, standard pattern.
- .6 Cast-Iron Flanges and Flanged Fittings: Galvanized and uncoated flanges and flanged fittings, ASME B16.1, Class 125 and Class 250.
- .7 Steel Flanges and Flanged Fittings: ASME B16.5, Class 150 and Class 300.
- .8 Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick, ASME B16.21, nonmetallic and asbestos free or EPDM rubber gasket.
 - .1 Class 125 and Class 250, Cast-Iron, Flat-Face Flanges: Full-face gaskets.
 - .2 Class 150 and Class 300, Ductile-Iron or -Steel, Raised-Face Flanges: Ring-type gaskets.
 - .3 Metal, Pipe-Flange Bolts and Nuts: ASME B18.21.1 carbon steel unless otherwise indicated.
- .9 Steel Welding Fittings: ASTM A234/A234M and ASME B16.9.
 - .1 Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- .10 Grooved-Joint, Steel-Pipe Appurtenances:
 - .1 Manufacturers: Provide products by one of the following manufacturers:
 - .1 Golvok; an ASC Engineered Solution.
 - .2 Shurjoint; a part of Aalberts Integrated piping Systems.
 - .3 Smith-Cooper International.
 - .4 Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.
 - .2 Victaulic Company.
 - .3 Pressure Rating: 300 psig (2070 kPa) minimum.
 - .4 Grooved-End Fittings for Steel Piping: Painted grooved-end fittings, ASTM A47/A47M, malleable-iron casting or ASTM A536, ductile-iron casting, with dimensions matching steel pipe.
 - .5 Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213 rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.
 - .1 In lieu of rigid groove type couplings and fittings, Installation-Ready™ fittings for Schedule 10 grooved end steel piping in fire protection applications sizes 1-1/4" thru 2 1/2" may be used. Fittings shall consist of a ductile iron housing conforming to ASTM A536, Grade 65-45-12, with Installation-Ready™ ends, pre-lubricated Grade "E" EPDM Type 'A' gasket; and ASTM A449 electroplated steel bolts and nuts. UL listed for a working pressure of 300 psig (2070 kPa) and FM approved for working

pressure 365 psig (2517 kPa).

- .2 In lieu of threaded steel piping systems, the Victaulic FireLock IGS System with "Installation-Ready™" fittings and couplings may be used for NPS 1 (DN 25) Schedule 10 and Schedule 40 carbon steel pipe in fire protection applications. System rated for a working pressure to 365 psig (2517 kPa).
- .3 Groove: IGS "Innovative Groove System" groove with shortened "A" dimension and tapered groove backside for ease of installation. Victaulic RG2100, with IGS Confirmation Gauge. Not for use with Type F Schedule 40 pipe.

2.3 FIRE DEPARTMENT CONNECTIONS

- .1 Fire Department Connection, Exposed Type:
 - .1 Manufacturers:
 - .1 Croker; a Division of Morris Group International.
 - .2 Elkhart Brass Mfg. Co., Inc.
 - .3 Fire Protection Products Inc (FPPI); a brand of Anvil International and Smith-Cooper International.
 - .4 Guardian Fire Equipment, Inc.
 - .5 Potter Roemer LLC; a Division of Morris Group International.
 - .2 Standard: UL 405.
 - .3 Description: Exposed, projecting, for wall mounting.
 - .4 Pressure Rating: 175 psig (1200 kPa) minimum.
 - .5 Body Material: Corrosion-resistant metal.
 - .6 Inlets: Brass with threads in accordance with NFPA 1963 and matching local fire department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
 - .7 Caps: Brass, lugged type, with gasket and chain.
 - .8 Escutcheon Plate: Round, brass, wall type.
 - .9 Outlet: Back, with pipe threads.
 - .10 Number of Inlets: Two.
 - .11 Escutcheon Plate Marking: "AUTO SPKR & STANDPIPE".
 - .12 Finish: Polished chrome plated.
 - .13 Outlet Size: NPS 4 (DN 100).
- .2 Fire Department Connection, Flush Wall Mounted Type:
 - .1 Manufacturers: Provide products by one of the following manufacturers:
 - .1 Croker; a Division of Morris Group International.
 - .2 Elkhart Brass Mfg. Co., Inc.
 - .3 Guardian Fire Equipment, Inc.
 - .4 Potter Roemer LLC; a Division of Morris Group International.
 - .2 Standard: UL 405.
 - .3 Description: Flush, for wall mounting.
 - .4 Pressure Rating: 175 psig (1200 kPa) minimum.
 - .5 Body Material: Corrosion-resistant metal.
 - .6 Inlets: Brass with threads in accordance with NFPA 1963 and matching local fire department sizes and threads. Include extension pipe nipples, brass lugged swivel

- connections, and check devices or clappers.
- .7 Caps: Brass, lugged type, with gasket and chain.
- .8 Escutcheon Plate: Rectangular, brass, wall type.
- .9 Outlet: With pipe threads.
- .10 Body Style: Horizontal.
- .11 Number of Inlets: Two.
- .12 Outlet Location: Back.
- .13 Escutcheon Plate Marking: "AUTO SPKR & STANDPIPE".
- .14 Finish: Polished chrome plated.
- .15 Outlet Size: NPS 4 (DN 100).
- .3 Fire Department Connection, Yard Type:
 - .1 Manufacturers: Provide products by one of the following manufacturers:
 - .1 Croker; a Division of Morris Group International.
 - .2 Elkhart Brass Mfg. Co., Inc.
 - .3 Guardian Fire Equipment, Inc.
 - .4 Potter Roemer LLC; a Division of Morris Group International.
 - .2 Standard: UL 405.
 - .3 Description: Exposed, freestanding.
 - .4 Pressure Rating: 175 psig (1200 kPa) minimum.
 - .5 Body Material: Corrosion-resistant metal.
 - .6 Inlets: Brass with threads in accordance with NFPA 1963 and matching local fire department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
 - .7 Caps: Brass, lugged type, with gasket and chain.
 - .8 Escutcheon Plate: Round, brass, floor type.
 - .9 Outlet: Bottom, with pipe threads.
 - .10 Number of Inlets: Two.
 - .11 Sleeve: Brass.
 - .12 Sleeve Height: 18 inches (460 mm).
 - .13 Escutcheon Plate Marking: "AUTO SPKR & STANDPIPE".
 - .14 Finish, Including Sleeve: Polished chrome plated.
 - .15 Outlet Size: NPS 4 (DN 100).
- .4 Fire Department Connection, Storz Type:
 - .1 Manufacturers: Provide products by one of the following manufacturers:
 - .1 Croker; a Division of Morris Group International.
 - .2 Guardian Fire Equipment, Inc.
 - .3 Potter Roemer LLC; a Division of Morris Group International.
 - .2 Standard: UL 405.
 - .3 Type: Exposed [Exposed] [Flush] [Yard (Freestanding)].
 - .4 Orientation Straight.
 - .5 Pressure Rating: 175 psig (1200 kPa) minimum.
 - .6 Body Material: Corrosion-resistant metal.
 - .7 Inlets: Universal, threadless (Storz) connector in accordance with NFPA 1963.
 - .8 Storz Caps: Corrosion-resistant metal, with gasket and chain.

- .9 Escutcheon Plate: Round, brass.
- .10 Outlet: Back, with pipe threads.
- .11 Number of Inlets: One.
- .12 Escutcheon Plate Marking: "AUTO SPKR & STANDPIPE".
- .13 Finish: Polished chrome plated.
- .14 Inlet Size: NPS 4 Storz
- .15 Outlet Size: NPS 4 (DN 100).

2.4 HOSE CONNECTIONS AND HOSE STATIONS

- .1 Hose Connections, Pressure Regulating:
 - .1 Manufacturers:
 - .1 Croker; a Division of Morris Group International.
 - .2 Elkhart Brass Mfg. Co., Inc.
 - .3 Guardian Fire Equipment, Inc.
 - .4 Potter Roemer LLC; a Division of Morris Group International.
 - .5 Zurn Industries, LLC.
 - .2 Standards:
 - .1 UL 668.
 - .2 UL 1468.
 - .3 Description: Field adjustable fire hose valve, with integral reducing or restricting pressure-control device, for connecting fire hose.
 - .4 Pressure Rating: 400 psig (2760 kPa) maximum inlet.
 - .5 Material: Brass or bronze.
 - .6 Size: NPS 1-1/2 or NPS 2-1/2 (DN 40 or DN 65), as indicated.
 - .7 Inlet: Female pipe threads.
 - .8 Outlet: Male hose threads with lugged cap, gasket, and chain. Include hose valve threads in accordance with NFPA 1963 and matching local fire department threads.
 - .9 Pattern: Angle or gate.
 - .10 Pressure-Control Device Type: Pressure reducing.
 - .11 Design Outlet Pressure Setting: _____.
 - .12 Finish: Rough brass or bronze.
- .2 Hose Connections, Non-pressure regulating:
 - .1 Manufacturers:
 - .1 Croker; a Division of Morris Group International.
 - .2 Elkhart Brass Mfg. Co., Inc.
 - .3 Guardian Fire Equipment, Inc.
 - .4 Potter Roemer LLC; a Division of Morris Group International.
 - .5 Zurn Industries, LLC.
 - .2 Standard: UL 668.
 - .3 Description: Fire hose valve for connecting fire hose.
 - .4 Pressure Rating: 300 psig (2070 kPa) minimum.
 - .5 Material: Brass or bronze.
 - .6 Size: NPS 1-1/2 or NPS 2-1/2 (DN 40 or DN 65), as indicated.
 - .7 Inlet: Female pipe threads.

- .8 Outlet: Male hose threads with lugged cap, gasket, and chain. Include hose valve threads in accordance with NFPA 1963 and matching local fire department threads.
- .9 Pattern: Angle or gate.
- .10 Finish: Rough brass or bronze.
- .3 Hose Stations, Rack Type, NPS 1-1/2 (DN 40):
 - .1 Manufacturers:
 - .1 Croker; a Division of Morris Group International.
 - .2 Guardian Fire Equipment, Inc.
 - .3 Potter Roemer LLC; a Division of Morris Group International.
 - .2 Hose Rack:
 - .1 Standard: UL 47.
 - .2 Material: Steel with red-enamel finish.
 - .3 Type: Hose-rack assembly. Include hose valve, hose rack, water-retention device, hose pins, and hose.
 - .4 Operation: Semiautomatic.
 - .5 Sized to hold fire hose.
 - .3 Hose Valve:
 - .1 Standards:
 - .1 UL 668.
 - .2 UL 1468.
 - .2 NPS 1-1/2 (DN 40), for connecting fire hose.
 - .3 Type: Adjustable.
 - .4 Pressure-Control Device: Pressure reducing or pressure restricting, UL 1468 integral or for field installation if indicated.
 - .5 Design Outlet Pressure Setting: _____.
 - .6 Hose Valve and Trim Finish: Polished chrome plated.
 - .7 Pressure Rating: 300 psig (2070 kPa) minimum.
 - .8 Pattern: Angle.
 - .9 Material: Brass or bronze.
 - .10 Size: NPS 1-1/2 (DN 40).
 - .11 Inlet: Female pipe threads.
 - .12 Outlet: Male hose threads in accordance with NFPA 1963 and matching local fire department threads.
 - .4 Hose:
 - .1 Standards:
 - .1 NFPA 1961.
 - .2 UL 219.
 - .3 UL 401.
 - .2 Description: Lined fire hose with swivel inlet, coupling, gaskets, and nozzle.
 - .3 Size: NPS 1-1/2 (DN 40).
 - .5 Length: 50 ft (15 m).
 - .1 Jacket: Combination of natural and synthetic threads.
 - .2 Lining: Rubber, plastic, or combination of rubber and plastic compounds.
 - .3 Cover: Rubber, plastic, or combination of rubber and plastic compounds.

- .4 Nozzle:
 - .1 Material: Brass.
 - .2 Type: Plain, for nonadjustable water stream.
- .4 Hose Stations, Rack Type, NPS 1-1/2 by NPS 2-1/2 (DN 40 by DN 65):
 - .1 Manufacturers:
 - .1 Croker; a Division of Morris Group International.
 - .2 Guardian Fire Equipment, Inc.
 - .3 Potter Roemer LLC; a Division of Morris Group International.
 - .2 Hose Rack:
 - .1 Standard: UL 47.
 - .2 Material: Brass or bronze with polished chrome-plated finish.
 - .3 Type: Hose-rack assembly. Include hose valve, reducer adapter, hose rack, water-retention device, hose pins, and hose.
 - .4 Operation: Semiautomatic.
 - .5 Sized to hold fire hose.
 - .3 Hose Valve:
 - .1 Standards:
 - .1 UL 668.
 - .2 UL 1468.
 - .3 NFPA 1963.
 - .2 NPS 2-1/2 (DN 65), for connecting fire hose.
 - .3 Type: Adjustable.
 - .4 Pressure-Control Device: Pressure reducing or pressure restricting, UL 1468 integral or for field installation if indicated.
 - .5 Design Outlet Pressure Setting: _____.
 - .6 Hose Valve and Trim Finish: Polished chrome plated.
 - .7 Pressure Rating: 300 psig (2070 kPa) minimum.
 - .8 Pattern: Angle.
 - .9 Material: Brass or bronze.
 - .10 Size: NPS 2-1/2 (DN 65).
 - .11 Inlet: Female pipe threads.
 - .12 Outlet: Male hose threads and matching local fire department threads.
 - .13 Reducer Adapter: NPS 2-1/2 by NPS 1-1/2 (DN 65 by DN 40).
 - .4 Hose:
 - .1 Standards:
 - .1 UL 219.
 - .2 UL 401.
 - .3 NFPA 1961.
 - .2 Description: Lined fire hose with swivel inlet, coupling, gaskets, and nozzle.
 - .3 Size: NPS 1-1/2 (DN 40).
 - .4 Length: 50 ft (15 m) .
 - .5 Jacket: Combination of natural and synthetic threads.
 - .6 Lining: Rubber, plastic, or combination of rubber and plastic compounds.

- .7 Cover: Rubber, plastic, or combination of rubber and plastic compounds.
- .8 Nozzle: Spray nozzle unless plain nozzle is indicated.
 - .1 Material: Brass.
 - .2 Type: Plain, for nonadjustable water stream.
- .5 Hose Stations, Reel Type, NPS 1-1/2 (DN 40):
 - .1 Manufacturers:
 - .1 Croker; a Division of Morris Group International.
 - .2 Guardian Fire Equipment, Inc.
 - .3 Potter Roemer LLC; a Division of Morris Group International.
 - .2 Hose Reel:
 - .1 Standard: UL 47.
 - .2 Hose Reel and Bracket Material: Steel.
 - .3 Description: Hose-reel assembly. Include hose valve, wall bracket, hose reel, water-retention device, hose pins, and hose.
 - .3 Operation: Semiautomatic.
 - .1 Sized to hold fire hose.
 - .2 Finish: Red enamel.
 - .4 Hose Valve:
 - .1 Standards:
 - .1 UL 668.
 - .2 UL 1468.
 - .3 NFPA 1963.
 - .2 NPS 1-1/2 (DN 40)), for connecting fire hose.
 - .3 Type: Adjustable.
 - .4 Pressure-Control Device: Pressure reducing or pressure restricting, UL 1468 integral or for field installation if indicated.
 - .5 Design Outlet Pressure Setting: _____.
 - .6 Hose Valve and Trim Finish: Polished chrome plated.
 - .7 Pressure Rating: 300 psig (2070 kPa) minimum.
 - .8 Pattern: Angle.
 - .9 Material: Brass or bronze.
 - .10 Size: NPS 1-1/2 (DN 40).
 - .11 Inlet: Female pipe threads.
 - .12 Outlet: Male hose threads and matching local fire department threads.
 - .5 Hose:
 - .1 Standards:
 - .1 UL 219.
 - .2 UL 401.
 - .3 NFPA 1961.
 - .2 Description: Lined fire hose with swivel inlet, coupling, gaskets, and nozzle.
 - .3 Size: NPS 1-1/2 (DN 40).
 - .4 Length: 50 ft (15 m).
 - .5 Jacket: Combination of natural and synthetic threads.

- .6 Lining: Rubber, plastic, or combination of rubber and plastic compounds.
- .7 Cover: Rubber, plastic, or combination of rubber and plastic compounds.
- .8 Nozzle:
 - .1 Material: Brass.
 - .2 Type: Spray, adjustable from shutoff to fog spray or straight stream.

2.5 SYSTEM CONTROL VALVES

- .1 Listed in UL's "Fire Protection Equipment Directory" or FM Approvals' "Approval Guide."
- .2 Pressure Rating:
 - .1 Standard-Pressure Piping Valves: 175 psig (1200 kPa) minimum.
 - .2 High-Pressure Piping Valves: 250 psig (1725 kPa) minimum.
- .3 Body Material: Cast or ductile iron.
- .4 Size: Same as connected piping.
- .5 End Connections: Flanged or grooved.
- .6 System Control Valve, Dry-Pipe Valve:
 - .1 Manufacturers:
 - .1 Reliable Automatic Sprinkler Co., Inc. (The).
 - .2 Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.
 - .3 Victaulic Company.
 - .4 Viking Group Inc.
 - .2 Standards:
 - .1 UL 260.
 - .2 UL 1486.
 - .3 Design: Low-pressure, mechanically operated, latching type with external reset. Valve shall be able to reset without removing a face plate.
 - .4 Include quick-opening devices, trim sets for supervisory gas supply, drain, priming level, alarm connections, ball drip valves, pressure gauges, priming chamber attachment, and fill-line attachment with strainer Accelerator shall be mechanical type.
 - .5 Provide a preassembled dry pipe system assembly, including dry pipe valve with the required trim, supervised control valve, with release control panel. Include air compressor, dehydrator(s), nitrogen tank, nitrogen generator and supervised discharge side control valve for testing. The entire package shall be prewired and installed within a free-standing, textured inside and outside rust proof coated fire red cabinet. The cabinet shall be tested as an assembly by the manufacturing prior to shipping.
 - .6 Include trim sets for alarm-test bypass, drain, electrical water-flow alarm switch, pressure gauges, drip cup assembly piped without valves and separate from main drain line, and fill-line attachment with strainer.
 - .7 Supervisory Gas - Pressure Maintenance Device for Dry-Pipe Valve:
 - .1 Manufacturers: Provide products by one of the following manufacturers:
 - .1 General Air Products, Inc.
 - .2 Potter Electric Signal Company, LLC.
 - .3 Reliable Automatic Sprinkler Co., Inc. (The).
 - .4 Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.

- .5 Victaulic Company.
 - .6 Viking Group Inc.
 - .2 Standard: UL 260.
 - .3 Description: Automatic device to maintain minimum air pressure in piping.
 - .4 Include shutoff valves to permit servicing without shutting down sprinkler piping, bypass valve for quick filling, pressure regulator or switch to maintain pressure, strainer, pressure ratings with 14 to 60 psig (95 to 410 kPa) adjustable range, and 175 psig (1200 kPa) outlet pressure.
- .7 System Control Valve, Deluge Valve:
 - .1 Manufacturers:
 - .1 BERMAD Control Valves.
 - .2 CLA-VAL.
 - .3 OCV Control Valves.
 - .2 Reliable Automatic Sprinkler Co., Inc. (The).
 - .1 Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.
 - .2 Victaulic Company.
 - .3 Viking Group Inc.
 - .3 Standard: UL 260.
 - .4 Design: Hydraulically operated, differential-pressure type.
 - .5 Include trim sets for alarm-test bypass, drain, electrical water-flow alarm switch, pressure gauges, drip cup assembly piped without valves and separate from main drain line, and fill-line attachment with strainer.
 - .6 Wet, Pilot-Line Trim Set: Include gauge to read diaphragm-chamber pressure and manual control station for manual operation of deluge valve, and connection for actuation device.
- .8 System Control Valve, Preaction Valve:
 - .1 Manufacturers: Provide products by one of the following manufacturers:
 - .1 Reliable Automatic Sprinkler Co., Inc. (The).
 - .2 Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.
 - .3 Victaulic Company.
 - .4 Viking Group Inc.
 - .2 Standard: UL 260.
 - .3 Design: Low-pressure, mechanically operated, latching type with external reset. Valve shall be able to reset without removing a face plate.
 - .4 Include UL 1486, quick-opening devices, trim sets for supervisory gas supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, anti-flood device and fill-line attachment. Accelerator shall be mechanical type.
 - .5 Provide a preassembled preaction system assembly, including preaction valve with the required trim, with release control panel. Include air compressor, dehydrator(s), nitrogen tank, nitrogen generator and supervised discharge side control valve for testing. The entire package shall be prewired and installed within a free-standing, textured inside and outside rust proof coated fire red cabinet. The cabinet shall be tested as an assembly by the manufacturing prior to shipping.

- .6 Include trim sets for alarm-test bypass, drain, electrical water-flow alarm switch, pressure gauges, drip cup assembly piped without valves and separate from main drain line, and fill-line attachment with strainer.
- .7 Supervisory Gas - Pressure Maintenance Device for Preaction Valve:
 - .1 Manufacturers: Provide products by one of the following manufacturers:
 - .1 Reliable Automatic Sprinkler Co., Inc. (The).
 - .2 Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.
 - .3 Victaulic Company.
 - .4 Viking Group Inc.
 - .2 Standard: UL 260.
 - .3 Description: Automatic device to maintain minimum air pressure in piping.
 - .4 Include shutoff valves to permit servicing without shutting down sprinkler piping, bypass valve for quick filling, pressure regulator or switch to maintain pressure, strainer, pressure ratings with 14 to 60 psig (95 to 410 kPa) adjustable range, and 175 psig (1200 kPa) outlet pressure.

2.6 FIRE-PROTECTION PIPING SPECIALTIES

- .1 Branch Outlet Fittings:
 - .1 Manufacturers:
 - .1 ASC Engineered Solutions, Gruvlok Figure 7046.
 - .2 Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America, Grinnell Figure 730.
 - .3 Victaulic Company, Figure 920 and 920N.
 - .2 Standard: UL 213.
 - .3 Pressure Rating: 175 psig (1200 kPa) minimum.
 - .4 Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
 - .5 Type: Mechanical-tee and -cross fittings.
 - .6 Configurations: Galvanized and painted, two-piece flanged ductile-iron housing with bolted connections. U-bolt and snap on type outlets are not acceptable.
 - .7 Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
 - .8 Branch Outlets: Grooved or threaded.
- .2 Flow Detection and Test Assemblies:
 - .1 Manufacturers: Provide products by one of the following manufacturers:
 - .1 AGF Manufacturing, Inc.
 - .2 Reliable Automatic Sprinkler Co., Inc. (The).
 - .3 Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.
 - .4 Victaulic Company.
 - .2 Standard: UL's "Fire Protection Equipment Directory" or FM Approvals' "Approval Guide."
 - .3 Pressure Rating: 175 psig (1200 kPa) minimum.
 - .4 Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
 - .5 Size: Same as connected piping.

- .6 Inlet and Outlet: Threaded or grooved.
- .3 Branch Line Testers:
 - .1 Manufacturers: Provide products by one of the following manufacturers:
 - .1 AGF Manufacturing, Inc.
 - .2 Croker; a Division of Morris Group International.
 - .3 Potter Roemer LLC; a Division of Morris Group International.
 - .2 Standard: UL 199.
 - .3 Pressure Rating: 175 psig (1200 kPa).
 - .4 Body Material: Brass.
 - .5 Size: Same as connected piping.
 - .6 Inlet: Threaded.
 - .7 Drain Outlet: Threaded and capped.
 - .8 Branch Outlet: Threaded, for sprinkler.
- .4 Sprinkler Inspector's Test Fittings:
 - .1 Manufacturers: Provide products by one of the following manufacturers:
 - .1 Reliable Automatic Sprinkler Co., Inc. (The).
 - .2 Viking Group Inc.
 - .2 Standard: UL's "Fire Protection Equipment Directory" or FM Approvals' "Approval Guide."
 - .3 Pressure Rating: 175 psig (1200 kPa) minimum.
 - .4 Body Material: Cast- or ductile-iron housing with sight glass.
 - .5 Size: Same as connected piping.
 - .6 Inlet and Outlet: Threaded.
- .5 Adjustable Drop Nipples:
 - .1 Manufacturers: Provide products by one of the following manufacturers:
 - .1 Aegis Technologies, Inc.
 - .2 Standard: UL 1474.
 - .3 Pressure Rating: 250 psig (1725 kPa) minimum.
 - .4 Body Material: Steel pipe with EPDM-rubber O-ring seals.
 - .5 Size: Same as connected piping.
 - .6 Length: Adjustable.
 - .7 Inlet and Outlet: Threaded.
- .6 Flexible Sprinkler Hose Fittings:
 - .1 Manufacturers: Provide products by one of the following manufacturers:
 - .1 Flexhead; an ASC Engineered Solution – Model Superflex for maximum system pressures of 175 psi.
 - .2 Victaulic Company – Model AH2 for maximum system pressures of 175 psi and AH2-300 for maximum system pressures of 300 psi.
 - .3 Victaulic Company – VicFlex model VS-1 dry pendent flexible sprinkler for maximum system pressures of 175 psi.
 - .4 Victaulic Company – AB6 Hanger Bracket Assembly with Victaulic Model AH2 or AH2-CC in lieu of rigid pipe offsets or return bends for sprinkler drops in wet, dry, and preaction systems in cold storage applications, the Victaulic VicFlex™ V33, V36, or V40 Dry Sprinkler with Integral AB6 Assembly may be used for maximum system pressures of 175 psi.

- .2 Standards:
 - .1 UL 2443.
 - .2 FM 1637.
- .3 Description: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.
- .4 Pressure Rating: 175 psig (1200 kPa) minimum.
- .5 Size: Same as connected piping, for sprinkler.
- .7 Automatic (Ball-Drip) Drain Valves:
 - .1 Manufacturers: Provide products by one of the following manufacturers:
 - .1 Reliable Automatic Sprinkler Co., Inc. (The).
 - .2 Viking Group Inc.
 - .2 Pressure Rating: 175 psig (1200 kPa) minimum.
 - .3 Type: Automatic draining, ball check.
 - .4 Size: NPS 3/4 (DN 20).
 - .5 End Connections: Threaded.
- .8 Manual Air Vent/Valve:
 - .1 Manufacturers: Provide products by one of the following manufacturers:
 - .1 AGF Manufacturing, Inc.
 - .2 Description: Ball valve that requires human intervention to vent air.
 - .3 Body: Forged brass.
 - .4 Ends: Threaded.
 - .5 Minimize Size: 1/2 inch (13 mm).
 - .6 Minimum Water Working Pressure Rating: 300 psig (2070 kPa).
- .9 Automatic Air Vent:
 - .1 Manufacturers: Provide products by one of the following manufacturers:
 - .1 AGF Manufacturing, Inc.
 - .2 CLA-VAL.
 - .3 Engineered Corrosion Solutions.
 - .4 Metraflex Company (The).
 - .5 Reliable Automatic Sprinkler Co., Inc. (The).
 - .2 Description: Automatic air vent that automatically vents trapped air without human intervention. Approved for use in wet-pipe fire-Protection system.
 - .3 Vents oxygen continuously from system.
 - .4 Float valve to prevent water discharge.
 - .5 Minimum Water Working Pressure Rating: 175 psig (1200 kPa) minimum.
- .10 Automatic Air Vent Assembly:
 - .1 Manufacturers: Provide products by one of the following manufacturers:
 - .1 AGF Manufacturing, Inc.
 - .2 Engineered Corrosion Solutions.
 - .3 South-Tek Systems, LLC.
 - .2 Description: Automatic dual air vent assembly that automatically vents trapped air without human intervention, including Y-strainer and ball valve in a pre-piped assembly. Approved for use in wet-pipe Fire-Protection system.
 - .3 Vents oxygen continuously from system.

- .4 Float valve to prevent water discharge.
- .5 Minimum Water Working Pressure Rating: 175 psig (1200 kPa) minimum.

2.7 SPRINKLERS

- .1 Manufacturers:
 - .1 Reliable Automatic Sprinkler Co., Inc. (The).
 - .2 Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.
 - .3 Victaulic Company.
 - .4 Viking Group Inc.
- .2 Standards:
 - .1 UL 199 for standard automatic sprinklers.
 - .2 UL 1767 for ESFR sprinklers.
 - .3 UL 1626 for residential sprinklers.
 - .4 FM 2000 for nonstorage application sprinklers.
 - .5 FM 2008 for storage application sprinklers.
 - .6 FM 2030 for residential sprinklers.
- .3 Listed in UL's "Fire Protection Equipment Directory" or FM Approvals' "Approval Guide."
- .4 Pressure Rating for Sprinklers:
 - .1 Standard Automatic Sprinklers: 175 psig (1200 kPa) minimum.
 - .2 High-Pressure Automatic Sprinklers: 250 psig (1725 kPa) minimum
 - .3 Residential Sprinklers: 175 psig (1200 kPa) maximum.
- .5 Sprinklers, Automatic with Heat-Responsive Element, for wet pipe sprinkler systems:
 - .1 Characteristics: Nominal 1/2 inch (13 mm) orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.
- .6 Sprinkler Finishes: As indicated in Part 3 "Application".
- .7 Special Coatings: As indicated in Part 3 "Application".
- .8 Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
 - .1 Ceiling Mounting: Chrome-plated steel, one piece, flat.
 - .2 Sidewall Mounting: Chrome-plated steel, one piece, flat.
- .9 Sprinkler Guards and Water Shields:
 - .1 Manufacturers:
 - .1 Reliable Automatic Sprinkler Co., Inc. (The).
 - .2 SprinkGuard, LLC.
 - .3 Tyco Fire Products; brand of Johnson Controls International plc, Building Solutions North America.
 - .4 Victaulic Company.
 - .5 Viking Group Inc.
 - .2 Standard: UL 199.
 - .3 Description: Wire cage with fastening device for attaching to sprinkler.
 - .4 Models: Inline SprinkGuard Part Number 2010400 and Endline SprinkGuard Part number 201049.

- .5 Type: Laser cut, mild grade steel, with fastening device for attaching sprinkler to branch line.
- .6 Sprinklers used with sprinkler guards shall only be those listed (by sprinkler identification number - SIN) in the SprinkGuard product data for use with the specific SprinkGuard models.
- .10 Escutcheons and guards shall be listed, supplied, and approved for use with the sprinkler by the sprinkler manufacturer.
- .11 Wrenches shall be provided by the sprinkler manufacturer that directly engage the wrench boss cast in the sprinkler body.

2.8 EXPANSION PLATE

- .1 Manufacturers:
 - .1 Reliable Automatic Sprinkler Co., Inc. (The).
 - .2 Viking Group, Inc.
- .2 Expansion plates shall be listed by the manufacturer for use with recessed sprinkler escutcheon or cover-plate assembly.
- .3 Expansion plates shall have a 2" oversized ring to allow for free movement of at least 1" of ceiling movement in all horizontal directions.

2.9 PIPE EXPANSION LOOPS AND JOINTS

- .1 Expansion Loops:
 - .1 Manufacturers:
 - .1 Metraflex.
 - .2 Anvil International.
 - .3 Reliable Automatic Sprinkler Co., Inc. (The).
 - .2 Expansion Loops shall be UL listed and Factory Mutual Global approved for a working pressure of 300 psig (2070 kPa) for sizes up to and including NPS 6 (DN 80) and a working pressure of 175 psig (1200 kPa) for sizes NPS 8 (DN 100) and greater.
 - .3 Expansion loops may be used for both seismic applications and for non-seismic applications where crossing building expansion or movement joints.
- .2 Expansion Joints:
 - .1 Manufacturers: Provide products by one of the following manufacturers:
 - .1 Victaulic Company – Style 155 Expansion Joint.
 - .2 Size: 4" to 10".
 - .3 Listing: Manufactured with UL listed and FM approved Victaulic Style 75 flexible couplings.
 - .4 Pressure rating: Couplings listed for a minimum working pressure of 300 psi.
 - .5 Design: Providing a total maximum linear movement of 3" (1.5" of compression and 1.5" of expansion from the neutral position). Expansion joint assembled, shipped and installed in neutral position held by tie bars. Tie bars to be removed only after installation and anchoring of pipe on each side of expansion joint.
 - .6 Expansion joints shall only be used in non-seismic applications.

2.10 ALARM DEVICES

- .1 Match alarm-device material and connection types to piping and equipment materials and connection types.
- .2 Electrically Operated Notification Appliances:
 - .1 Manufacturers:

- .1 Notifier; Honeywell International, Inc.
 - .2 Potter Electric Signal Company, LLC.
 - .2 Electric Bell:
 - .1 Standard: UL 464.
 - .2 Type: Vibrating, metal alarm bell.
 - .3 Size: 6 inch (150 mm) minimum diameter located inside of fire pump room and 10 inch (250 mm) minimum diameter above each fire department connection location.
 - .4 Voltage: 120 V ac, 60 Hz, single phase.
 - .5 Finish: Red-enamel or polyester powder-coat factory finish, suitable for outdoor use with approved and listed weatherproof backbox.
 - .3 Strobe/Horn:
 - .1 Standard: UL 464.
 - .2 Tone: Selectable, steady, Temporal-3 (T-3) in accordance with ISO 8201 and ANSI/ASA S3.41, 2400 Hz, electromechanical, broadband.
 - .3 Voltage: 120 V ac, 60 Hz.
 - .4 Effective Intensity: 110 cd.
 - .5 Finish: Red, suitable for outdoor use with approved and listed weatherproof backbox. White letters on housing identifying device as for "Fire."
 - .6 Sign, Integrated: Mount between backbox and strobe/horn with text visible on both sides, above and below strobe/horn. Housing to be shaped to cover surface-mounted weatherproof backbox. Sign is to consist of white lettering on red plastic identifying it as a "Sprinkler Fire Alarm" and instructing viewers to call 911, police or fire department.
- .3 Water-Flow Indicators for Wet Pipe Systems:
 - .1 Manufacturers:
 - .1 Potter Electric Signal Company, LLC.
 - .2 System Sensor; Honeywell International, Inc.
 - .3 Viking Group Inc.
 - .2 Standard: UL 346.
 - .3 Water-Flow Detector: Electrically supervised.
 - .4 Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125 V ac and 0.25 A, 24 V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
 - .5 Type: Paddle operated.
 - .6 Pressure Rating: 250 psig (1725 kPa) minimum.
 - .7 Design Installation: Horizontal or vertical.
- .4 Water-Flow Indicators for Dry Pipe and Preaction Systems:
 - .1 Manufacturers:
 - .1 Potter Electric Signal Company, LLC.
 - .2 System Sensor; Honeywell International, Inc.
 - .2 Standard: UL 346.
 - .3 Description: Electrically supervised, pressure-activated water-flow switch with retard feature.
 - .4 Components: Two single-pole, double-throw switches with normally closed contacts.

- .5 Design Operation: Rising pressure to 6 psig (40 kPa), plus or minus 2 psig (13.8 kPa) signals water flow.
- .6 Adjustability: Each switch is to be independently adjustable.
- .7 Wire Separation: Pressure switch to provide for separation of wiring to each switch connection to allow for low- and high-voltage connections to comply with NFPA 70, Article 760 requirements.
- .5 Pressure Switches - Low/High Supervisory Gas Pressure:
 - .1 Manufacturers:
 - .1 Potter Electric Signal Company, LLC.
 - .2 System Sensor; Honeywell International, Inc.
 - .2 Description: Electrically supervised pressure supervisory switch.
 - .3 Components: Two single-pole, double-throw switches.
 - .4 Design Operation: Detects increase and/or decrease from normal supervisory air pressure.
 - .5 Adjustability: Each switch is to be independently adjustable.
 - .6 Wire Separation: Pressure switch to provide for separation of wiring to each switch connection to allow for low- and high-voltage connections to comply with NFPA 70, Article 760 requirements.
- .6 Valve Supervisory Switches:
 - .1 Manufacturers:
 - .1 Kennedy Valve Company; a division of McWane, Inc.
 - .2 Potter Electric Signal Company, LLC.
 - .3 System Sensor; Honeywell International, Inc.
 - .2 Standard: UL 346.
 - .3 Type: Electrically supervised.
 - .4 Design: Signals that controlled valve is in other than fully open position.
 - .5 Wire Terminal Designations: Indicates normal switch position when switch is properly installed on valve and valve is fully open.
 - .6 Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - .7 OS&Y Valve Supervisory Switches:
 - .1 Two single-pole, double-throw switches.
 - .2 NEMA Rating: NEMA 4 and NEMA 6P enclosures suitable for mounting in any position indoors or outdoors.
 - .3 Visual Switch Indication: Indicates device is properly installed and OS&Y valve is fully open.
 - .4 Mounting Hardware: Mounting bracket to grip valve yoke and prevent movement of switch assembly on OS&Y valve.
 - .5 Trip Rod Length: Adjustable
 - .8 Butterfly Valve Supervisory Switches:
 - .1 Two single-pole, double-throw switches.
 - .2 NEMA Rating: NEMA 4 and NEMA 6P enclosures suitable for mounting in any position indoors or outdoors.
 - .3 Mounting Hardware: Removable nipple.
 - .4 Trip Rod Length: Adjustable

- .9 Ball Valve Supervisory Switches:
 - .1 One single-pole, double-throw switch.
 - .2 NEMA Rating: NEMA 4 enclosure suitable for mounting in any position indoors or outdoors.
 - .3 Mounting Hardware: Suitable for mounting directly to pipe, ball valves, or backflow preventers sized from up to NPS 2 (DN 50).
- .7 Indicator-Post Supervisory Switches:
 - .1 Manufacturers:
 - .1 Potter Electric Signal Company, LLC.
 - .2 System Sensor; Honeywell International, Inc.
 - .2 Type: Electrically supervised.
 - .3 Components: Single-pole, double-throw switch with normally closed contacts.
 - .4 Design: Signals that controlled indicator-post valve is in other than fully open position.

2.11 MANUAL CONTROL STATIONS

- .1 Listed in UL's "Fire Protection Equipment Directory" and FM Approvals' "Approval Guide."
- .2 Description: For hydraulic operation, with union, NPS 1/2 (DN 15) pipe nipple, and bronze ball valve.
- .3 Include metal enclosure labeled "MANUAL CONTROL STATION," with operating instructions and cover held closed by breakable strut to prevent accidental opening.

2.12 CONTROL PANELS

- .1 Description: Single-area, two-area, or single-area cross-zoned control panel as indicated, including NEMA ICS 6, Type 1 enclosure, detector, alarm, and solenoid-valve circuitry for operation of preaction valves.
 - .1 Listed in UL's "Fire Protection Equipment Directory" and FM Approvals' "Approval Guide" when used with thermal detectors and Class A detector circuit wiring.
 - .2 Electrical characteristics are 120 V ac, 60 Hz, with 24 V dc rechargeable batteries.
 - .3 Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- .2 Manual Control Stations, Hydraulic Operation: Provide union, NPS 1/2 (DN 15) pipe nipple, and bronze ball valve. Include metal enclosure, labeled "MANUAL CONTROL STATION," with operating instructions and cover held closed by breakable strut to prevent accidental opening.
- .3 Panel Components:
 - .1 Power supply.
 - .2 Battery charger.
 - .3 Standby batteries sized for 24 hour battery back-up.
 - .4 Field-wiring terminal strip.
 - .5 Electrically supervised solenoid valves and polarized fire-alarm bell.
 - .6 Lamp test facility.
 - .7 Single-pole, double-throw auxiliary alarm contacts.
 - .8 Rectifier.

2.13 FIRE DETECTION DEVICES

- .1 Refer to Specification Section 28 46 21.11 "Addressable Fire Alarm Systems" for detection devices for preaction system release.
- .2 Praction system shall also be activated by an air sampling smoke detection system. See Specification Section 28 46 21.11 "Addressable Fire Alarm Systems".
- .3 Praction system shall also be activated by UL listed and FM Global approved photoelectric smoke detectors.
 - .1 Type: Addressable.
 - .2 Zoning: Single zone per sprinkler system.
- .4 Praction system shall also be activated by UL listed and FM Global approved heat detectors.
 - .1 Type: Addressable.
 - .2 Zoning: Single zone per sprinkler system.
 - .3 Activation method: Rate compensation.
 - .4 Temperature rating: 195 degree F.

2.14 PRESSURE GAUGES

- .1 Manufacturers:
 - .1 AGF Manufacturing, Inc.
 - .2 Ametek U.S. Gauge.
 - .3 Ashcroft Inc.
 - .4 Brecco Corporation.
 - .5 WIKA Instrument Corporation.
- .2 Standard: UL 393.
- .3 Dial Size: 3-1/2- to 4-1/2 inch (90- to 115 mm) diameter.
- .4 Pressure Gauge Range: Zero to 250 psig (Zero to 1725 kPa) minimum.
- .5 Water System Piping Gauge: Include "WATER" or "AIR/WATER" label on dial face.
- .6 Air System Piping Gauge: Include retard feature and "AIR" or "AIR/WATER" label on dial face.

PART 3 EXECUTION

3.1 APPLICATION

- .1 Piping Application:
 - .1 Above Ground Piping between Fire Department Connections and Check Valves: Standard-weight steel pipe with grooved ends, grooved-end fittings, grooved-end-pipe couplings, and grooved joints.
 - .2 Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.
 - .3 Standard-pressure, wet-pipe fire protection system steel piping shall be one of the following:
 - .1 Schedule 40, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
 - .2 Schedule 40, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
 - .3 Schedule 40, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

- .4 Schedule 40, galvanized-steel pipe with cut- or roll-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
- .5 Schedule 40, black-steel pipe with plain ends; steel welding fittings; and welded joints.
- .6 Schedule 10 black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
- .7 Schedule 10, black-steel pipe with plain ends; welding fittings; and welded joints.
- .4 High-Pressure, Wet-Pipe Fire Protection System Steel Piping to Be One of the Following:
 - .1 Schedule 40, black steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
 - .2 Schedule 40, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
 - .3 Schedule 40, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 - .4 Schedule 40, galvanized-steel pipe with cut- or roll-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 - .5 Schedule 40, black-steel pipe with plain ends; steel welding fittings; and welded joints.
 - .6 Where maximum system pressure does not exceed 300 psig (2070 kPa): Schedule 10 black-steel or galvanized steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 - .7 Where maximum system pressure does not exceed 300 psig (2070 kPa): Schedule 10, black-steel pipe with plain ends; welding fittings; and welded joints.
- .5 Standard and high-Pressure, dry-pipe and preaction fire Protection system steel piping to be one of the following:
 - .1 Schedule 40, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
 - .2 Schedule 40, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
 - .3 Schedule 40, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 - .4 Schedule 40, galvanized-steel pipe with cut- or-roll grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 - .5 Schedule 40, black-steel pipe with plain ends; steel welding fittings; and welded joints.
 - .6 Where maximum system pressure does not exceed 300 psig and nitrogen generator is used as the supervisory gas: Schedule 10 black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

- .7 Where maximum system pressure does not exceed 300 psig and nitrogen generator is used as the supervisory gas: Schedule 10, black-steel pipe with plain ends; welding fittings; and welded joints.
- .2 Sprinkler Application:
 - .1 Use sprinkler types in subparagraphs below for the following applications:
 - .1 Rooms without Ceilings: Upright, pendent and sidewall sprinklers as indicated.
 - .2 Rooms with Suspended Ceilings: Recessed pendent sprinklers.
 - .3 Wall Mounting: Recessed horizontal sidewall sprinklers.
 - .4 Spaces Subject to Freezing: Upright sprinklers.
 - .5 Special Applications: Extended-coverage and quick-response sprinklers where indicated.
 - .2 Provide sprinkler types in subparagraphs below with finishes indicated:
 - .1 Upright, Pendent, and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces and locations not generally exposed to view.
 - .2 Recessed Sprinklers: Bright chrome on sprinkler and escutcheon.
 - .3 Flat Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
 - .4 Outdoor areas and high humidity areas, including but not limited to: exterior areas, shower rooms, steam rooms, saunas, laundry rooms, kitchens: manufacturer's polyester corrosion resistant coating.
 - .5 Areas exposed to acids, chemicals, chlorine, ammonia or other corrosive fumes, including but not limited to, over pools, pool equipment rooms and ammonia refrigeration machine rooms: Wax over polyester coated finish.
 - .6 Two-piece escutcheon plates on pendent or sidewall sprinklers are not allowed, unless specifically noted otherwise.

3.2 EXAMINATION

- .1 Examine roughing-in for hose connections and hose stations to verify actual locations of piping connections before installation.
- .2 Examine walls and partitions for suitable thickness, fire- and smoke-rated construction, framing for hose-connection cabinets, and other conditions where hose connections and hose stations are to be installed.
- .3 Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 PREPARATION

- .1 Perform fire-hydrant flow test. Use results for system design calculations required in "Quality Assurance" Article.
 - .1 Fire hydrant or Fire pump flow test shall be performed to meet the criteria established by NFPA 13, NFPA 14, and NFPA 20.
 - .2 Flow test is to be conducted in accordance with NFPA 291.
 - .3 Test is to be performed during a period of ordinary demand for the water system.
 - .1 To obtain satisfactory test results of expected flow or rated capacities, sufficient discharge should be achieved to cause drop of at least 10 percent.
 - .4 Pitot readings are to be taken at the 2-1/2 inch (65 mm) orifice connection.
 - .5 The pitot reading is to range from 10 to 35 psig (68.9 kPa to 241.3 kPa).
 - .6 Open additional hydrant outlets as needed to control pitot readings.
 - .7 The pitot pressure and corresponding residual pressure readings are to be taken consecutively as pressure fluctuates between a high number and low number.

- .2 Flow Test Data Written Report:
 - .1 Flow data report is to be written in accordance with NFPA 291.
 - .2 Flow data report is to include a copy of all flow data recorded during the test, including a site plan showing the tested fire hydrants with respect to the fire water service to the building. Site plan is to indicate which hydrant was flowed and which hydrant was used for pressure reading. Provide date of test, name of testing agency, and name of individual performing test.
- .3 Water Supply Curve: Provide water supply curve based on the lowest supply for a given set of test data. For a given residual pressure reading, the supply is to be graphed utilizing the corresponding pitot pressure/flow reading and static pressure reading.
- .4 Documentation is to include calibration certifications for gauges used in the flow tests. The certifications are to be from within the previous six (6) months from a reputable agency recognized for certifying pressure gauges.
- .5 Report flow test results promptly and in writing. A copy of the flow test data report is to be submitted with the hydraulic calculations.

3.4 INSTALLATION

- .1 Installation of Fire-Protection Piping
 - .1 Water Supply Connection Installation:
 - .1 Install shutoff valve, backflow preventer, pressure gauge, drain, and other accessories indicated at connection to water-distribution piping.
 - .2 Fire-Protection Piping Installation:
 - .1 Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated on approved working plans.
 - .1 Deviations from approved working plans for piping require written approval from AHJs. File written approval with Architect before deviating from approved working plans.
 - .2 Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.
 - .3 Piping shall be installed with a minimum number of joints and couplings, but with adequate and accessible connections for disassembly, maintenance, and replacement of piping components. Pipe shall be reamed and deburred to remove any rough edges from the end of pipe. Piping joints and connections shall be assembled airtight and watertight.
 - .4 All piping, valves and devices shall be installed as high as possible, and shall not obstruct any portion of a window, doorway, stairway, or passageway, and shall not interfere with the operation or accessibility of any existing mechanical, plumbing or electrical equipment to the Owner's satisfaction.
 - .2 General:
 - .1 Piping Standard: Comply with NFPA 13 and NFPA 14 requirements for installation of fire-Protection piping.
 - .2 Orient longitudinal weld seams toward the building roof, at the 12 o'clock position.
 - .3 Dry-Pipe system piping shall be pitched back to riser or low point drains as required by NFPA 13.

- .4 Preaction system piping shall be pitched back to riser or low point drains as required by NFPA 13.
- .5 Gridded and looped systems shall not be allowed for Dry-Pipe systems.
- .6 Gridded and looped systems shall not be allowed for Preaction systems.
- .7 Install seismic restraints on piping. Comply with NFPA standards requirements for seismic-restraint device materials and installation.
- .8 Install pipe expansion loops where piping crosses building expansion or movement joints in seismic applications.
- .9 Install pipe expansion joints or pipe expansion loops where piping crosses building expansion or movement joints in non-seismic applications.
- .10 Install listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- .11 Install inspector's test connections in sprinkler system piping, complete with shutoff valve, and sized and located in accordance with NFPA 13 based on system type.
- .12 Install fire-protection system piping with drains for complete system drainage. Extend drain piping to exterior of building when possible or open hub drain capable of accepting required flow rate without flooding.
- .13 Install relief valve on every wet pipe sprinkler system. Relief valve shall not less than ½ inch in size and set to operate at 175 psi or 10 psi in excess of the maximum system pressure, whichever is greater.
- .14 Provide air vent at top of sprinkler risers, standpipe risers, combination risers and drain risers.
- .15 Provide air vent conforming to NFPA 13 requirements on each wet pipe system utilizing metallic pipe. Air vents shall be installed near a high point in the system. Where automatic relief vents are used, they shall be piped to the drain riser or other safe discharge location.
- .16 Install wet-pipe sprinkler system control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.
- .17 Install automatic (ball drip) drain valve at each check valve for fire department connection, to drain piping between fire department connection and check valve. Install drain piping to and spill over floor drain or to exterior of building.
- .18 Install alarm devices in piping systems.
- .19 Install hangers and supports for fire-protection piping in accordance with NFPA standards. Comply with requirements for hanger materials in NFPA standards.
- .20 Install pressure gauges on riser or feed main, at each sprinkler test connection, at top of each standpipe/sprinkler riser and all other locations in accordance with NFPA standards. Include pressure gauges with connection not less than NPS 1/4 (DN 8) and with soft-metal seated globe valve, arranged for draining pipe between gauge and valve. Install gauges to permit removal and install where they are not subject to freezing.
- .21 Pressurize and check dry-pipe sprinkler system piping and air-pressure maintenance devices.

- .22 Pressurize and check preaction sprinkler system piping and air-pressure maintenance devices.
- .23 Fill wet-type fire-protection system piping with water.
- .24 Drain dry-type fire-protection system piping.
- .25 Drain preaction fire-protection system piping.
- .26 Install sleeves for piping penetrations of walls, ceilings, and floors.
- .27 Install sleeve seals for piping penetrations of concrete walls and slabs.
- .28 Install escutcheons for piping penetrations of walls, ceilings, and floors.
- .29 The Contractor shall provide Owner approved, adequate permanent protection for any installed piping, valves, devices, or accessories which, in the Owner's opinion, are subject to physical damage.
- .30 When welding is performed on black steel pipe, piping shall be shop welded. Welding methods shall conform to the applicable requirements of AWS B2. Welding and welded outlets shall not be acceptable on galvanized pipe.
- .31 Penetrations of ductwork shall not be permissible.
- .32 Dry-type standpipes shall not be concealed in building walls or built into pilasters.
- .33 Fire-protection system piping shall not pass-through hazardous areas and shall be located so that it is protected from mechanical and fire damage.
- .34 All piping on dry-type fire-protection systems shall be installed so that the entire system may be drained. The number of auxiliary drains shall be kept to a minimum.
- .35 All piping on preaction fire protection systems shall be installed so that the entire system may be drained. The number of auxiliary drains shall be kept to a minimum.
- .36 Install a NPS 3 (DN 75) grooved capped inlet on the NPS 3 (DN 75) drain riser(s) to allow testing of the pressure regulating hose valve(s).
- .37 Pooling of cutting oil or other petroleum-based products in the sprinklers must be avoided. Always cut and thread pipe without the sprinkler being attached and always be sure to check and drain the drops of any excessive oil prior to the installation of sprinklers.
- .38 Provide a minimum clearance of 12 inches under bottom of fire-protection piping above suspended ceiling for lighting to be installed under tenant improvements.
- .39 Route fire-protection piping in orderly manner, plumb and parallel to building structure. Maintain gradient.
- .40 Where corrosive conditions exist or piping is exposed to the weather, corrosion resistant type of pipe, fittings, and hangers shall be used.
- .41 Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- .42 No fire-protection system piping shall be installed inside of electrical equipment rooms except for sprinkler branch line piping serving sprinklers within the same electrical room, and all such branch line piping shall dead end within the electrical equipment room. Avoid routing sprinkler system piping and installing sprinkler heads directly over electrical equipment. Reroute piping and add additional sprinklers as required to avoid sprinklers and pipe installed directly over electrical

equipment.

.3 Piping Joint Installation:

- .1 Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- .2 Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- .3 Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- .4 Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts in accordance with ASME B31.9.
- .5 Threaded Joints: Thread pipe with tapered pipe threads in accordance with ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - .1 Apply appropriate tape or thread compound to external pipe threads.
 - .2 Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- .6 Welded Joints: Construct joints in accordance with AWS D10.12/D10.12M, using qualified processes and welding operators in accordance with "Quality Assurance" Article.
- .7 Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.
- .8 Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe in accordance with AWWA C606 in accordance with the manufacturer's latest published instructions. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings in accordance with AWWA C606 for steel-pipe joints. Grooved coupling manufacturer's factory trained field representative shall provide on-site training for contractor's field personnel in the proper use of grooving tools, application of groove, and installation of grooved piping products. The factory trained representative shall periodically visit the jobsite to ensure best practices in grooved product installation are being followed. Contractor shall remove and replace any improperly installed products.
- .9 Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe in accordance with AWWA C606 in accordance with the manufacturer's latest published instructions. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings in accordance with AWWA C606 for steel-pipe grooved joints. Grooved coupling manufacturer's factory trained field representative shall provide on-site training for contractor's field personnel in the proper use of grooving tools, application of groove, and installation of grooved piping products. The factory trained representative shall periodically visit the jobsite to ensure best practices in grooved product installation are being followed. Contractor shall remove and replace any improperly installed products.
- .10 Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

- .11 Rubber gasketed pipe fittings and couplings shall not be installed where ambient temperatures can be expected to exceed 150 degrees Fahrenheit unless listed for this service.
- .12 A one-piece reducing fitting shall be used wherever a change is made in the size of pipe.
- .13 Do not use couplings to provide support point for vertical piping.
- .14 All grooved mechanical couplings, fittings and gaskets shall be of the same manufacturer.
- .3 Fire Department Connection Installation:
 - .1 Install exposed-type fire department connections.
 - .2 Install flush mounted wall-type fire department connections.
 - .3 Install yard-type fire department connections in concrete slab support.
 - .4 Install Storz type fire department connections.
 - .5 Install automatic (ball-drip) drain valve at each check valve for fire department connection.
- .4 Hose Connection and Hose Station Installation:
 - .1 Install hose connections adjacent to standpipes.
 - .2 Install freestanding hose connections and hose stations for access and minimum passage restriction.
 - .3 Install NPS 1-1/2 (DN 40) hose-connection and hose-station valves with flow-restricting device unless otherwise indicated.
 - .4 Install NPS 2-1/2 (DN 65) hose connections with quick-disconnect NPS 2-1/2 (DN 65) by NPS 1-1/2 (DN 40) reducer adapter and flow-restricting device unless otherwise indicated.
 - .5 Install wall-mounted-type hose connections and wall-mounted, rack hose stations in cabinets. Include pipe escutcheons, with finish matching valves, inside cabinet where water-supply piping penetrates cabinet. Install valves at angle required for connection of fire hose.
 - .6 Install freestanding hose stations with support or bracket attached to standpipe.
 - .7 Install hose-reel hose stations on wall with bracket.
 - .8 Install valved outlet for pressure gage immediately upstream of each pressure-regulating fire hose valve.
- .5 Valves and Specialties Installation:
 - .1 Install listed Fire-Protection system control valves, trim and drain valves, specialty valves and trim, controls, and specialties in accordance with manufacturer's installation instructions, NFPA standards, and Authorities Having Jurisdiction.
 - .2 Install listed Fire-Protection system shutoff valves in supervised open position, located to control sources of water supply except from fire department connections. Install permanent identification signs indicating portion of system controlled by each valve. Fire protection valves intended to be normally closed, such as fire pump test connection control valve, shall be supervised closed.
 - .3 System Control Valves:
 - .1 Install dry-pipe valves with trim sets for air supply, drain, priming level, alarm connections, ball-drip valves, pressure gauges, priming chamber attachment, and fill-line attachment.
 - .2 Install preaction valves with trim sets for air supply, drain, priming level, alarm connections, ball-drip valves, pressure gauges, priming chamber

- attachment, and fill-line attachment.
- .3 Install deluge valves with trim sets for drain, priming level, alarm connections, ball-drip valves, pressure gauges, priming chamber attachment, and fill-line attachment.
- .4 Install air-pressure maintenance device with shutoff valves to permit servicing without shutting down system; bypass valve for quick system filling; pressure regulator or switch to maintain system pressure; strainer; pressure ratings with 14 to 60 psig adjustable range; and 175 psig maximum inlet pressure.
- .5 Air Vent:
 - .1 Provide at least one air vent at high point in each wet-pipe fire-Protection system in accordance with NFPA standards. Connect vent into top of fire-Protection piping.
 - .2 Provide dielectric union for dissimilar metals, ball valve, and strainer upstream of automatic air vent.
 - .3 For automatic air vents, pipe from outlet of air vent to drain.
- .6 Control valves installed overhead, shall be positioned so that the indicating feature is visible from the floor. Wafer type valves with components that extend beyond the valves body shall be installed in a manner that does not interfere with the operation of any system component.
- .7 Provide drain valves at main shutoff valves, low points of piping and trapped portions of piping per NFPA 13 based on system type.
- .6 Sprinkler Installation:
 - .1 Install sprinklers in accordance with their listing.
 - .2 Unless otherwise indicated, all sprinklers shall be arranged symmetrically within each room or space. All sprinklers to be installed in suspended ceilings of any type shall be aligned and shall be located as indicated on the architectural reflected ceiling plans or fire protection plans. In areas without a suspended ceiling, install sprinkler piping as high as possible.
 - .3 The sprinkler deflector distance for recessed pendent or flush pendent sprinklers below the suspended ceiling shall be consistent.
 - .4 Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, soffits, ceiling and elevation changes and partition assemblies.
 - .5 Coordinate layout and installation of sprinklers in exposed construction areas with structural elements and work of other trades.
 - .6 Placement of sprinklers shall comply with NFPA 13 obstruction rules.
 - .7 Do not install sprinklers that have been dropped, damaged, show a visible loss of fluid, or a cracked bulb.
 - .8 The sprinkler bulb protector shall be removable by hand, without tools or devices that may damage the bulb.
 - .9 Where codes require seismic protection in seismic design category C, sprinkler penetrations as ceilings shall have a minimum of ¼" clearance on all sides. Where codes require seismic protection is seismic design category D, E or F, sprinkler penetrations at ceiling shall have a 2" oversized ring (expansion plate) to allow for free movement of at least 1" of ceiling movement in all horizontal directions. As an option, Factory Mutual Global approved braided flexible sprinkler drops as manufactured by Flexhead Industries, "Flexhead", passing ICC AC-156 seismic qualification testing of nonstructural components or equivalent manufacturers whose products have also passed ICC AC-156 testing may be used.

- .10 Install sprinklers in suspended ceilings symmetrically in center of narrow dimension of acoustical ceiling panels within tolerance of 1/2 inch. Coordinate entire pattern of sprinkler locations with approved reflected ceiling plan.
 - .11 Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing. Install dry pendent sprinklers in tee fitting. The minimum length between the sprinklers and fittings shall be in accordance with the manufacturer's instructions.
 - .12 Install sprinklers into flexible, sprinkler hose fittings, and install hose into bracket on ceiling grid.
 - .13 Horizontal sidewall sprinklers shall not be installed back-to-back in residential occupancies. Provide a minimum of 6 inch horizontal separation to reduce sound transmission.
 - .14 Horizontal sidewall, standard response, intermediate temperature rated sprinklers shall be installed at the bottom of each elevator hoist-way. Sprinklers at the bottom of hoist-way shall not be more than 2 feet above the floor of the pit. Provide a supervised dedicated shut off valve and water-flow switch in the supply feeding the sprinklers in each elevator pit.
 - .15 Upright or pendent standard response, intermediate temperature rated sprinklers shall be installed in the elevator hoist-ways and machine rooms. Provide a dedicated supervised shutoff valve and water-flow switch in the supply feeding the sprinklers in each elevator machine room and at the top of each elevator shaft.
 - .16 Sprinklers shall be installed under fixed obstructions or grouped obstruction over 4 feet or as required by NFPA 13 obstruction rules.
 - .17 Sprinklers installed below 7 feet above finished floor in areas having exposed construction shall be provided with head guards.
 - .18 Sprinklers installed under open grating shall be of the intermediate level/rack storage type or otherwise shielded from the discharge of overhead sprinklers.
 - .19 Positioning of sprinkler deflector under ceiling, metal deck or slab shall conform to the requirements of NFPA 13. Deflector of sprinklers shall be aligned parallel to ceiling or roof.
 - .20 Provide sprinkler protection in the accessible vertical shaft and/or around vertical opening if the vertical opening(s) are not protected by fire rated enclosure.
 - .21 Protective caps and straps shall be removed from all sprinklers prior to the time when the sprinkler system is placed in service.
 - .22 A minimum of 18-inch clearance shall be maintained between top of storage and ceiling sprinkler deflector.
 - .23 Sprinklers having both a K-factor exceeding 5.6 and having 1/2 inch national standard threads shall not be installed.
 - .24 Sidewall sprinklers shall only be installed in light hazard occupancies with smooth, horizontal, or sloped, flat ceilings. Sidewall sprinklers, in ordinary hazard occupancies with smooth, flat ceilings where specifically listed for such use.
 - .25 Sprinklers shall be designed to open at temperature from 135 deg F to 165 deg F in locations where the ceiling temperature does not exceed 100 deg F. Where the ceiling temperature exceeds 100 deg F, the temperature rating of sprinklers shall be in accordance with NFPA 13. Comply with NFPA 13 for alternate sprinkler temperature requirements based on proximity to heat sources, etc.
- .7 Preaction System Installation:

- .1 Supervised control valves shall be installed upstream and downstream of deluge valve on preaction valve assemblies.
- .2 The system size for double interlock preaction system shall be based on water delivery time no more than 60 seconds. Contractor shall perform water delivery calculations to confirm water delivery requirement is met and installed accelerators where required to meet the 60 second requirement.
- .3 Starter and power wiring, including local disconnect, and final terminations for supervisory gas system will be provided under this Section.
- .4 Sprinklers installed in the pendent position shall be dry pendent type except when pendent sprinklers are installed on return bends and sprinklers and branch line piping are in areas maintained at or above 40 deg F.
- .5 An approved relief valve shall be provided between the air supply and the shutoff valve and shall be set to relieve pressure no less than 10 psi more than system pressure and shall not exceed manufacturer's limitation. Installation of relieve valve is not required on single interlock systems when air pressure supplied from a source that is not capable of developing pressure more than 15 psi.
- .6 Listed pressure gauges shall be installed upstream and downstream of the preaction valve and the supervisory gas supply line to the preaction valve and deluge valves.
- .7 Sprinkler system and fire detection devices shall be automatically supervised.
- .8 A supply of spare fusible elements for heat-responsive devices, not less than two of each temperature rating, shall be maintained on the premises for replacement purposes.
- .9 Detection circuits for the initiation of preaction systems shall utilize Class A wiring.
- .10 An additional detection device shall be provided on each circuit for test purposes at an accessible location and shall be connected to the circuit at a point that will assure a proper test of the circuit.
- .11 Provide all conduit, wire and modules required for signaling of Protection system panel "alarm" and "trouble" conditions to the Building Fire Alarm System, including annunciation of each alarm and trouble condition at the Fire Alarm Annunciator/Command Panel.
- .12 Verify location(s) of existing Building Fire Alarm Control Panel or multiplex transponder panel in field for connection of alarm/trouble signals. Provide zones/modules if spares are not available.
- .13 Provide all conduit, wire and modules required for signaling of preaction system panel "alarm" and "trouble" conditions from the local releasing panel to the Building Fire Alarm System, including annunciation of each alarm and trouble condition at the Fire Alarm Annunciator/Command Panel.
- .14 Spacing of releasing devices shall be in accordance with their listing and NFPA 72. Where thermal activation is utilized, the activation temperature of the release system shall be less than the activation temperature of the sprinkler.
- .15 The wiring for control panel and associated components shall be provided under this section. The wiring must be installed in minimum 3/4-inch metallic conduits. The wiring shall conform to the National Electric Code and NFPA 72.
- .16 Provide power calculation (standby battery) to demonstrate that the system has 90 hour power supply in the event of power failure.
- .17 Provide maintenance manuals and training for Owner's personnel upon completion of installation.

- .18 Install alarm bell adjacent to preaction valve assembly for local annunciation of alarm conditions.
- .19 Sequence of Operation:
 - .1 Upon closure of control valve on the preaction valve assemblies or loss of supervisory gas in the piping due to activation of a sprinkler or rupture of pipe and/or fitting, a trouble/supervisory signal shall be transmitted to the preaction releasing control panel, building fire alarm panel and BAS panel.
 - .2 Upon activation of heat detector, the following sequence shall occur:
 - .1 Transmit alarm signal at the releasing control panel and building fire alarm panel.
 - .2 Alarm bell/horn sound alarm.
 - .3 Water will enter the piping but will not discharge over the hazard until the sprinkler is operated in the single interlock systems.
 - .4 Water will enter the piping only upon activation of a detection device and loss of supervisory gas as registered by a pneumatic actuator in double interlock system(s).
 - .5 Water flow alarm signal is transmitted at the releasing control panel, the building fire alarm panel and BAS panel.
 - .6 Continuous audible device sounds alarm.
 - .3 Upon manual activation of the preaction valve by the operation of the manual emergency release causes the following:
 - .1 Continuous audible device sounds alarm.
 - .2 Waterflow alarm is transmitted at the releasing and building fire alarm panel.

3.5 CONNECTIONS

- .1 Connect supervisory gas supply to sprinkler piping.
- .2 Connect air compressors and nitrogen generators to the following piping and wiring:
 - .1 Pressure gages and controls.
 - .2 Electrical power system.
 - .3 Fire-alarm devices, including low-pressure alarm.

3.6 FIELD TESTING

- .1 Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - .1 Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
 - .2 Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - .3 Flush, test, and inspect fire-protection systems in accordance with NFPA standards.
 - .4 Energize circuits to electrical equipment and devices.
 - .5 Standpipe Flow Test: Conduct a flow test flowing 250 gpm out of each of the top two hose outlets on the same riser for each zone. Record the pressure at the hose outlets.
 - .6 Coordinate with fire-alarm tests. Operate as required.
 - .7 Coordinate with fire-pump tests. Operate as required.
 - .8 Verify that equipment hose threads are same as local fire department equipment.

- .9 Verify that sprinklers original factory finish has not been contaminated with dirt, debris, or paint. Sprinklers containing other-than-original factory finish are to be considered defective and replaced with new products. Repair and/or cleaning is not acceptable.
- .2 The installer shall perform all the required acceptance tests per the provisions of applicable sections of NFPA standards, complete the contractor's Material and Test Certificate(s), forward the certificates to the authority having jurisdiction prior to asking approval for installation. Contractor shall give advance notification of the time and date the testing will be performed.
- .3 All fire-protection system piping shall be tested hydrostatically at not less than 200 psig (1378 kPa) minimum pressure for 2 hours, except when the system pressure is more than 150 psig (1035 kPa), then all fire protection system piping shall be tested at a pressure of 50 psig (345 kPa) more than the maximum system working pressure for two (2) hours. The test pressure shall be read from a gauge located at the low elevation point of the system being tested. If weather does not permit testing system with water, an interim test may be conducted with air pressure of at least 40 psig (276 kPa) allowed to stand for 24 hours with no leakage more than 1.5 psig (10 kPa). The standard hydrostatic test shall be conducted when weather permits.
 - .1 Additives, corrosive chemicals such as sodium silicate or derivative of sodium silicate brine or other chemicals shall not be used for stopping leaks while hydrostatically testing systems. However, use of biocides and other chemicals that are approved and used for prevention and mitigation of MIC and that do not adversely affect the fire-fighting properties are permitted.
 - .2 Submit contractors and material test certificates signed by installing contractor and owner's representative in accordance with NFPA standards.
- .4 There shall be no visible leakage when the fire-protection systems are subjected to the hydrostatic pressure test.
- .5 Dry pipe fire-protection system piping shall be tested pneumatically at 40 psi in addition to the hydrostatic test. Maximum permissible loss in the pneumatic test is 1 ½ psi over the period of 24 hours.
 - .1 The test on dry pipe fire-protection systems shall measure the time to trip the valve and the time for water to be discharged by opening the inspector's test valve.
- .6 Preaction fire-protection system piping shall be tested pneumatically at 40 psi in addition to the hydrostatic test. Maximum permissible loss in the pneumatic test is 1 ½ psi over the period of 24 hours.
 - .1 The test on preaction fire-protection systems shall measure the time to trip the valve and the time for water to be discharged by opening the inspector's test valve.
- .7 Piping between the exterior fire department connection and the check valve in the fire department inlet pipe shall be tested hydrostatically in the same manner as the balance of the system.
- .8 The main drain valve shall be opened and remain open until the system pressure stabilizes. The static and residual pressures shall be recorded on the contractor's test certificate.
- .9 Water flow detecting devices, including the associated alarm circuits, shall be tested by an actual water flow through use of a test connection.
- .10 Fire-protection systems shall be considered defective if it does not pass tests and inspections.
- .11 Fire-protection system components considered defective during testing will be replaced with new components. Repair of defective components is not acceptable.
- .12 Automatic operation of the preaction sprinkler systems shall be tested in the presence of the authorities having jurisdiction, in accordance with the manufacturer's instructions. The manual and remote-control operation shall also be tested.

- .13 Prepare test and inspection reports.

3.7 IDENTIFICATION

- .1 Install labeling and pipe markers on equipment and piping in accordance with requirements for identification specified in Section 21 05 00 "Common Work Results for Fire Protection".
- .2 Identify system components, wiring, cabling, and terminals.

3.8 CLEANING

- .1 Clean dirt and debris from fire-protection system piping, system control valves, sprinklers, and associated components.
- .2 Only sprinklers with their original factory finish are acceptable. Remove and replace any sprinklers that are painted or have any other finish than their original factory finish.
- .3 Remove tape and other temporary coverings used to protect sprinklers.

3.9 DEMONSTRATION AND TRAINING

- .1 Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain water-based fire-Protection systems.

END OF SECTION

Fire Extinguishers

PART 1 GENERAL

1.1 SCOPE

- .1 Provide portable fire extinguishers as indicated on the drawings, in accordance with the listed codes, bylaws, standards and approvals including NFPA 10, the Provincial Building Code and Local Building By-Laws.
- .2 The following is a general description of the work involved:
 - .1 Portable fire extinguishers:
 - .1 Multipurpose dry chemical fire extinguishers
 - .2 Fire extinguisher cabinets

1.2 RELATED REQUIREMENTS

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted, and coordinated with all other parts.
- .2 Coordinate the work of this Section with the HVAC trades, plumbing trades, electrical trades, and ceiling trades.
- .3 Refer to and comply with the following sections:
 - .1 General Mechanical Provisions - Division 20
 - .2 General Documentation - Section 20 05 05
 - .3 Systems Demonstration and Instruction - Section 20 05 06
 - .4 Equipment Testing and Start-up - Section 20 05 08
 - .5 Common Work for Fire Suppression - Section 21 05 00
- .4 Coordinate the work of this Section with the HVAC trades, plumbing trades, electrical trades, and ceiling trades.

1.3 SUSTAINABILITY

- .1 Refer to Section 20 05 00, Sustainability

1.4 APPLICABLE CODES AND STANDARDS

- .1 Refer to Section 20 05 01, Codes, Bylaws and Standards.
- .2 Installation, workmanship, and testing shall conform to the following standards:
 - .1 Ontario Building Code
 - .2 City of Toronto (Etobicoke) Building By-Laws.
 - .3 Fire protection equipment and installation shall be approved by local Fire Commissioner.
 - .4 National Fire Protection Association NFPA 10 - Standard for Portable Fire Extinguishers.

1.5 SUBMITTALS

Fire Extinguishers

- .1 Submit shop drawings and product data for fire extinguishers and extinguisher cabinets.
- .2 Provide maintenance data for incorporation into the Mechanical Operation and Maintenance Manuals.
- .3 Refer to Section 20 05 05 Documentation and Submittals.

PART 2 PRODUCTS

2.1 GENERAL

- .1 Refer to equipment schedules on drawings for additional information.

2.2 STANDARD OF ACCEPTANCE:

- .1 Refer to Section 21 99 65 for Acceptable Manufacturers.

2.3 FIRE EXTINGUISHERS GENERAL:

- .1 All fire extinguisher assemblies shall be as per the following:
 - .1 Refer to drawings for equipment schedules and additional details.
 - .2 Cabinets as indicated in the following clauses (special finish where scheduled).
 - .3 Fully rechargeable
 - .4 Steel cylinder with bottom skirt
 - .5 Polyester powder coat finish (chrome plated where scheduled)
 - .6 Waterproof gauge
 - .7 Stainless steel or aluminum valve body and rivets, and gauge
 - .8 Handles with polyester powder coat finish (chrome plated where scheduled)
 - .9 Steel pull pin
 - .10 Compatible hook
 - .11 Service info tag, hose strap, hose, and nozzle
 - .12 As applicable, meet or exceed requirements of
 - .1 CAN/ULC-S504 Multipurpose Dry Chemical Extinguishers
 - .2 CAN/ULC-S 508-02-R13 Standard for The Rating and Fire Testing of Fire Extinguishers
 - .3 NFPA 10 Standard for Portable Fire Extinguishers
 - .4 NFPA 2001 Clean Agent Fire Extinguishing Systems

2.4 MULTIPURPOSE FIRE EXTINGUISHER

- .1 5 LB Dry Chemical Multipurpose ABC, exposed wall hung on hook
 - .2 Cabinet:
 - .1 N/A, exposed wall hung on hook
 - .3 Extinguisher:
-

Fire Extinguishers

- .1 2.3 kg [5 lb.] Dry Chemical Multipurpose 2-A:10-B:C

2.5 MULTIPURPOSE FIRE EXTINGUISHER

- .1 5 LB Dry Chemical Multipurpose ABC, surface mount cabinet
- .2 Cabinet, surface mount:
 - .1 203 mm [8"] wide x 432 mm [17"] high x 127 mm [5"] deep cabinet for surface mounting.
 - .2 22-gauge steel tub, 16-gauge steel door and trim with 5 mm [3/16"] clear tempered glass.
 - .3 Full length semi-concealed piano hinge for 180-degree swing and flush stainless-steel door latch with no exposed fasteners
- .3 Extinguisher:
 - .1 2.3 kg [5 lb.] Dry Chemical Multipurpose ABC,

2.6 MULTIPURPOSE FIRE EXTINGUISHER

- .1 5 LB Dry Chemical Multipurpose ABC, semi-recessed cabinet
- .2 Cabinet, semi-recessed:
 - .1 203 mm [8"] wide x 432 mm [17"] high x 127 mm [5"] deep semi-recessed cabinet with 25mm [1"] turnback frame for minimum 102 mm [4"] wall thickness
 - .2 22-gauge steel tub, 16-gauge steel door and trim with 5 mm [3/16"] clear tempered glass.
 - .3 Full length semi-concealed piano hinge for 180-degree swing and flush stainless-steel door latch with no exposed fasteners
 - .4 Gray baked enamel finish that can be used for either prime coat for field painting, or final finish.
- .3 Extinguisher:
 - .1 2.3 kg [5 lb.] Dry Chemical Multipurpose 2-A:10-B:C

2.7 MULTIPURPOSE FIRE EXTINGUISHER

- .1 5 LB Dry Chemical Multipurpose ABC, fully recessed cabinet
- .2 Cabinet, fully recessed:
 - .1 203 mm [8"] wide x 432 mm [17"] high x 127 mm [5"] deep fully recessed cabinet with 6mm [1/4"] turnback frame for minimum 127 mm [5"] wall thickness
 - .2 22-gauge steel tub, 16-gauge steel door and trim with 5 mm [3/16"] clear tempered glass.
 - .3 Full length semi-concealed piano hinge for 180-degree swing and flush stainless-steel door latch with no exposed fasteners

Fire Extinguishers

- .4 Gray baked enamel finish that can be used for either prime coat for field painting, or final finish.
 - .3 Extinguisher:
 - .1 2.3 kg [5 lb.] Dry Chemical Multipurpose 2-A:10-B:C
 - 2.8 MULTIPURPOSE FIRE EXTINGUISHER**
 - .1 10 LB Multipurpose ABC, exposed wall hung on hook
 - .2 Cabinet:
 - .1 N/A, exposed wall hung on hook
 - .3 Extinguisher:
 - .1 4.5 kg [10 lb.] Dry Chemical Multipurpose 4-A: 20-B:C,
 - 2.9 MULTIPURPOSE FIRE EXTINGUISHER**
 - .1 10 LB Multipurpose ABC, surface mounted cabinet
 - .2 Cabinet, surface mount:
 - .1 229 mm [9"] wide x 610 mm [24"] high x 152 mm [6"] deep cabinet for surface mounting.
 - .2 22-gauge steel tub, 16-gauge steel door and trim with 5 mm [3/16"] clear tempered glass.
 - .3 Full length semi-concealed piano hinge for 180-degree swing and flush stainless-steel door latch with no exposed fasteners
 - .4 Gray baked enamel finish that can be used for either prime coat for field painting, or final finish.
 - .3 Extinguisher:
 - .1 4.5kg [10 lb.] dry chemical, multipurpose ABC 4-A:80-B:C
 - 2.10 MULTIPURPOSE FIRE EXTINGUISHER**
 - .1 10 LB Multipurpose ABC, semi-recessed cabinet
 - .2 Cabinet, semi-recessed:
 - .1 229 mm [9"] wide x 610 mm [24"] high x 152 mm [6"] deep semi-recessed cabinet with 50mm [2"] turnback frame for minimum 102 mm [4"] wall thickness
 - .2 22-gauge steel tub, 16-gauge steel door and trim with 5 mm [3/16"] clear tempered glass.
 - .3 Full length semi-concealed piano hinge for 180-degree swing and flush stainless-steel door latch with no exposed fasteners
 - .4 Gray baked enamel finish that can be used for either prime coat for field painting, or final finish.
 - .3 Extinguisher:
 - .1 4.5 kg [10 lb.] dry chemical, multipurpose ABC 4-A:80-B:C
-

Fire Extinguishers

2.11 MULTIPURPOSE FIRE EXTINGUISHER

- .1 10 LB Dry Chemical Multipurpose ABC, fully recessed cabinet
- .2 Cabinet, fully recessed:
 - .1 229 mm [9"] wide x 610 mm [24"] high x 152 mm [6"] deep recessed cabinet with 6mm [1/4"] turnback frame for minimum 152 mm [6"] wall thickness
 - .2 22-gauge steel tub, 16-gauge steel door and trim with 5 mm [3/16"] clear tempered glass.
 - .3 Full length semi-concealed piano hinge for 180-degree swing and flush stainless-steel door latch with no exposed fasteners
 - .4 Gray baked enamel finish that can be used for either prime coat for field painting, or final finish.
- .3 Extinguisher:
 - .1 4.5 kg [10 lb.] dry chemical, multipurpose ABC 4-A:80-B:C

2.12 CLEAN AGENT FIRE EXTINGUISHER

- .1 SPEC NOTE: Specify Clean Agent Fire Extinguishers for facilities in which clean agent fire extinguishing systems are specified.
- .2 11 LB Clean Agent, exposed wall hung on hook
- .3 Cabinet:
 - .1 N/A, exposed wall hung on hook
- .4 Extinguisher:
 - .1 Rating: 1-A:10-B:C
 - .2 5 kg (11 lb)
 - .3 Extinguisher shell factory hydrostatically tested to 4130 kPa (600 psi) and leak tested at the factory.
 - .4 Stainless-steel shell and non-magnetic valve, hose, and nozzle.
 - .5 Large, color-coded pressure gauge.
 - .6 Easy grip handle with ring pin and retention chain.
 - .7 Factory charged with colorless, odorless, electrically non-conductive, residue free, low toxicity agent with zero ozone depletion potential.

PART 3 EXECUTION

3.1 INSTALLATION

- .1 Install fire extinguishers in cabinets at locations as indicated on the drawings.
 - .2 Coordinate locations of fire extinguisher cabinets with the framing trades in order to facilitate recessed and semi-recessed installations.
 - .3 Mount fire extinguishers and cabinets such that the top of the extinguisher is at 1,220 mm [4 feet] above the floor.
-

Fire Extinguishers

- .4 Install fire extinguisher cabinet doors, glazing panels and fire extinguishers in the cabinets prior to the project substantial completion review by the Consultant.

3.2 IDENTIFICATION

- .1 Identify fire extinguishers in accordance with the recommendations of NFPA 10.
- .2 Attach a tag or label to all fire extinguishers, indicating the month and year of installation, with space for recording subsequent service dates.

END OF SECTION

PART 1 GENERAL

1.1 GENERAL REFERENCES

- .1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.
- .2 Division 20, including all Common Mechanical Requirements in Section 20 00 00, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.

1.2 COORDINATION

- .1 Divisions 20, 21, 22 and 23 are used to communicate the requirements for the total Mechanical scope of work. It is intended for these four Divisions to serve as a single document, communicating the Mechanical scope of work.
- .2 Division 20 Specifications serve as common Mechanical requirements that apply to all Division 21, 22, and 23 Specifications and Scope of Work.
- .3 All requirements of Division 20 Specifications shall apply to all Division 23 Specifications and Scope of Work, unless noted otherwise.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- .1 Domestic Water Piping
 - .1 Copper Tube and Fittings.
 - .2 Stainless-Steel Piping.
 - .3 Transition Fittings.
 - .4 Dielectric Fittings.
 - .5 Flexible Connectors.
- .2 Sanitary Waste and Vent Piping
 - .1 Copper Tube and Fittings.
 - .2 Ductile-Iron Pipe and Fittings.
 - .3 Galvanized-Steel Pipe and Fittings.
 - .4 Stainless-Steel Pipe and Fittings.
 - .5 PVC Pipe and Fittings.
 - .6 Hub-and-Spigot, Cast-iron Soil Pipe and Fittings.
 - .7 Hubless, Cast-iron Soil Pipe and Fittings.
 - .8 High performance coated hub-and-spigot, cast-iron soil pipe and fittings.
 - .9 High performance coated hubless, cast-iron soil pipe and fittings.
 - .10 Transition Fittings.
 - .11 Dielectric Fittings.
- .3 Storm Drainage Piping
 - .1 Copper Tube and Fittings.
 - .2 Ductile-Iron Pipe and Fittings.
 - .3 Galvanized-Steel Pipe and Fittings.
 - .4 PVC Pipe and Fittings.
 - .5 Perforated PVC Pipe and Fittings.
 - .6 Hub-and-Spigot, cast-iron soil pipe and fittings.
 - .7 High performance coated hub-and-spigot, cast-iron soil pipe and fittings.
 - .8 High performance coated hubless, cast-iron soil pipe and fittings.
 - .9 Hubless, cast-iron soil pipe and fittings.
 - .10 Transition Fittings.
 - .11 Dielectric Fittings.

1.2 GENERAL REFERENCES

- .1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.
- .2 Division 20, including all Common Mechanical Requirements in Section 20 00 00, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.

1.3 REFERENCE STANDARDS

- .1 ASCE/SEI 7 - Minimum Design Loads and Associated Criteria for Buildings and Other Structures.

- .2 ASME A112.3.1 - x.
- .3 ASME B1.20.1 - Pipe Threads, General Purpose, Inch.
- .4 ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
- .5 ASME B16.4 - Gray Iron Threaded Fittings: Classes 125 and 250; The American Society of Mechanical Engineers.
- .6 ASME B16.12 - Cast Iron Threaded Drainage Fittings.
- .7 ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
- .8 ASME B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges.
- .9 ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
- .10 ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings: DWV.
- .11 ASME B16.24 - Cast Copper Alloy Pipe Flanges, Flanged Fittings, and Valves: Classes 150, 300, 600, 900, 1500, and 2500.
- .12 ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder-Joint Drainage Fittings—DWV.
- .13 ASME B16.39 - Malleable Iron Threaded Pipe Unions: Classes 150, 250, and 300.
- .14 ASME B16.45 - Cast Iron Fittings for Solvent Drainage Systems.
- .15 ASME B18.2.1 - Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series).
- .16 ASME B31.9 - Building Services Piping.
- .17 ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators.
- .18 ASSE 1043 - Performance Standard for Cast Iron Solvent Sanitary Drainage Systems.
- .19 ASSE 1061 - Performance Requirements for Push-Fit Fittings.
- .20 ASSE 1079 - x.
- .21 ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings.
- .22 ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
- .23 ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings.
- .24 ASTM A106/A106M - Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
- .25 ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
- .26 ASTM A312/A312M - Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
- .27 ASTM A536 - Standard Specification for Ductile Iron Castings.
- .28 ASTM A674 - Standard Practice for Polyethylene Encasement for Ductile Iron Pipe.
- .29 ASTM A733 - Standard Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples.
- .30 ASTM A815/A815M - x.
- .31 ASTM A888 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
- .32 ASTM B29 - Standard Specification for Refined Lead.
- .33 ASTM B32 - Standard Specification for Solder Metal.
- .34 ASTM B75/B75M - Standard Specification for Seamless Copper Tube.

- .35 ASTM B88 - Standard Specification for Seamless Copper Water Tube.
- .36 ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric).
- .37 ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.
- .38 ASTM B813 - Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube.
- .39 ASTM B828 - Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings.
- .40 ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
- .41 ASTM C1173 - Standard Specification for Flexible Transition Couplings for Underground Piping Systems.
- .42 ASTM C1277 - Standard Specification for Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings.
- .43 ASTM C1460 - Standard Specification for Shielded Transition Couplings for Use with Dissimilar DWV Pipe and Fittings Above Ground.
- .44 ASTM C1540 - Standard Specification for Heavy-Duty Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings.
- .45 ASTM D1784 - Standard Classification System and Basis for Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
- .46 ASTM D2235 - Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.
- .47 ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
- .48 ASTM D2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
- .49 ASTM D2661 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings.
- .50 ASTM D2665 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.
- .51 ASTM D2729 - Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
- .52 ASTM D2846/D2846M - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems.
- .53 ASTM D2855 - Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets.
- .54 ASTM D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
- .55 ASTM D3311 - Standard Specification for Drain, Waste, and Vent (DWV) Plastic Fittings Patterns.
- .56 ASTM D5926 - Standard Specification for Poly (Vinyl Chloride) (PVC) Gaskets for Drain, Waste, and Vent (DWV), Sewer, Sanitary, and Storm Plumbing Systems.
- .57 ASTM E84 - x.
- .58 ASTM F402 - Standard Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings.
- .59 ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

- .60 ASTM F656 - x.
- .61 ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications.
- .62 ASTM F1545 - x.
- .63 ASTM F1807 - Standard Specification for Metal Insert Fittings Utilizing a Copper Crimp Ring, or Alternate Stainless Steel Clamps, for SDR9 Cross-Linked Polyethylene (PEX) Tubing and SDR9 Polyethylene of Raised Temperature (PE-RT) Tubing.
- .64 ASTM F1960 - Standard Specification for Cold Expansion Fittings with PEX Reinforcing Rings for Use with Cross-Linked Polyethylene (PEX) and Polyethylene of Raised Temperature (PE-RT) Tubing.
- .65 ASTM F2014 - x.
- .66 AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems.
- .67 AWWA C110/A21.10 - Ductile-Iron and Gray-Iron Fittings.
- .68 AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
- .69 AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast.
- .70 AWWA C153/A21.53 - Ductile-Iron Compact Fittings.
- .71 AWWA C219 - Bolted Sleeve-Type Couplings for Plain-End Pipe.
- .72 AWWA C600 - Installation of Ductile-Iron Mains and Their Appurtenances.
- .73 40 CFR 59, Subpart D - National Volatile Organic Compound Emission Standards for Architectural Coatings; U.S. Environmental Protection Agency.
- .74 AWWA C606 - Grooved and Shouldered Joints.
- .75 AWWA C651 - Disinfecting Water Mains.
- .76 AWWA C652 - Disinfection of Water-Storage Facilities.
- .77 AWWA M41 - Ductile-Iron Pipe and Fittings.
- .78 CISPI 301 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
- .79 CISPI 310 - Specification for Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
- .80 IAPMO PS 66 - x.
- .81 MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.
- .82 MSS SP-69 - x.
- .83 MSS SP-123 - x.
- .84 NFPA 262 - x.
- .85 NSF 14 - x.
- .86 NSF 61 - Drinking Water System Components - Health Effects.
- .87 NSF 372 - Drinking Water System Components - Lead Content.
- .88 UL 1887 - x.

1.4 PERFORMANCE REQUIREMENTS

- .1 Domestic Water Piping
 - .1 Domestic water piping, tubing, fittings, and appurtenances intended to convey or dispense water for human consumption are to comply with the U.S. Safe Drinking Water Act, with requirements of authorities having jurisdiction, and with NSF 61 and NSF 372, or be certified in compliance with NSF 61 and NSF 372 by an ANSI-accredited third-party certification body, in that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.

- .2 Sanitary Waste and Vent Piping
 - .1 Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
 - .1 Soil, Waste, and Vent Piping: 10-foot head of water.
 - .2 Waste, Force-Main Piping: 50 psig.
 - .2 Seismic Performance: Soil, waste, and vent piping and support and installation shall withstand the effects of earthquake motions determined according to ASCE/SEI 7. See Division 20 Section "Vibration and Seismic Controls for Piping and Equipment."
 - .1 The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 - .3 Seismic Performance: Storm drainage piping and support and installation to withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7. See Division 20 Section "Vibration and Seismic Controls for Piping and Equipment."
 - .1 The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 - .2 Component Importance Factor: 1.5.
- .3 Storm Drainage Piping
 - .1 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 (30 kPa).
 - .2 Storm Drainage, Force-Main Piping: 50 psig (345 kPa).
 - .2 Seismic Performance: Storm drainage piping and support and installation shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1.5 SUBMITTALS

- .1 Action Submittals
 - .1 Product Data:
 - .1 Pipe and tube.
 - .2 Fittings.
 - .3 Joining materials.
 - .4 Transition fittings.
 - .2 Installers of pressure-sealed joints shall submit proof of manufacturer certification for installation of pressure-sealed joints.
 - .3 Shop Drawings: For hubless, single-stack drainage system. Include plans, elevations, sections, and details.
 - .4 Shop Drawings: For Sorent drainage system. Include plans, elevations, sections, and details.
 - .5 Shop Drawings: For controlled-flow or siphonic roof drainage system. Include calculations, plans, and details.
- .2 Informational Submittals
 - .1 Coordination Drawings: Plans and elevations or Building Information Model (BIM) as indicated in Division 01 drawn to scale, showing items described in this Section and coordinated with all building trades.
 - .2 Coordination Drawings: Detail sanitary, waste, and storm drainage piping. Show support locations, type of support, weight on each support, required clearances, and other details, drawn to scale, on which the following items are shown and coordinated

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

- .1 Structural members to which drainage piping will be attached or suspended from.
- .3 System purging and disinfecting activities report.
- .4 Seismic Qualification Certificates: For waste and vent piping, accessories, and components, from manufacturer.
 - .1 Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - .2 Detailed description of piping anchorage devices on which the certification is based and their installation requirements.
- .5 Field Quality-Control Reports: Inspection reports signed by authorities having jurisdiction.
- .3 LEED Submittals
 - .1 Sustainable Design Submittals:
 - .1 Product Data: For solvent cements, adhesive primers, and adhesives, indicating VOC content.
 - .2 Laboratory Test Reports: For solvent cements, adhesive primers, and adhesives, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers"

1.6 WARRANTIES

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

1.7 QUALITY ASSURANCE

- .1 Welding Materials and Procedures: Comply with ASME BPVC-IX and applicable state labor regulations.
- .2 Welder Qualifications: Certified in accordance with ASME BPVC-IX.
- .3 Installer Qualifications: Installers of pressure-sealed joints are to be certified by pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.
- .4 Piping materials shall bear label, stamp, or other markings of specified testing agency.
- .5 Each pipe shall be marked with manufacturer's name or registered trademark, county of origin, and date of manufacture.
- .6 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.

1.8 DELIVERY, STORAGE AND HANDLING

- .1 Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- .2 Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.
- .3 Follow manufacturer recommendations for storage.

1.9 FIELD CONDITIONS

- .1 Do not install underground piping when bedding is wet or frozen.
- .2 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 Architect no fewer than two days in advance of proposed interruption of water service.
- .2 Do not interrupt water service without Architect 's written permission.
- .3 Interruption of Existing Sanitary Waste Service: Do not interrupt service facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
 - .1 Notify Architect no fewer than two days in advance of proposed interruption of sanitary waste service.
 - .2 Do not interrupt sanitary waste service without Architect 's written permission.
- .4 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 Architect no fewer than two days in advance of proposed interruption of storm drainage service.
 - .2 Do not proceed with interruption of storm drainage service without Architect 's written permission.

PART 2 PRODUCTS

2.1 GENERAL

- .1 Piping Materials
 - .1 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 Potable-water piping and components shall comply with NSF 14, NSF 61 and NSF 372. Plastic piping components shall be marked with "NSF-pw."

2.2 DOMESTIC WATER PIPING

- .1 Copper Tube and Fittings
 - .1 Drawn-Temper "Hard" Copper Tube: ASTM B88 , Type K water tube.
 - .2 Annealed "Soft" Copper Tube: ASTM B88 , Type K water tube.
 - .3 Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings. Do not use solder joints on pipe sizes greater than NPS 3.
 - .4 Wrought-Copper, Solder-Joint Fittings: ASME B16.22, pressure fittings. Do not use solder joints on pipe sizes greater than NPS 3.
 - .5 Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Do not use solder joints on pipe sizes greater than NPS 3.
 - .6 Cast Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends. Do not use solder joints on pipe sizes greater than NPS 3.
 - .7 Copper-Tube, Extruded-Tee Connections:
 - .1 Manufacturers:
 - .1 T-Drill Industries Inc.
 - .2 Description: Tee formed in copper tube according to ASTM F2014.
 - .8 Appurtenances for Grooved-End Copper Tubing:
 - .1 Manufacturers:
 - .1 Anvil International.
 - .2 Grinnell Mechanical Products.

- .3 Victaulic Company.
 - .4 Shurjoint Piping Products.
 - .2 Source Limitations: Obtain grooved, mechanical-joint copper tube appurtenances from single manufacturer.
 - .3 Grooved-End, Copper Fittings: ASTM B75/B75M copper tube or ASTM B584 bronze castings.
 - .4 Grooved-End-Tube Couplings: To fit copper-tube dimensions; rigid pattern unless otherwise indicated; gasket fitting, EPDM-rubber gasket, UL classified per NSF 61 and NSF 372, and rated for minimum 180 deg F, for use with ferrous housing and steel bolts and nuts; 300 psig minimum CWP pressure rating.
 - .1 Coordinate the use of all lubricants with manufacturer requirements for the application.
 - .2 Stainless-Steel Piping
 - .1 Potable-water piping and components shall comply with NSF 61 and NSF 372.
 - .2 Stainless-Steel Pipe: ASTM A312/A312M, with wall thickness as indicated in "Piping Applications" Article.
 - .3 Stainless-Steel Pipe Fittings: ASTM A815/A815M.
 - .4 Appurtenances for Grooved-End, Stainless-Steel Pipe:
 - .1 Manufacturers:
 - .1 Anvil International.
 - .2 Grinnell Mechanical Products.
 - .3 Victaulic Company.
 - .4 Shurjoint Piping Products.
 - .2 Fittings for Grooved-End, Stainless-Steel Pipe: Stainless-steel casting with dimensions matching stainless-steel pipe.
 - .3 Mechanical Couplings for Grooved-End, Stainless-Steel Pipe:
 - .1 AWWA C606 for stainless-steel-pipe dimensions.
 - .2 Stainless-steel housing sections.
 - .3 Stainless-steel bolts and nuts.
 - .4 EPDM-rubber gaskets suitable for hot and cold water.
 - .5 Minimum Pressure Rating:
 - .1 NPS 8 (DN 200) and Smaller: 600 psig (4137 kPa) .
 - .2 NPS 10 and NPS 12 (DN 250 to DN 300) : 400 psig (2758 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600) : 250 psig (1725 kPa) .
 - .1 Install backwater valves in accessible locations.
 - .3 Transition Fittings
 - .1 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.
 - .2 Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
 - .3 Sleeve-Type Transition Coupling: AWWA C219.
 - .1 Manufacturers:

- .1 Cascade Waterworks Manufacturing.
 - .2 Dresser, Inc.; Piping Specialties Products.
 - .3 Ford Meter Box Company, Inc. (The).
 - .4 Jay R. Smith Mfg. Co.
 - .5 JCM Industries.
 - .6 Romac Industries, Inc.
 - .7 Smith-Blair, Inc.; a Sensus company.
 - .8 Viking Johnson.
 - .4 Plastic-to-Metal Transition Fittings:
 - .1 Manufacturers:
 - .1 Charlotte Pipe and Foundry Company.
 - .2 Harvel Plastics, Inc.
 - .3 Spears Manufacturing Company.
 - .4 Uponor.
 - .2 Description:
 - .1 CPVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions.
 - .2 One end with threaded brass insert and one solvent-cement-socket end.
 - .5 Plastic-to-Metal Transition Unions:
 - .1 Manufacturers:
 - .1 Colonial Engineering, Inc.
 - .2 NIBCO Inc.
 - .3 Spears Manufacturing Company.
 - .2 Description:
 - .1 CPVC four-part union.
 - .2 Brass threaded end.
 - .3 Solvent-cement-joint or threaded plastic end.
 - .4 Rubber O-ring.
 - .5 Union nut.
- .4 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 Comply with the requirements of Division 20 Section 20 05 00 "Common Work Results."
 - .3 Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for general-duty metal valves.
 - .4 Comply with requirements in Division 22 Section "Plumbing Piping Specialties" for balancing valves, drain valves, backflow preventers, and vacuum breakers.
 - .5 Dielectric Unions:
 - .1 Manufacturers:
 - .1 Capitol Manufacturing Company; member of the Phoenix Forge Group.
 - .2 Central Plastics Company.
 - .3 Hart Industries International, Inc.

- .4 Jomar International.
- .5 Matco-Norca.
- .6 McDonald, A. Y. Mfg. Co.
- .7 Watts; a division of Watts Water Technologies, Inc.
- .8 Wilkins; a Zurn company.
- .2 Standard: ASSE 1079.
- .3 Pressure Rating: 150 psig (1035 kPa) .
- .4 End Connections: Solder-joint copper alloy and threaded ferrous.
- .6 Dielectric Flanges:
 - .1 Manufacturers:
 - .1 Capitol Manufacturing Company; member of the Phoenix Forge Group.
 - .2 Central Plastics Company.
 - .3 Matco-Norca.
 - .4 Watts; a division of Watts Water Technologies, Inc.
 - .5 Wilkins; a Zurn company.
 - .2 Standard: ASSE 1079.
 - .3 Factory-fabricated, bolted, companion-flange assembly.
 - .4 Pressure Rating: 125 psig (860 kPa) minimum at 180 deg F (82 deg C).
 - .5 End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
- .7 Dielectric-Flange Insulating Kits:
 - .1 Manufacturers:
 - .1 Advance Products & Systems, Inc.
 - .2 Calpico, Inc.
 - .3 Central Plastics Company.
 - .4 Pipeline Seal and Insulator, Inc.
 - .2 Nonconducting materials for field assembly of companion flanges.
 - .3 Pressure Rating: 150 psig (1035 kPa) .
 - .4 Gasket: Neoprene or phenolic.
 - .5 Bolt Sleeves: Phenolic or polyethylene.
 - .6 Washers: Phenolic with steel backing washers.
- .8 Dielectric Nipples:
 - .1 Manufacturers:
 - .1 Elster Perfection Corporation.
 - .2 Grinnell Mechanical Products; Tyco Fire Products LP.
 - .3 Matco-Norca.
 - .4 Precision Plumbing Products, Inc.
 - .5 Victaulic Company.
 - .2 Standard: IAPMO PS 66.
 - .3 Electroplated steel nipple complying with ASTM F1545.
 - .4 Pressure Rating and Temperature: 300 psig (2070 kPa) at 225 deg F (107 deg C) .
 - .5 End Connections: Male threaded or grooved.

- .6 Lining: Inert and noncorrosive, propylene.
- .5 Flexible Connectors
 - .1 Manufacturers:
 - .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.
 - .2 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 (1380 kPa).
 - .2 End Connections NPS 2 (DN 50) and Smaller: Threaded copper pipe or plain-end copper tube.
 - .3 End Connections NPS 2-1/2 (DN 65) and Larger: Flanged copper alloy.
 - .3 Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.
 - .1 Working-Pressure Rating: Minimum 200 psig (1380 kPa).
 - .2 End Connections NPS 2 (DN 50) and Smaller: Threaded steel-pipe nipple.
 - .3 End Connections NPS 2-1/2 (DN 65) and Larger: Flanged steel nipple.

2.3 SANITARY WASTE AND VENT PIPING

- .1 Copper Tube and Fittings
 - .1 Hard Copper Tube: ASTM B88, Type L (ASTM B88M, Type B), drawn temper.
 - .2 Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.
 - .3 Copper Pressure Fittings:
 - .1 Copper Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
 - .2 Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
 - .4 Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
 - .1 Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
 - .2 Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
 - .5 Solder: ASTM B32, lead free with ASTM B813, water-flushable flux.
- .2 Ductile-Iron Pipe and Fittings
 - .1 Ductile-Iron, Mechanical-Joint Piping:
 - .1 Ductile-Iron Pipe: AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
 - .2 Ductile-Iron Fittings: AWWA C110/A21.10, mechanical-joint, ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.

- .3 Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
- .2 Ductile-Iron, Push-on-Joint Piping:
 - .1 Ductile-Iron Pipe: AWWA C151/A21.51, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.
 - .2 Ductile-Iron Fittings: AWWA C110/A21.10, push-on-joint ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
 - .3 Gaskets: AWWA C111/A21.11, rubber.
- .3 Ductile-Iron, Grooved-Joint Piping:
 - .1 Ductile-Iron Pipe: AWWA C151/A21.51 with round-cut-grooved ends according to AWWA C606.
 - .2 Ductile-Iron-Pipe Appurtenances:
 - .1 Manufacturers:
 - .1 Anvil International.
 - .2 Shurjoint Piping Products.
 - .3 Star Pipe Products.
 - .4 Victaulic Company.
 - .5 Smith-Cooper International.
 - .2 Grooved-End, Ductile-Iron Fittings: ASTM A536 ductile-iron castings with dimensions matching AWWA C110/A21.10 ductile-iron pipe or AWWA C153/A21.53 ductile-iron fittings and complying with AWWA C606 for grooved ends.
 - .3 Grooved Mechanical Couplings for Ductile-Iron Pipe: ASTM F1476, Type I. Include ferrous housing sections with continuous curved keys; EPDM-rubber center-leg gasket suitable for hot and cold water; and bolts and nuts.
- .3 Galvanized-Steel Pipe and Fittings
 - .1 Galvanized-Steel Pipe: ASTM A53/A53M, Type E, Standard Weight class. Include square-cut-grooved or threaded ends matching joining method.
 - .2 Galvanized-Cast-Iron Drainage Fittings: ASME B16.12, threaded.
 - .1 Galvanized-Steel Pipe Nipples: ASTM A733, made of ASTM A53/A53M or ASTM A106/A106M, Schedule 40, seamless steel pipe. Include ends matching joining method.
 - .2 Malleable-Iron Unions: ASME B16.39; Class 150; hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface; and female threaded ends.
 - .3 Galvanized-Gray-Iron, Threaded Fittings: ASME B16.4, Class 125, standard pattern.
 - .3 Cast-Iron Flanges: ASME B16.1, Class 125.
 - .1 Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
 - .2 Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
 - .4 Grooved-Joint, Galvanized-Steel-Pipe Appurtenances:
 - .1 Manufacturers:
 - .1 Anvil International; a subsidiary of Mueller Water Products, Inc.
 - .2 Grinnell Mechanical Products.

- .3 Shurjoint Piping Products.
- .4 Victaulic Company.
- .5 Smith-Cooper International.
- .2 Galvanized, Grooved-End Fittings for Galvanized-Steel Piping: ASTM A536 ductile-iron castings, ASTM A47/A47M malleable-iron castings, ASTM A234/A234M forged steel fittings, or ASTM A106/A106M steel pipes with dimensions matching ASTM A53/A53M steel pipe, and complying with AWWA C606 for grooved ends.
- .3 Grooved Mechanical Couplings for Galvanized-Steel Piping: ASTM F1476, Type I. Include ferrous housing sections with continuous curved keys; EPDM-rubber gasket suitable for hot and cold water; and bolts and nuts.
- .4 Stainless-Steel Pipe and Fittings
 - .1 Manufacturers:
 - .1 Anvil International/Smith-Cooper International; Tailwind Capital, LLC.
 - .2 BLÜCHER; A Watts Water Technologies Company.
 - .3 Josam Company.
 - .2 Description: Comply with requirements of ASME A112.3.1, drainage pattern.
 - .3 Material: Type 304 stainless steel or Type 316L stainless steel.
 - .4 Pipe Construction: Seamless.
 - .5 Internal Sealing Rings: EPDM, marked or color coded for the application.
 - .6 Joints: Single or double, socket and spigot ends.
 - .7 Pipe and fittings are to be joined by heat Fusion or mechanical methods using the equipment supplied by the manufacturers.
- .5 PVC Pipe and Fittings
 - .1 Comply with NSF 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.
 - .2 Solid-Wall PVC Pipe: ASTM D2665, drain, waste, and vent.
 - .3 PVC Socket Fittings: ASTM D2665, made to ASTM D3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
 - .4 Adhesive Primer: ASTM F656.
 - .1 Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - .2 Adhesive primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
 - .5 Solvent Cement: ASTM D2564.
 - .1 PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - .2 Solvent cement shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- .6 Hub-and-Spigot, Cast-Iron Soil Pipe and Fittings
 - .1 Pipe and Fittings: ASTM A74, Service and Extra Heavy class(es). All pipe and fittings shall be marked with manufacturer's name or Registered Trademark, country of origin,

- and date of manufacture. Pipe and fittings shall also bear the mark of the National Sanitation Foundation
- .2 Gaskets: ASTM C564, rubber.
- .3 Calking Materials: ASTM B29, pure lead and oakum or hemp fiber.
- .4 Tensile Strength: 21,000 psig mi
- .5 Each length of pipe and each fitting shall be plainly marked with size, country of origin, and name of manufacturer, or manufacturer's registered trademark by which the manufacturer can be readily identified after installation.
- .7 Hubless, Cast-Iron Soil Pipe and Fittings
 - .1 Pipe and Fittings: ASTM A888 and CISPI 301 All pipe and fittings shall be marked with manufacturer's name or Registered Trademark, country of origin, and date of manufacture. Pipe and fittings shall also bear the mark of the National Sanitation Foundation
 - .1 Tensile Strength: 21,000
 - .2 Each length of pipe and each fitting shall be plainly marked with size, country of origin, and name of manufacturer, or manufacturer's registered trademark by which the manufacturer can be readily identified after installation.
 - .2 Solvent Stack Fittings: ASME B16.45 or ASSE 1043, hubless, cast-iron aerator and deaerator drainage fittings.
 - .1 Manufacturers:
 - .1 Conine Manufacturing Co., Inc.
 - .2 SE Solvent.
 - .3 CISPI, Hubless-Piping Couplings:
 - .1 Manufacturers:
 - .1 Charlotte Pipe and Foundry Company
 - .2 Fernco Inc.
 - .3 Ideal Clamp Products
 - .4 Josam Company.
 - .5 MIFAB, Inc.
 - .6 Mission Rubber Company; a division of MCP Industries, Inc.
 - .7 Tyler Pipe; a subsidiary of McWane Inc.
 - .8 Dallas Specialty & Mfg. Co.
 - .9 Matco-Norca, Inc.
 - .2 Couplings shall bear CISPI collective trademark and NSF certification mark.
 - .3 Standards: ASTM C1277 and CISPI 310.
 - .4 Description: Stainless-steel corrugated shield with a minimum of four stainless-steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.
 - .4 Heavy-Duty, Hubless-Piping Couplings:
 - .1 Manufacturers:
 - .1 ANACO-Husky.
 - .2 Charlotte Pipe and Foundry Company.
 - .3 Clamp-All Corp.
 - .4 Ideal Clamp Products
 - .5 MIFAB, Inc.
 - .6 Mission Rubber Company; a division of MCP Industries, Inc.

- .7 Tyler Pipe.
 - .8 Dallas Specialty & Mfg. Co.
 - .2 Standards: ASTM C1277 and ASTM C1540.
 - .3 Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.
- .8 High Performance Coated Hub-and-Spigot, Cast-Iron Soil Pipe and Fittings
 - .1 Pipe and Fittings: ASTM A74, Service class.
 - .2 Gaskets: ASTM C564, rubber.
 - .3 Caulking Materials: ASTM B29, pure lead and oakum or hemp fiber.
 - .4 Tensile Strength: 21,000 psig minimum.
 - .5 All cast iron soil pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute (CISPI), and listed by NSF International.
 - .6 Each length of pipe and each fitting shall be plainly marked with size, country of origin, and name of manufacturer, or manufacturer's registered trademark by which the manufacturer can be readily identified after installation.
 - .7 The inside of each pipe shall be reamed prior to coating to decrease the coefficient of friction.
 - .8 Pipe Coating: Chemically deposited zinc-phosphate pretreatment layer followed by an electrically deposited, high performance cathodic epoxy coating, and finally an electrically deposited, high performance anodic epoxy top coat. Coating thickness shall be 5 mils or greater on both the OD and ID.
 - .9 Fitting Coating: Chemically deposited zinc-phosphate pretreatment layer followed by an electrically deposited, high performance cathodic epoxy coating, and finally an epoxy acrylic powder top coat. Coating thickness shall be 5 mils or greater on both the OD and ID.
 - .10 Coating Performance: Pipe and Fitting Coatings must pass the following performance specifications per EN 877:
 - .1 350 hours of salt spray testing
 - .2 Resistance to wastewater for 30 days at 73 deg F
 - .3 Chemical resistance from pH 2 to pH 12 for 30 days at 73 deg F
 - .4 Resistance to hot water for 24 hours at 203 deg F
- .9 High Performance Coated Hubless, Cast-Iron Soil Pipe and Fittings
 - .1 Pipe and Fittings: ASTM A888 or CISPI 301 .
 - .2 Tensile Strength: 21,000 psig minimum.
 - .3 All cast iron soil pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute (CISPI), and listed by NSF International.
 - .4 Each length of pipe and each fitting shall be plainly marked with size, country of origin, and name of manufacturer, or manufacturer's registered trademark by which the manufacturer can be readily identified after installation.
 - .5 The inside of each pipe shall be reamed prior to coating to decrease the coefficient of friction.
 - .6 Pipe Coating: Chemically deposited zinc-phosphate pretreatment layer followed by an electrically deposited, high performance cathodic epoxy coating, and finally an electrically deposited, high performance anodic epoxy top coat. Coating thickness shall be 5 mils or greater on both the OD and ID.
 - .7 Fitting Coating: Chemically deposited zinc-phosphate pretreatment layer followed by an electrically deposited, high performance cathodic epoxy coating, and finally an

- epoxy acrylic powder top coat. Coating thickness shall be 5 mils or greater on both the OD and ID.
- .8 Coating Performance: Pipe and Fitting Coatings must pass the following performance specifications per EN 877:
 - .1 350 hours of salt spray testing
 - .2 Resistance to wastewater for 30 days at 73 deg F
 - .3 Chemical resistance from pH 2 to pH 12 for 30 days at 73 deg F
 - .4 Resistance to hot water for 24 hours at 203 deg F.
 - .9 Heavy-Duty, Hubless-Piping Couplings:
 - .1 Manufacturers:
 - .1 ANACO-Husky.
 - .2 Charlotte Pipe and Foundry Company.
 - .3 Mission Rubber Company, LLC; a division of MCP Industries.
 - .4 Mifab.
 - .2 Standards: ASTM C1277 and ASTM C1540.
 - .3 Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.
 - .10 Transition Fittings
 - .1 Transition Couplings:
 - .1 General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
 - .2 Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
 - .3 Unshielded, Nonpressure Transition Couplings:
 - .1 Manufacturers:
 - .1 Fernco Inc.
 - .2 Froet Industries LLC.
 - .3 Mission Rubber Company; a division of MCP Industries, Inc.
 - .2 Standard: ASTM C1173.
 - .3 Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - .1 Froet Industries LLC.
 - .4 Sleeve Materials:
 - .1 For Cast-Iron Soil Pipes: ASTM C564, rubber.
 - .2 For Plastic Pipes: ASTM F477, elastomeric seal or ASTM D5926, PVC.
 - .3 For Dissimilar Pipes: ASTM D5926, PVC or other material compatible with pipe materials being joined.
 - .4 Shielded, Nonpressure Transition Couplings:
 - .1 Manufacturers:
 - .1 Fernco Inc.
 - .2 Froet Industries LLC.
 - .3 Mission Rubber Company; a division of MCP Industries, Inc.

- .2 Standard: ASTM C1460.
- .3 Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
- .4 End Connections: Same size as and compatible with pipes to be joined.
- .5 Pressure Transition Couplings:
 - .1 Manufacturers:
 - .1 Cascade Waterworks Mfg. Co.
 - .2 Dresser, Inc.
 - .3 EBAA Iron, Inc.
 - .4 Jay R. Smith Mfg. Co.
 - .5 JCM Industries, Inc.
 - .6 Romac Industries, Inc.
 - .7 Smith-Blair, Inc.; a Sensus company.
 - .8 The Ford Meter Box Company, Inc.
 - .9 Viking Johnson.
 - .2 Standard: AWWA C219.
 - .3 Description: Metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.
 - .4 Center-Sleeve Material: Manufacturer's standard.
 - .5 Gasket Material: Natural or synthetic rubber.
 - .6 Metal Component Finish: Corrosion-resistant coating or material.
- .11 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:
 - .1 Manufacturers:
 - .1 Capitol Manufacturing Company.
 - .2 Hart Industries International, Inc.
 - .3 Jomar International Ltd.
 - .4 Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - .5 Wilkins; a Zurn company.
 - .6 Central Plastics Company.
 - .7 Matco-Norca, Inc.
 - .8 McDonald, A. Y. Mfg. Co.
 - .2 Description:
 - .1 Standard: ASSE 1079.
 - .2 Pressure Rating: 250 psig (1725 kPa) .
 - .3 End Connections: Solder-joint copper alloy and threaded ferrous.
 - .3 Dielectric Flanges:
 - .1 Manufacturers:
 - .1 Capitol Manufacturing Company.
 - .2 Watts Regulator Co.; a division of Watts Water Technologies, Inc.

- .3 Wilkins; a Zurn company.
 - .4 Central Plastics Company.
 - .5 Matco-Norca, Inc.
- .2 Description:
 - .1 Standard: ASSE 1079.
 - .2 Factory-fabricated, bolted, companion-flange assembly.
 - .3 Pressure Rating: 300 psig (2070 kPa).
 - .4 End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
- .4 Dielectric-Flange Insulating Kits:
 - .1 Manufacturers:
 - .1 Advance Products & Systems, Inc.
 - .2 Calpico, Inc.
 - .3 Central Plastics Company.
 - .4 Pipeline Seal and Insulator, Inc.
 - .2 Description:
 - .1 Nonconducting materials for field assembly of companion flanges.
 - .2 Pressure Rating: 150 psig (1035 kPa).
 - .3 Gasket: Neoprene or phenolic.
 - .4 Bolt Sleeves: Phenolic or polyethylene.
 - .5 Washers: Phenolic with steel backing washers.
- .5 Dielectric Nipples:
 - .1 Manufacturers:
 - .1 Elster Perfection.
 - .2 Grinnell Mechanical Products.
 - .3 Josam Company.
 - .4 Matco-Norca, Inc.
 - .5 Precision Plumbing Products, Inc.
 - .6 Victaulic Company.
 - .2 Description:
 - .1 Standard: IAPMO PS 66.
 - .2 Electroplated steel nipple.
 - .3 Pressure Rating: 300 psig (2070 kPa) at 225 deg F (107 deg C) .
 - .4 End Connections: Male threaded or grooved.
 - .5 Lining: Inert and noncorrosive, propylene.

2.4 STORM DRAINAGE PIPING

- .1 Copper Tube and Fittings
 - .1 Hard Copper Tube: ASTM B88, Type L (ASTM B88M, Type B), drawn temper.
 - .2 Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.
 - .3 Copper Pressure Fittings:
 - .1 Copper Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.

- .2 Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
- .4 Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
 - .1 Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
 - .2 Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- .5 Solder: ASTM B32, lead free with ASTM B813, water-flushable flux.
- .2 Ductile-Iron Pipe and Fittings
 - .1 Ductile-Iron, Mechanical-Joint Piping:
 - .1 Ductile-Iron Pipe: AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
 - .2 Ductile-Iron Fittings: AWWA C110/A21.10, mechanical-joint, ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
 - .3 Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
 - .2 Ductile-Iron, Push-on-Joint Piping:
 - .1 Ductile-Iron Pipe: AWWA C151/A21.51, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.
 - .2 Ductile-Iron Fittings: AWWA C110/A21.10, push-on-joint ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
 - .3 Gaskets: AWWA C111/A21.11, rubber.
 - .3 Ductile-Iron, Grooved-Joint Piping:
 - .1 Ductile-Iron Pipe: AWWA C151/A21.51 with round-cut-grooved ends according to AWWA C606.
 - .2 Ductile-Iron-Pipe Appurtenances:
 - .1 Manufacturers:
 - .1 Anvil International.
 - .2 Shurjoint Piping Products.
 - .3 Star Pipe Products.
 - .4 Victaulic Company.
 - .5 Smith-Cooper International.
 - .2 Grooved-End, Ductile-Iron Fittings: ASTM A536 ductile-iron castings with dimensions matching AWWA C110/A21.10 ductile-iron pipe or AWWA C153/A21.53 ductile-iron fittings and complying with AWWA C606 for grooved ends.
 - .3 Grooved Mechanical Couplings for Ductile-Iron Pipe: ASTM F1476, Type I. Include ferrous housing sections with continuous curved keys; EPDM-rubber center-leg gasket suitable for hot and cold water; and bolts and nuts.
- .3 Galvanized-Steel Pipe and Fittings
 - .1 Galvanized-Steel Pipe: ASTM A53/A53M, Type E, Standard Weight class. Include square-cut-grooved or threaded ends matching joining method.
 - .2 Galvanized-Cast-Iron Drainage Fittings: ASME B16.12, threaded.
 - .1 Galvanized-Steel Pipe Nipples: ASTM A733, made of ASTM A53/A53M or ASTM A106/A106M, Schedule 40, seamless steel pipe. Include ends matching joining method.

- .2 Malleable-Iron Unions: ASME B16.39; Class 150; hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface; and female threaded ends.
- .3 Galvanized-Gray-Iron, Threaded Fittings: ASME B16.4, Class 125, standard pattern.
- .3 Cast-Iron Flanges: ASME B16.1, Class 125.
 - .1 Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
 - .2 Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- .4 Grooved-Joint, Galvanized-Steel-Pipe Appurtenances:
 - .1 Manufacturers:
 - .1 Anvil International; a subsidiary of Mueller Water Products, Inc.
 - .2 Grinnell Mechanical Products.
 - .3 Shurjoint Piping Products.
 - .4 Victaulic Company.
 - .5 Smith-Cooper International.
 - .2 Galvanized, Grooved-End Fittings for Galvanized-Steel Piping: ASTM A536 ductile-iron castings, ASTM A47/A47M malleable-iron castings, ASTM A234/A234M forged steel fittings, or ASTM A106/A106M steel pipes with dimensions matching ASTM A53/A53M steel pipe, and complying with AWWA C606 for grooved ends.
 - .3 Grooved Mechanical Couplings for Galvanized-Steel Piping: ASTM F1476, Type I. Include ferrous housing sections with continuous curved keys; EPDM-rubber gasket suitable for hot and cold water; and bolts and nuts.
- .4 PVC Pipe and Fittings
 - .1 Comply with NSF 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.
 - .2 Solid-Wall PVC Pipe: ASTM D2665, drain, waste, and vent.
 - .3 PVC Socket Fittings: ASTM D2665, made to ASTM D3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
 - .4 Adhesive Primer: ASTM F656.
 - .1 Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - .2 Adhesive primer shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
 - .5 Solvent Cement: ASTM D2564.
 - .1 PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - .2 Solvent cement shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- .5 Perforated PVC Pipe and Fittings
 - .1 Solvent cemented Perforated PVC Pipe and fittings.

- .1 Pipe and fittings shall be manufactured from PVC compound with a cell class of 12364 as per ASTM D1784. PVC SDR 35 PSM pipe shall conform to ASTM D3034 for gasket or solvent weld pipe with a minimum pipe stiffness of 46. Pipe shall be plastic sewer main outside diameter with a standard dimension ratio (SDR) of 35.
 - .1 Perforations shall be minimum 0.5" diameter, spaced at 5" maximum, with two holes at 120 deg per ASTM D2729.
 - .2 Piping and fittings shall be joined with primers for PVC piping per ASTM F656 and solvent cements per ASTM D2564.
- .6 Hub-and-Spigot, Cast-Iron Soil Pipe and Fittings
 - .1 Pipe and Fittings: ASTM A74, Service and Extra Heavy class(es). All pipe and fittings shall be marked with manufacturer's name or Registered Trademark, country of origin, and date of manufacture. Pipe and fittings shall also bear the mark of the National Sanitation Foundation
 - .2 Gaskets: ASTM C564, rubber.
 - .3 Calking Materials: ASTM B29, pure lead and oakum or hemp fiber.
 - .4 Tensile Strength: 21,000 psig mi
 - .5 Each length of pipe and each fitting shall be plainly marked with size, country of origin, and name of manufacturer, or manufacturer's registered trademark by which the manufacturer can be readily identified after installation.
- .7 High Performance Coated Hub-and-Spigot, Cast-Iron Soil Pipe and Fittings
 - .1 Pipe and Fittings: ASTM A74, Service class.
 - .2 Gaskets: ASTM C564, rubber.
 - .3 Caulking Materials: ASTM B29, pure lead and oakum or hemp fiber.
 - .4 Tensile Strength: 21,000 psig minimum.
 - .5 All cast iron soil pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute (CISPI), and listed by NSF International.
 - .6 Each length of pipe and each fitting shall be plainly marked with size, country of origin, and name of manufacturer, or manufacturer's registered trademark by which the manufacturer can be readily identified after installation.
 - .7 The inside of each pipe shall be reamed prior to coating to decrease the coefficient of friction.
 - .8 Pipe Coating: Chemically deposited zinc-phosphate pretreatment layer followed by an electrically deposited, high performance cathodic epoxy coating, and finally an electrically deposited, high performance anodic epoxy top coat. Coating thickness shall be 5 mils or greater on both the OD and ID.
 - .9 Fitting Coating: Chemically deposited zinc-phosphate pretreatment layer followed by an electrically deposited, high performance cathodic epoxy coating, and finally an epoxy acrylic powder top coat. Coating thickness shall be 5 mils or greater on both the OD and ID.
 - .10 Coating Performance: Pipe and Fitting Coatings must pass the following performance specifications per EN 877:
 - .1 350 hours of salt spray testing
 - .2 Resistance to wastewater for 30 days at 73 deg F
 - .3 Chemical resistance from pH 2 to pH 12 for 30 days at 73 deg F
 - .4 Resistance to hot water for 24 hours at 203 deg F
- .8 High Performance Coated Hubless, Cast-Iron Soil Pipe and Fittings
 - .1 Pipe and Fittings: ASTM A888 or CISPI 301 .

- .2 Tensile Strength: 21,000 psig minimum.
- .3 All cast iron soil pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute (CISPI), and listed by NSF International.
- .4 Each length of pipe and each fitting shall be plainly marked with size, country of origin, and name of manufacturer, or manufacturer's registered trademark by which the manufacturer can be readily identified after installation.
- .5 The inside of each pipe shall be reamed prior to coating to decrease the coefficient of friction.
- .6 Pipe Coating: Chemically deposited zinc-phosphate pretreatment layer followed by an electrically deposited, high performance cathodic epoxy coating, and finally an electrically deposited, high performance anodic epoxy top coat. Coating thickness shall be 5 mils or greater on both the OD and ID.
- .7 Fitting Coating: Chemically deposited zinc-phosphate pretreatment layer followed by an electrically deposited, high performance cathodic epoxy coating, and finally an epoxy acrylic powder top coat. Coating thickness shall be 5 mils or greater on both the OD and ID.
- .8 Coating Performance: Pipe and Fitting Coatings must pass the following performance specifications per EN 877:
 - .1 350 hours of salt spray testing
 - .2 Resistance to wastewater for 30 days at 73 deg F (23 deg C)
 - .3 Chemical resistance from pH 2 to pH 12 for 30 days at 73 deg F (23 deg C)
 - .4 Resistance to hot water for 24 hours at 203 deg F (95 deg C).
- .9 Heavy-Duty, Hubless-Piping Couplings:
 - .1 Manufacturers:
 - .1 ANACO-Husky.
 - .2 Charlotte Pipe and Foundry Company.
 - .3 Mission Rubber Company, LLC; a division of MCP Industries.
 - .4 Mifab.
 - .2 Standards: ASTM C1277 and ASTM C1540.
 - .3 Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.
- .9 Hubless, Cast-Iron Soil Pipe and Fittings
 - .1 Pipe and Fittings: ASTM A888 and CISPI 301 stamped with the Cast Iron Soil Pipe Institute trademark. Pipe shall be cast vertically or by centrifugal process and the inside and outside diameters shall be concentric, smooth, and free from cracks, sand holes, and other defects.
 - .2 Heavy-Duty, Hubless-Piping Couplings:
 - .1 Manufacturers:
 - .1 ANACO-Husky, Series 4000.
 - .2 Charlotte Pipe and Foundry Company.
 - .3 Clamp-All Corp.
 - .4 Ideal Clamp Products.
 - .5 MIFAB, Inc.
 - .6 Mission Rubber Company; a division of MCP Industries, Inc.
 - .7 Tyler Pipe.
 - .8 Dallas Specialty & Mfg. Co.

- .9 NewAge Casting
- .2 Standards: ASTM C1540.
- .3 Description: Stainless-steel shield with a minimum of four stainless-steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.
- .10 Transition FITTINGS (SANITARY WASTE AND Vent PIPING, Storm Drainage Piping)
 - .1 Transition Couplings:
 - .1 General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
 - .2 Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
 - .3 Unshielded, Nonpressure Transition Couplings:
 - .1 Manufacturers:
 - .1 Fernco Inc.
 - .2 Froet Industries LLC.
 - .3 Mission Rubber Company; a division of MCP Industries, Inc.
 - .2 Standard: ASTM C1173.
 - .3 Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - .1 Froet Industries LLC.
 - .4 Sleeve Materials:
 - .1 For Cast-Iron Soil Pipes: ASTM C564, rubber.
 - .2 For Plastic Pipes: ASTM F477, elastomeric seal or ASTM D5926, PVC.
 - .3 For Dissimilar Pipes: ASTM D5926, PVC or other material compatible with pipe materials being joined.
 - .4 Shielded, Nonpressure Transition Couplings:
 - .1 Manufacturers:
 - .1 Fernco Inc.
 - .2 Froet Industries LLC.
 - .3 Mission Rubber Company; a division of MCP Industries, Inc.
 - .2 Standard: ASTM C1460.
 - .3 Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - .4 End Connections: Same size as and compatible with pipes to be joined.
 - .5 Pressure Transition Couplings:
 - .1 Manufacturers:
 - .1 Cascade Waterworks Mfg. Co.
 - .2 Dresser, Inc.
 - .3 EBAA Iron, Inc.
 - .4 Jay R. Smith Mfg. Co.
 - .5 JCM Industries, Inc.

- .6 Romac Industries, Inc.
- .7 Smith-Blair, Inc.; a Sensus company.
- .8 The Ford Meter Box Company, Inc.
- .9 Viking Johnson.
- .2 Standard: AWWA C219.
- .3 Description: Metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.
- .4 Center-Sleeve Material: Manufacturer's standard.
- .5 Gasket Material: Natural or synthetic rubber.
- .6 Metal Component Finish: Corrosion-resistant coating or material.
- .11 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:
 - .1 Manufacturers:
 - .1 Capitol Manufacturing Company.
 - .2 Hart Industries International, Inc.
 - .3 Jomar International Ltd.
 - .4 Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - .5 Wilkins; a Zurn company.
 - .6 Central Plastics Company.
 - .7 Matco-Norca, Inc.
 - .8 McDonald, A. Y. Mfg. Co.
 - .3 Description:
 - .1 Standard: ASSE 1079.
 - .2 Pressure Rating: 250 psig (1725 kPa) .
 - .3 End Connections: Solder-joint copper alloy and threaded ferrous.
 - .4 Dielectric Flanges:
 - .1 Manufacturers:
 - .1 Capitol Manufacturing Company.
 - .2 Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - .3 Wilkins; a Zurn company.
 - .4 Central Plastics Company.
 - .5 Matco-Norca, Inc.
 - .2 Description:
 - .1 Standard: ASSE 1079.
 - .2 Factory-fabricated, bolted, companion-flange assembly.
 - .3 Pressure Rating: 300 psig (2070 kPa).
 - .4 End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
 - .5 Advance Products & Systems, Inc.
 - .6 Calpico, Inc.
 - .7 Central Plastics Company.

- .8 Pipeline Seal and Insulator, Inc.
- .5 Dielectric-Flange Insulating Kits:
 - .1 Description:
 - .1 Nonconducting materials for field assembly of companion flanges.
 - .2 Pressure Rating: 150 psig (1035 kPa).
 - .3 Gasket: Neoprene or phenolic.
 - .4 Bolt Sleeves: Phenolic or polyethylene.
 - .5 Washers: Phenolic with steel backing washers.
- .6 Dielectric Nipples:
 - .1 Manufacturers:
 - .1 Elster Perfection.
 - .2 Grinnell Mechanical Products.
 - .3 Josam Company.
 - .4 Matco-Norca, Inc.
 - .5 Precision Plumbing Products, Inc.
 - .6 Victaulic Company.
 - .2 Description:
 - .1 Standard: IAPMO PS 66.
 - .2 Electroplated steel nipple.
 - .3 Pressure Rating: 300 psig (2070 kPa) at 225 deg F (107 deg C) .
 - .4 End Connections: Male threaded or grooved.
 - .5 Lining: Inert and noncorrosive, propylene.

PART 3 EXECUTION

3.1 INSTALLATION

- .1 Domestic Water Piping
 - .1 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.
 - .2 Install piping as tight to underside of structure or as coordinated prior to installation with all other trades dictated by the general or prime contractor.
 - .3 Unless approved by a registered and licensed structural engineer, building structure shall not be cut, drilled, notched, spliced or altered in any way.
 - .4 Install underground copper tube and ductile-iron pipe in PE encasement according to ASTM A674 or AWWA C105/A21.5.
 - .5 Copper Tubing
 - .1 Install copper tubing under building slab according to CDA's "Copper Tube Handbook." All under slab piping shall be Annealed Type K copper with no soldered joints.
 - .6 Ductile Iron Piping:
 - .1 Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.
 - .7 Install shutoff valve immediately upstream of each dielectric fitting.

- .8 Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Division 22 Section "Plumbing Piping Specialties."
- .9 Install domestic water piping level without pitch with 0.25 percent slope downward toward drain and plumb.
- .10 Rough-in domestic water piping for water-meter installation according to utility company's requirements.
- .11 Install seismic restraints on piping. Comply with requirements for seismic-restraint devices in Division 20 Section "Vibration and Seismic Controls for Piping and Equipment."
- .12 Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- .13 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.
- .14 Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- .15 Install piping to permit valve servicing.
- .16 Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.
- .17 Install piping free of sags and bends.
- .18 Install fittings for changes in direction and branch connections.
- .19 Install PEX piping with loop at each change of direction of more than 90 degrees.
- .20 Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- .21 Install pressure gages on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gages in Division 22 Section "Meters and Gages for Plumbing Piping."
 - .1 Install thermostats in hot-water circulation piping. Comply with requirements for thermostats in Division 22 Section 22 11 23 "Domestic Water Pumps."
 - .2 Install thermometers on inlet and outlet piping from each water heater. Comply with requirements for thermometers in Division 22 Section 22 05 19 "Meters and Gages for Plumbing Piping."
 - .3 Install sleeves for piping penetrations of walls, ceilings, and floors.
 - .4 Install sleeve seals for piping penetrations of concrete walls and slabs.
 - .5 Install escutcheons for piping penetrations of walls, ceilings, and floors.
 - .6 Install branch connections to mains using tee fittings in main pipe.
- .22 All non-metallic piping installed in an air supply or return plenum that shall be provided with a high temperature fiber blanket encapsulated in a fiberglass reinforced aluminized foil, with a 96 kg/m³ density and have a nominal thickness of 1/2". Fiber blanket shall have a continuous use limit in excess of 1,832 deg F. Flame spread index and smoke developed index shall be <25 / <50. Product shall be tested to ASTM E84, NFPA 262, and UL 1887.
- .23 Transition Fittings
 - .1 Install transition couplings at joints of dissimilar piping.
 - .2 Transition Fittings in Underground Domestic Water Piping:

- .1 Fittings for NPS 1-1/2 (DN 40) and Smaller: Fitting-type coupling.
- .2 Fittings for NPS 2 (DN 50) and Larger: Sleeve-type coupling.
- .3 Transition Fittings in Aboveground Domestic Water Piping NPS 2 (DN 50) and Smaller: Plastic-to-metal transition fittings or unions.
- .24 Dielectric Fittings
 - .1 Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
 - .2 Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric unions.
 - .3 Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100) : Use dielectric flanges or nipples.
 - .4 Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.
- .25 Flexible Connectors
 - .1 Install flexible connectors in suction and discharge piping connections to each domestic water pump and in suction and discharge manifold connections to each domestic water booster pump.
 - .2 Install bronze-hose flexible connectors in copper domestic water tubing.
 - .3 Install stainless-steel-hose flexible connectors in steel domestic water piping.
- .26 Hangers and Supports
 - .1 Comply with requirements for seismic-restraint devices in Division 20 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."
 - .2 Comply with requirements for pipe hanger, support products, and installation in Division 20 Section "Hangers and Supports for Piping and Equipment."
 - .3 Support vertical piping and tubing at base and at each floor, or as required by prevailing code if such code is more stringent.
 - .4 Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch (10 mm) .
 - .5 Install hangers for copper tubing and piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
 - .6 Install vinyl-coated hangers for CPVC piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
 - .7 Install vinyl-coated hangers for PEX tubing, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
 - .8 Support horizontal piping within 12 inches (300 mm) of each fitting.
 - .9 Support vertical runs of copper tubing and piping to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
 - .10 Support vertical runs of CPVC piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
 - .11 Support vertical runs of PEX tubing to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

- .12 Support piping and tubing not listed in this article according to MSS SP-58 and manufacturer's written instructions.
- .27 Escutcheons
 - .1 Install escutcheons for penetrations of walls, ceilings, and floors.
 - .2 Comply with the requirements of Division 20 Section 20 05 00 "Common Work Results."
 - .3 Escutcheons for New Piping:
 - .4 Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
 - .5 Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
 - .6 Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
 - .7 Bare Piping in Unfinished Service Spaces: One piece, cast brass with polished chrome-plated finish.
 - .8 Bare Piping in Equipment Rooms: One piece, cast brass.
 - .9 Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting floor plate.
 - .10 Escutcheons for Existing Piping:
 - .11 Chrome-Plated Piping: Split casting, cast brass with chrome-plated finish.
 - .12 Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish.
 - .13 Bare Piping at Ceiling Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish.
 - .14 Bare Piping in Unfinished Service Spaces: Split casting, cast brass with polished chrome-plated finish.
 - .15 Bare Piping in Equipment Rooms: Split casting, cast brass.
 - .16 Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting floor plate.
- .28 Joint Construction
 - .1 Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
 - .2 Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
 - .3 Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - .1 Apply appropriate tape or thread compound to external pipe threads.
 - .2 Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
 - .4 Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.
 - .5 Soldered Joints for Copper Tubing: Apply ASTM B813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B828 or CDA's "Copper Tube Handbook."
 - .6 Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer. Leave insertion marks on pipe after assembly.

- .7 Extruded-Tee Connections: Form tee in copper tube according to ASTM F2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.
- .8 Joint Construction for Grooved-End Copper Tubing: Make joints according to AWWA C606. Roll groove ends of tubes. Lubricate and install gasket over ends of tubes or tube and fitting. Install coupling housing sections over gasket with keys seated in tubing grooves. Install and tighten housing bolts.
- .9 Joint Construction for Grooved-End, Ductile-Iron Piping: Make joints according to AWWA C606. Cut round-bottom grooves in ends of pipe at gasket-seat dimension required for specified (flexible or rigid) joint. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.
- .10 Joint Construction for Grooved-End Stainless and Galvanized Steel Piping: Make joints according to AWWA C606. Roll groove ends of pipe as specified. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.
- .11 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.
- .12 Joint Construction for Solvent-Cemented Plastic Piping: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - .1 Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.
 - .2 CPVC Piping: Join according to ASTM D2846/D2846M Appendix.
- .13 Joint Construction for Grooved-End CPVC Piping: Make joints according to PGS-300. Cut groove ends of pipe as specified. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.
- .14 Joint Construction for polypropylene and PVDF Piping: Per manufacturer's recommendations.
- .15 Joints for PEX Tubing: Join according to ASTM F1807 for metal insert and copper crimp ring fittings and ASTM F1960 for cold expansion fittings and reinforcing rings.
- .16 Joints for PEX Tubing: Join according to ASSE 1061 for push-fit fittings.
- .17 Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.
- .29 Valves
 - .1 General-Duty Valves: Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for valve installations.
 - .2 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 or groups of plumbing fixtures within the same room. Use ball or gate valves for piping NPS 2 (DN 50) and smaller. Use gate valves for piping NPS 2-1/2 (DN 65) and larger.
 - .1 Install shutoff valve on each water supply serving each patient room per IDPH requirements.
 - .3 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 Division 22 Section "Domestic Water Piping Specialties."
- .1 Hose-End Drain Valves: At low points in water mains, risers, and branches.
 - .2 Stop-and-Waste Drain Valves: Instead of hose-end drain valves where indicated.
 - .4 Install balancing valve in each hot-water circulation return branch and discharge side of each pump and circulator. Set balancing valves partly open to restrict but not stop flow. Use ball valves for piping NPS 2 (DN 50) and smaller and butterfly valves for piping NPS 2-1/2 (DN 65) and larger. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for balancing valves. Balancing valve assembly to include shutoff valve, check valve and balancing valve.
 - .5 Install calibrated balancing valves in each hot-water circulation return branch and discharge side of each pump and circulator. Set calibrated balancing valves partly open to restrict but not stop flow. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for calibrated balancing valves. Balancing valve assembly to include shutoff valve, check valve and balancing valve.
- .2 Sanitary Waste and Vent Piping
- .1 Unless approved by a registered and licensed structural engineer, building structure shall not be cut, drilled, notched, spliced or altered in any way.
 - .2 Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.
 - .1 Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
 - .2 Install piping as indicated unless deviations to layout are approved on coordination drawings.
 - .3 Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
 - .4 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.
 - .5 Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
 - .6 Install piping to permit valve servicing.
 - .7 Install piping at indicated slopes.
 - .8 Install piping free of sags and bends.
 - .9 Install fittings for changes in direction and branch connections.
 - .10 Install wall-penetration fitting at each service pipe penetration through foundation wall. Make installation watertight.
 - .11 Install piping and support devices to allow application of insulation.
 - .12 Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Division 20 Section "Vibration and Seismic Controls" for piping and equipment.
 - .13 Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.
 - .1 Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical.

- .2 Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe.
 - .1 Straight tees, elbows, and crosses may be used on vent lines.
- .3 Do not change direction of flow more than 90 degrees.
- .4 Use proper size of standard increasers and reducers if pipes of different sizes are connected.
 - .1 Reducing size of waste piping in direction of flow is prohibited.
- .14 Lay buried building waste piping beginning at low point of each system.
 - .1 Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
 - .2 Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
 - .3 Maintain swab in piping and pull past each joint as completed.
- .15 Install soil and waste drainage and vent piping at the minimum slopes required by code.
- .16 Install soil and waste and vent piping at the following minimum slopes unless otherwise indicated:
 - .1 Slope of Horizontal Drainage Piping:

Pipe Size	Minimum Slope (Inch per Foot)
2-1/2" or Less	1/4"
3" to 6"	1/8"
8" or Larger	1/16"
 - .2 Slope of Horizontal Drainage Piping:

Pipe Size	Minimum Slope (Inch per Foot)
3" or Less	1/4"
4" or Larger	1/8"
 - .3 Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
- .17 Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
 - .1 Install encasement on underground piping according to ASTM A674 or AWWA C105/A21.5
- .18 Install steel piping according to applicable plumbing code.
- .19 Install stainless-steel piping according to ASME A112.3.1 and applicable plumbing code.
- .20 Install aboveground copper tubing according to CDA's "Copper Tube Handbook."
- .21 Install aboveground PVC piping according to ASTM D2665 .
- .22 All non-metallic piping installed in an air supply or return plenum that shall be provided with a high temperature fiber blanket encapsulated in a fiberglass reinforced aluminized foil, with a 96 kg/m3 density and have a nominal thickness of 1/2". Fiber blanket shall have a continuous use limit in excess of 1,832 deg F. Flame spread index and smoke developed index shall be <25 / <50. Product shall be tested to ASTM E84, NFPA 262, and UL 1887.
- .23 Install engineered soil and waste drainage and vent piping systems as follows:
 - .1 Combination Waste and Vent: Comply with standards of authorities having jurisdiction.

- .2 Hubless, Single-Stack Drainage System: Comply with ASME B16.45 and hubless, single-stack aerator fitting manufacturer's written installation instructions.
- .3 Reduced-Size Venting: Comply with standards of authorities having jurisdiction.
- .24 Plumbing Specialties:
 - .1 Install backwater valves in sanitary waster gravity-flow piping. Comply with requirements for backwater valves specified in Division 22 Section "Plumbing Piping Specialties."
 - .2 Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping.
 - .3 Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping. Comply with requirements for cleanouts specified in Division 22 Section "Plumbing Piping Specialties."
 - .4 Install drains in sanitary drainage gravity-flow piping. Comply with requirements for drains specified in Division 22 Section "Plumbing Piping Specialties."
- .25 Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- .26 Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section Division 20 Section "Common Work Results for Mechanical."
- .27 Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 20 Section "Common Work Results for Mechanical."
- .28 Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 20 Section "Common Work Results for Mechanical."
- .29 Every vent stack shall connect to the base of the drainage stack at or below the lowest horizontal branch.
- .30 Horizontal offsets of drainage stacks shall be vented where 5 or more branch internals are located above the offset. The upper and lower sections of the drainage stack shall be vented and sized per code.
- .31 Branch vents must rise 6" above the flood level rim of the fixture being vented.
- .32 All vent terminations shall be a minimum of 12" above the roof, or 7 feet above any occupied roof area.
- .33 Vent through roofs shall be a minimum of 4" for frost protection.
- .34 The maximum distance between the vent and trap shall be 5 feet.
- .35 Soil and waste stacks in buildings having more than 10 branch intervals shall be provided with a full size relief vent at each tenth interval installed, beginning with the top floor.
- .36 All indirect waste shall be a minimum of 1" unless otherwise noted on drawing.
- .37 All sanitary offsets shall be vented per local authority.
- .38 Hangers and Supports
 - .1 Comply with requirements for seismic-restraint devices specified in Division 20 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."
 - .2 Comply with requirements for pipe hanger and support devices and installation specified in Division 20 Section "Hangers and Supports for 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:
 - .1 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
 - .2 Longer Than 100 Feet (30 m) : MSS Type 43, adjustable roller hangers.
 - .3 Longer Than 100 Feet (30 m) if Indicated: MSS Type 49, spring cushion rolls.
 - .1 NPS 4 and NPS 5 (DN 100 and DN 125) : 12 feet (3.7 m) with 5/8-inch (16-mm) rod.
- .7 Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
- .8 Base of Vertical Piping: MSS Type 52, spring hanger
- .3 Support horizontal piping and tubing within 12 inches (300 mm) of each fitting, valve and coupling.
- .4 Support vertical piping and tubing at base and at each floor.
- .5 Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.
- .6 Install hangers for cast-iron soil piping, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent (1500 mm).
- .7 Support vertical runs of cast-iron soil piping to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- .8 Install hangers for PVC piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- .9 Support vertical runs of PVC piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- .10 Support piping and tubing not listed above according to MSS SP-58 and manufacturer's written instructions.
- .11 Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.
- .39 Valves
 - .1 General valve installation requirements are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
 - .2 Shutoff Valves:

- .1 Install shutoff valve on each sewage pump discharge.
- .2 Install gate or full-port ball valve for piping NPS 2 (DN 50) and smaller.
- .3 Install gate valve for piping NPS 2-1/2 (DN 65) and larger.
- .3 Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.
- .4 Backwater Valves: Install backwater valves in piping subject to backflow.
 - .1 Horizontal Piping: Horizontal backwater valves.
 - .2 Floor Drains: Drain outlet backwater valves unless drain has integral backwater valve.
 - .3 Comply with requirements for backwater valve specified in Section 22 22 13 19 "Sanitary Waste Piping Specialties."
- .40 Suds Pressure Zones
 - .1 Drainage stacks receiving waste from kitchen sinks, automatic dishwashers, laundry trays, laundry washing machines and similar fixtures in which sudsy detergents are normal used shall have the drainage and vent piping so arranged that suds pressures will not affect fixtures in the lower portion of the drainage system. Suds zones shall be considered to exist at any offset of 60 degrees to 90 degrees or at the base of any drainage stack.
 - .1 When the drainage portion of a stack exceed 16 feet in height above a 45 degree to 90 degree offset or house drain, it shall have its lower portion consisting of 30% of its height from such offset free of any fixture drain or branch. Such suds pressure zone of the drainage stack need not exceed 24 feet in height.
 - .2 In the offset of 60 degrees to 90 degrees or a house drain, when the drainage portion of a stack exceed 16 feet in height, a zone in the horizontal piping consisting of 30% upstream of the drainage stack connection shall be free of any drainage openings. Such suds pressure zone of the offset or house drain need not exceed 24 feet in height.
 - .3 In the offset of 60 degrees to 90 degrees or a house drain, when the drainage portion of a stack exceed 16 feet in height, a zone in the horizontal piping consisting of 15% downstream of the drainage stack connection shall be free of any drainage openings. Such suds pressure zone of the offset or house drain need not exceed 12 feet in height.
 - .4 Where a vertical offset occurs in a soil or waste stack below the lowest horizontal branch, change in diameter of the stack because of the offset shall not be required. If a horizontal offset occurs in a soil or waste stack below the lowest horizontal branch, the required diameter of the offset and the stack below it shall be determined as for a building drain.
- .41 Air Chambers
 - .1 Install air chambers at the upper terminals of all up-feed riser pipes and in branch distributing pipes contiguous to, and directly above, the connection of such branch distributing pipes to the plumbing fixture or other water-supplied appliance. Such air chambers shall be installed in a direct line with the flow of water through such pipes and shall be of sufficient capacity to provide an air cushion which will absorb shock, stress, or strain or eliminate all excess noises which may be caused by the operation of any valves, faucets, bibbs, or cocks in the water supply system.
 - .1 All air chambers shall be the same size of the pipe which it serves and to which it is connected and shall be not less than 2 feet (610 mm) in length. The air chamber on each water supply branch connection to a

plumbing fixture shall be not less than 12 inches (300 mm) long. Flush valve air chambers shall be of pipe size by 18" long.

.3 Storm Drainage Piping

- .1 Unless approved by a registered and licensed structural engineer, building structure shall not be cut, drilled, notched, spliced or altered in any way.
- .2 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.
- .3 Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- .4 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.
- .5 Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- .6 Install piping to permit valve servicing.
- .7 Install piping at indicated slopes.
- .8 Install piping free of sags and bends.
- .9 Install fittings for changes in direction and branch connections.
- .10 Install wall-penetration fitting at each service pipe penetration through foundation wall. Make installation watertight.
- .11 Install piping to allow application of insulation.
- .12 Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Division 20 Section "Vibration and Seismic Controls for Piping and Equipment."
- .13 Make changes in direction for piping using appropriate branches, bends, and long-sweep bends.
 - .1 Do not change direction of flow more than 90 degrees.
 - .2 Use proper size of standard increasers and reducers if pipes of different sizes are connected.
 - .3 Reducing size of drainage piping in direction of flow is prohibited.
- .14 Lay buried building piping beginning at low point of each system.
 - .1 Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
 - .2 Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
 - .3 Maintain swab in piping and pull past each joint as completed.
- .15 Install storm drainage piping at the minimum slopes required by code.

.1 Slope of Horizontal Storm Piping:

Pipe Size	Minimum Slope (Inch per Foot)
2-1/2" or Less	1/4"
3" to 6"	1/8"
8" or Larger	1/16"

.2 Slope of Horizontal Storm Piping:

Pipe Size	Minimum Slope (Inch per Foot)
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3" or Less	1/4"
4" or Larger	1/8"

- .16 Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
 - .1 Install encasement on underground piping according to ASTM A674 or AWWA C105/A21.5.
- .17 Install steel piping according to applicable plumbing code.
- .18 Install aboveground copper tubing according to CDA's "Copper Tube Handbook."
- .19 Install aboveground ABS piping according to ASTM D2661.
- .20 Install aboveground PVC piping according to ASTM D2665 .
- .21 All non-metallic piping installed in an air supply or return plenum that shall be provided with a high temperature fiber blanket encapsulated in a fiberglass reinforced aluminized foil, with a 96 kg/m3 density and have a nominal thickness of 1/2". Fiber blanket shall have a continuous use limit in excess of 1,832 deg F. Flame spread index and smoke developed index shall be <25 / <50. Product shall be tested to ASTM E84, NFPA 262, and UL 1887.
- .22 Install underground PVC piping according to ASTM D2321 .
- .23 Install engineered controlled-flow drain specialties and storm drainage piping in locations indicated.
- .24 Install underground, ductile-iron, force-main piping according to AWWA C600 .
 - .1 Install buried piping inside building between wall and floor penetrations and connection to storm sewer piping outside building with restrained joints.
 - .2 Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.
 - .3 Install encasement on piping according to ASTM A674 or AWWA C105/A21.5 .
- .25 Install underground, copper, force-main tubing according to CDA's "Copper Tube Handbook."
 - .1 Install encasement on piping according to ASTM A674 or AWWA C105/A21.5 .
- .26 Install force mains at elevations indicated.
- .27 Plumbing Specialties:
 - .1 Install backwater valves in storm drainage gravity-flow piping.
 - .2 Comply with requirements for backwater valves specified in Division 22 Section 22 14 23 "Storm Drainage Piping Specialties."
 - .3 Install cleanouts at grade and extend to where building storm drains connect to building storm sewers in storm drainage gravity-flow piping.
 - .4 Install cleanout fitting with closure plug inside the building in storm drainage force-main piping.
 - .5 Comply with requirements for cleanouts specified in Division 22 Section 22 14 23 "Storm Drainage Piping Specialties."
 - .6 Install drains in storm drainage gravity-flow piping.
 - .7 Comply with requirements for drains specified in Division 22 Section 22 14 23 "Storm Drainage Piping Specialties."
- .28 Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- .29 Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 20 Section 20 05 13 "Common Work Results."

- .30 Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 20 Section 20 05 13 "Common Work Results."
- .31 Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 20 Section 20 05 13 "Common Work Results."
- .32 Hangers and Supports
 - .1 Comply with requirements for seismic-restraint devices specified in Division 20 Section "Vibration and Seismic Controls for Piping and Equipment."
 - .2 Comply with requirements for pipe hanger and support devices and installation specified in Division 20 Section "Hangers and Supports for 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:
 - .7 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
 - .8 Longer Than 100 Feet (30 m) : MSS Type 43, adjustable roller hangers.
 - .9 Longer Than 100 Feet (30 m) if Indicated: MSS Type 49, spring cushion rolls.
 - .10 Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - .11 Base of Vertical Piping: MSS Type 52, spring hangers.
 - .3 Support horizontal piping and tubing within 12 inches (300 mm) of each fitting, valve, and coupling.
 - .4 Support vertical piping and tubing at base and at each floor.
 - .5 Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.
 - .6 Install hangers for cast-iron soil tubing, with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
 - .7 Install hangers for PVC piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
 - .8 Support horizontal piping and tubing within 12 inches (300 mm) of each fitting, valve, and coupling.
 - .9 Support vertical cast-iron tubing to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent, but as a minimum at base and at each floor.

- .10 Support vertical ABS and PVC piping with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- .11 Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.
- .33 Joint Construction
 - .1 Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
 - .2 Hub-and-Spigot, Cast-Iron Soil Piping Calked Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum calked joints.
 - .3 Hubless, Cast-Iron Soil Piping Coupled Joints: Join according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.
 - .4 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.
 - .3 Do not use pipe sections that have cracked or open welds.
 - .5 Join copper tube and fittings with soldered joints according to ASTM B828 procedure. Use ASTM B813, water-flushable, lead-free flux and ASTM B32, lead-free-alloy solder.
 - .6 Grooved Joints: Cut groove ends of pipe according to AWWA C606 . Lubricate and install gasket over ends of pipes or pipe and fittings. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.
 - .7 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.
 - .8 Plastic, Nonpressure-Piping, Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - .1 Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
 - .2 ABS Piping: Join according to ASTM D2235 and ASTM D2661 Appendixes.
 - .3 PVC Piping: Join according to ASTM D2855 and ASTM D2665 Appendixes.
 - .9 Joint Restraints and Sway Bracing:
 - .1 Provide joint restraints and sway bracing for storm drainage piping joints to comply with the following conditions:
 - .2 Provide axial restraint for pipe and fittings 5 inches (125 mm) and larger, upstream and downstream of all changes in direction, branches, and changes in diameter greater than two pipe sizes.
 - .3 Provide rigid sway bracing for pipe and fittings 4 inches (100 mm) and larger, upstream and downstream of all changes in direction 45 degrees and greater.

- .4 Provide rigid sway bracing for pipe and fittings 5 inches (125 mm) and larger, upstream and downstream of all changes in direction and branch openings.
- .34 Valves
 - .1 General valve installation requirements are specified in Division 22 Section 22 05 23 "General-Duty Valves for Plumbing Piping."
 - .2 Shutoff Valves: Install shutoff valve on each sump pump discharge.
 - .1 Install gate or full-port ball valve for piping NPS 2 (DN 65) and smaller.
 - .2 Install gate valve for piping NPS 2-1/2 (DN 65) and larger.
 - .3 Check Valves: Install swing-check valve, between pump and shutoff valve, on each sump pump discharge.
 - .4 Backwater Valves: Install backwater valves in piping subject to backflow.
 - .1 Horizontal Piping: Horizontal backwater valves. Use normally closed type unless otherwise indicated.
 - .2 Install backwater valves in accessible locations.
 - .3 Comply with requirements for backwater valves specified in Division 22 Section 22 14 23 "Storm Drainage Piping Specialties."

3.2 CONNECTIONS

- .1 Domestic Water Piping
 - .1 Drawings indicate general arrangement of piping, fittings, and specialties.
 - .2 When installing piping adjacent to equipment and machines, allow space for service and maintenance.
 - .3 Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
 - .4 Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
 - .1 Domestic Water Booster Pumps: Cold-water suction and discharge piping.
 - .2 Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
 - .3 Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
 - .4 Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 (DN 65) and larger.
- .2 Sanitary Waste and Vent Piping
 - .1 Drawings indicate general arrangement of piping, fittings, and specialties.
 - .2 Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
 - .3 Connect drainage and vent piping to the following:
 - .4 Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
 - .1 Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
 - .2 Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.

- .3 Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
- .4 Install horizontal backwater valves with cleanout cover flush with floor.
- .5 Comply with requirements for backwater valves, cleanouts, and drains specified in Division 22 Section "Plumbing Piping Specialties."
- .6 Equipment: Connect drainage piping as indicated. Provide shutoff valve if indicated and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 (DN 65) and larger.
- .5 Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- .6 Make connections according to the following unless otherwise indicated:
 - .1 Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
 - .2 Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.
- .3 Storm Drainage Piping
 - .1 Drawings indicate general arrangement of piping, fittings, and specialties.
 - .2 Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.
 - .3 Connect storm drainage piping to roof drains and storm drainage specialties.
 - .1 Install test tees (wall cleanouts) in conductors near floor, and floor cleanouts with cover flush with floor.
 - .2 Install horizontal backwater valves with cleanout cover flush with floor.
 - .4 Comply with requirements for backwater valves, cleanouts, and drains specified in Division 22 Section "Plumbing Piping Specialties."
 - .5 Connect force-main piping to the following:
 - .1 Storm Sewer: To exterior force main.
 - .2 Sump Pumps: To sump pump discharge.
 - .6 Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
 - .7 Make connections according to the following unless otherwise indicated:
 - .8 Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
 - .1 Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.3 FIELD QUALITY CONTROL

3.4 FIELD TESTING

- .1 Domestic Water Piping
 - .1 Perform the following tests and inspections:
 - .1 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:

- .1 Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
- .2 Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
- .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.
- .2 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 (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 - .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.
- .2 Copper and Stainless Steel Pipe Press Fittings
 - .1 Copper and Stainless Steel pipe joined with pressure fit fittings shall be in accordance with the manufacturer's installation instructions. Obtain any required Viega or NIBCO certified training to successfully meet these requirements at no extra cost to the project. The tubing shall be fully inserted into the fitting and the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to ensure the tubing is fully engaged (inserted) into the fitting. The joints shall be pressed using the tool approved by the manufacturer.
 - .2 Contractor shall have a pipe fitting procedure in place to distinctly identify each individual's pipe connection. Each individual pipe fitter must identify their pipe connection with an approved identification marking (ie. colored electrical tape or initialed pipe connections, etc.)
- .3 Grooved Mechanical Joints:
 - .1 Correct installation of couplings shall be visually verifiable. Should couplings be used which have a torque requirement, the contractor shall create a log of the measured torque at every mechanical joint.
 - .2 The grooved coupling manufacturer's factory trained representative shall provide on-site training for contractor's field personnel in the use of grooving tools, application of groove, and installation of grooved joint products.
 - .3 Extended piping system warranty:

- .1 A manufacturer's factory trained inspector shall visit the job site and review an agreed upon percentage of the installed mechanical joints. This shall be at the expense of the installing contractor. The installing Contractor shall correct any identified deficiencies.
- .2 Grooved product that has been examined and has not met the visual inspection criteria for proper installation must be corrected and re-examined by manufacturer's representative prior to the completion of the project. Any grooved product that has not been corrected or was not examined will not be considered as part of the successful completion of inspection.
- .4 Domestic water piping will be considered defective if it does not pass tests and inspections.
- .5 Prepare test and inspection reports.
 - .1 Perform final testing in presence of owner or owner's representative
 - .2 Prepare reports for tests and for corrective action required.
 - .3 Provide owner documentation indicating successful testing is completed.
- .2 Sanitary Waste and Vent Piping
 - .1 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.
 - .2 Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
 - .3 Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
 - .4 Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - .1 Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - .2 Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - .3 Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water (30 kPa). From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
 - .4 Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg (250 Pa) . Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.

- .5 Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 - .6 Perform final testing in presence of owner or owner's representative
 - .7 Prepare reports for tests and for corrective action required.
 - .8 Provide owner documentation indicating successful testing is completed.
- .3 Storm Drainage Piping
 - .1 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.
 - .2 Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - .1 Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - .2 Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - .3 Test Procedure: Test storm drainage piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water (30 kPa). From 15 minutes before inspection starts until completion of inspection, water level must not drop. Inspect joints for leaks.
 - .4 Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 - .5 Prepare reports for tests and required corrective action.
 - .3 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 (345 kPa) 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.
 - .4 Piping will be considered defective if it does not pass tests and inspections.

3.5 IDENTIFICATION

- .1 Domestic Water Piping
 - .1 Identify system components. Comply with requirements for identification materials and installation in Division 20 Section "Mechanical Identification."
 - .2 Label pressure piping with system operating pressure.

- .2 Sanitary Waste and Vent Piping
 - .1 Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Division 20 Section 20 05 53 "Mechanical Identification."
- .3 Storm Drainage Piping
 - .1 Identify exposed storm drainage piping. Comply with requirements for identification specified in Division 20 Section 20 05 53 "Mechanical Identification."

3.6 ADJUSTING

- .1 Domestic Water Piping
 - .1 Perform the following adjustments before operation:
 - .1 Close drain valves, hydrants, and hose bibbs.
 - .2 Open shutoff valves to fully open position.
 - .3 Open throttling valves to proper setting.
 - .4 Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
 - .1 Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
 - .2 Adjust calibrated balancing valves to flows indicated.
 - .5 Remove plugs used during testing of piping and for temporary sealing of piping during installation.
 - .6 Remove and clean strainer screens. Close drain valves and replace drain plugs.
 - .7 Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
 - .8 Check plumbing specialties and verify proper settings, adjustments, and operation.

3.7 CLEANING

- .1 Domestic Water Piping
 - .1 Clean interior of domestic water piping system. Remove dirt and debris as work progresses.
 - .2 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:
 - .1 Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - .2 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 (50 mg/L) 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 (200 mg/L) of chlorine. Isolate and allow to stand for three hours.
 - .3 Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.

- .1 Submit water samples in sterile bottles to authorities having jurisdiction.
 - .2 Repeat procedures if biological examination shows contamination.
 - .3 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:
 - .1 Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - .2 Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
 - .3 Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.
- .2 Sanitary Waste and Vent Piping
 - .1 Clean interior of piping. Remove dirt and debris as work progresses.
 - .2 Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
 - .3 Place plugs in ends of uncompleted piping at end of day and when work stops.
 - .4 Exposed PVC and ABS Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.
 - .5 Repair damage to adjacent materials caused by waste and vent piping installation.
- .3 Storm Drainage Piping
 - .1 Clean interior of piping. Remove dirt and debris as work progresses.
 - .2 Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
 - .3 Place plugs in ends of uncompleted piping at end of day and when work stops.

3.8 EARTHWORK

- .1 Comply with requirements for excavating, trenching, and backfilling specified in Division 31 Section "Earth Moving." At minimum, backfill shall be free from discarded construction material and debris. Loose earth, free from rocks, broken concrete, frozen chunks and other rubble, shall be placed in the trench in 6-inch (150 mm) layers and tamped in place until the crown of the pipe is covered by 12 inches (305 mm) of tamped earth. The backfill under and beside the pipe shall be compacted for pipe support. Backfill shall be brought up evenly on both sides of the pipe so that the pipe remains aligned.
- .2 In instances where the manufacturer's installation instructions are more restrictive than those prescribed by the paragraph above, the material shall be installed in accordance with the more restrictive requirement.
- .3 Unless approved by a registered and licensed structural engineer, trenching installed parallel to footings shall not extend into the bearing plane of a footing or wall. The upper boundary of the bearing plane is a line that extends downward, at an angle of 45 degrees (0.79 rad) from horizontal, from the outside bottom of the footing or wall.

3.9 PIPING SCHEDULE

- .1 Domestic Water Piping
 - .1 Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
 - .2 Flanges and unions may be used for aboveground piping joints only unless otherwise indicated.

- .3 Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.
- .4 Only, and must be formed and pressure tested off-site prior to project installation.
- .5 Water service entry, domestic water, building-service piping, NPS 3 (DN 80) and smaller, shall be the following:
 - .1 Annealed copper tube, ASTM B88, Type K (ASTM B88M, Type A); wrought-copper, solder-joint fittings; and brazed joints.
- .6 Water service entry, domestic water, building-service piping, NPS 4 (DN 100 to DN 200) and larger, shall be one of the following:
 - .1 Annealed copper tube, ASTM B88, Type K (ASTM B88M, Type A); wrought-copper, solder-joint fittings; and brazed joints.
 - .2 Push-on-joint, ductile-iron pipe; standard-pattern, push-on-joint fittings; and gasketed joints.
- .7 Under-building-slab, combined domestic water, building-service, and fire-service-main piping, NPS 6 to NPS 12 (DN 150 to DN 300) , shall be the following:
 - .1 Push-on-joint, ductile-iron pipe; standard-pattern, push-on-joint fittings; and gasketed joints.
- .8 Under-building-slab, domestic water piping, NPS 2 (DN 50) and smaller, shall be the following:
 - .1 Soft copper tube, ASTM B88, Type K (ASTM B88M, Type B); rolled changes in direction, no underground joints.
- .9 Aboveground domestic water piping, NPS 2 (DN 50) and smaller, shall be one of the following:
 - .1 Hard copper tube, ASTM B88, Type L (ASTM B88M, Type B); cast- or wrought-copper, solder-joint fittings; and brazed or soldered joints.
 - .2 Hard copper tube, ASTM B88, Type L (ASTM B88M, Type B); copper pressure-seal-joint fittings; and pressure-sealed joints based upon satisfactory compliance with above sections governing the use of Viega Pro-Press as an alternate.
 - .3 CPVC, Schedule 40; socket fittings; and solvent-cemented joints for softened or process water applications only, refer to drawings for application. CPVC shall NOT be used for standard domestic water applications.
 - .4 PEX tube, NPS 1 (DN 25) and smaller.
 - .1 Fittings for PEX tube:
 - .1 ASTM F1807, metal insert and copper crimp rings.
 - .2 ASTM F1960, cold expansion fittings and reinforcing rings.
 - .3 ASSE 1061, push-fit fittings.
 - .5 PEX-AL-PEX tube, NPS 1 (DN 25) and smaller; fittings for PEX-AL-PEX tube; and crimped joints.
 - .6 PVDF pipe and fittings, with heat fusion joints.
- .10 Aboveground domestic water piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100) , shall be one of the following:
 - .1 Hard copper tube, ASTM B88, Type L (ASTM B88M, Type B); cast- or wrought-copper, solder-joint fittings; and brazed or soldered joints.
 - .2 Hard copper tube, ASTM B88, Type L (ASTM B88M, Type B); copper pressure-seal-joint fittings; and pressure-sealed joints based upon satisfactory compliance with above sections governing the use of Viega Pro-Press as an alternate.

- .3 Hard copper tube, ASTM B88, Type L (ASTM B88M, Type B); grooved-joint, copper-tube appurtenances; and grooved joints.
- .4 Stainless steel, Schedule 40 pipe; grooved-joint fittings, and grooved joints.
- .5 Stainless steel, Schedule 40 pipe, stainless steel pressure-seal-joint fittings; and pressure-sealed joints based upon satisfactory compliance with above sections governing the use of Viega Pro-Press as an alternate
- .6 CPVC, Schedule 40; socket fittings; and solvent-cemented joints for softened or process water applications only, refer to drawings for application. CPVC shall NOT be used for standard domestic water applications.
- .7 PVDF pipe and fittings, with heat fusion joints.
- .11 Aboveground domestic water piping, NPS 5 to NPS 8 (DN 125 to DN 200) , shall be one of the following:
 - .1 Hard copper tube, ASTM B88, Type L (ASTM B88M, Type B); grooved-joint, copper-tube appurtenances; and grooved joints.
 - .2 Stainless-steel pipe and fittings, stainless steel pipe appurtenances, and grooved joints.
 - .3 Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.
 - .4 Galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.
- .12 Aboveground, combined domestic water-service and fire-service-main piping, NPS 6 to NPS 12 (DN 150 to DN 300), shall be one of the following:
 - .1 Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.
 - .2 Mechanical joint, gasket and follower ring, bell end ductile-iron pipe; standard-pattern, push-on-joint fittings; and gasketed joints.
 - .3 Stainless-steel pipe and fittings, stainless steel pipe appurtenances, and grooved joints.
 - .4 Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.
 - .5 Galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.
- .2 Sanitary Waste and Vent Piping
 - .1 Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
 - .2 Aboveground, soil, waste, and vent piping NPS 4 (DN 100) and smaller shall be any of the following:
 - .1 Service class, hub and spigot cast-iron soil pipe and fittings; caulked lead and oakum joints.
 - .2 Hubless, cast-iron soil pipe and fittings and hubless, single-stack aerator fittings; CISPI hubless-piping couplings; and coupled joints.
 - .3 Galvanized-steel pipe, drainage fittings, and threaded joints.
 - .4 Stainless-steel pipe and fittings, sealing rings, and gasketed joints.
 - .5 Copper Type M tube, copper drainage fittings, and soldered joints.
 - .6 Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 - .7 Dissimilar Pipe-Material Couplings: Transition couplings and/or dielectric fittings as scheduled above.-

- .3 Aboveground, soil and waste piping NPS 5 (DN 125) and larger shall be any of the following:
 - .1 Service class, hub and spigot cast-iron soil pipe and fittings; caulked lead and oakum joints.
 - .2 Hubless, cast-iron soil pipe and fittings; CISPI cast-iron hubless-piping couplings; and coupled joints.
 - .3 Galvanized-steel pipe, drainage fittings, and threaded joints.
 - .4 Stainless-steel pipe and fittings, sealing rings, and gasketed joints.
 - .5 Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 - .6 Dissimilar Pipe-Material Couplings: Transition couplings and/or dielectric fittings as scheduled above.
- .4 Above ground, vent piping NPS 4 (DN 100) and smaller shall be any of the following:
 - .1 Hard copper tube, Type M (Type C); copper pressure fittings; and soldered joints (2-1/2" or less only).
 - .2 Service class, hub and spigot cast-iron soil pipe and fittings; caulked lead and oakum joints. Hubless, cast-iron soil pipe and fittings;
 - .3 CISPI cast-iron hubless-piping couplings; and coupled joints.
 - .4 Galvanized-steel pipe, drainage fittings, and threaded joints.
 - .5 Stainless-steel pipe and fittings gaskets, and gasketed joints.
 - .6 Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 - .7 Dissimilar Pipe-Material Couplings: Transition couplings and/or dielectric fittings as scheduled above.
- .5 Above ground, vent piping NPS 5 (DN 125) and larger shall be any of the following:
 - .1 Service class, hub and spigot cast-iron soil pipe and fittings; caulked lead and oakum joints. Hubless, cast-iron soil pipe and fittings; CISPI cast-iron hubless-piping couplings; and coupled joints. Galvanized-steel pipe, drainage fittings, and threaded joints. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints. Dissimilar Pipe-Material Couplings: Transition couplings and/or dielectric fittings as scheduled above.
 - .2 Hubless, cast-iron soil pipe and fittings; CISPI cast-iron hubless-piping couplings; and coupled joints.
 - .3 Galvanized-steel pipe, drainage fittings, and threaded joints.
 - .4 Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 - .5 Dissimilar Pipe-Material Couplings: Transition couplings and/or dielectric fittings as scheduled above.
- .3 Storm Drainage Piping
 - .1 Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.
 - .2 Refer to "Plumbing Piping System Application Schedule" in drawings.
 - .3 Aboveground storm drainage piping NPS 6 (DN 150) and smaller shall be any of the following:
 - .1 Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 - .2 Hubless, cast-iron soil pipe and fittings; heavy-duty CISPI hubless-piping couplings; and coupled joints.
 - .3 Galvanized-steel pipe, drainage fittings, and threaded joints.
 - .4 Copper DWV tube, copper drainage fittings, and soldered joints.
 - .5 Solid-wall ABS pipe, ABS socket fittings, and solvent-cemented joints.

- .6 Solid-wall Cellular-core PVC pipe, PVC socket fittings, and solvent-cemented joints.
- .7 Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
- .4 Aboveground, storm drainage piping NPS 8 (DN 200) and larger shall be any of the following:
 - .1 Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 - .2 Hubless, cast-iron soil pipe and fittings; heavy-duty CISPI hubless-piping couplings; and coupled joints.
 - .3 Galvanized-steel pipe, drainage fittings, and threaded joints.
 - .4 Copper DWV tube, copper drainage fittings, and soldered joints.
 - .5 Solid-wall Cellular-core PVC pipe, PVC socket fittings, and solvent-cemented joints.
 - .6 Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
- .5 Underground non pressure subsoil drainage ALL SIZES shall be the following:
 - .1 Perforated PVC piping; PVC socket fittings; and solvent-cemented joints.

3.10 VALVE SCHEDULE

- .1 Domestic Water Piping
 - .1 Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 - .1 Shutoff Duty: Use ball or gate valves for piping NPS 2 (DN 50) and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 (DN 65) and larger.
 - .2 Throttling Duty: Use ball or globe valves for piping NPS 2 (DN 50) and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 (DN 65) and larger.
 - .3 Hot-Water Circulation Piping, Balancing Duty: Calibrated balancing valves.
 - .4 Drain Duty: Hose-end drain valves.
 - .2 Use check valves to maintain correct direction of domestic water flow to and from equipment.
 - .3 Provide check valve on branch piping downstream of hot water circulation balancing valve.
 - .4 Iron grooved-end valves may be used with grooved-end piping.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- .1 Domestic Water Piping Specialties
 - .1 Vacuum Breakers.
 - .2 Backflow Preventers.
 - .3 Water Pressure-Reducing Valves.
 - .4 Automatic water shutoff valve systems.
 - .5 Mechanical Balancing Valves.
 - .6 Digital balancing and flushig valves.
 - .7 Mechanical, temperature-actuated balancing valves.
 - .8 Flow Splitter Valves.
 - .9 Temperature-Actuated, Water Mixing Valves.
 - .10 Strainers.
 - .11 Outlet Boxes.
 - .12 Hose Stations.
 - .13 Hose Bibbs.
 - .14 Wall Hydrants.
 - .15 Ground Hydrants.
 - .16 Post Hydrants.
 - .17 Roof Hydrants.
 - .18 Drain Valves.
 - .19 Water-Hammer Arresters.
 - .20 Air Vents.
 - .21 Pressure Trap-Seal Primer Device.
 - .22 Electronic Trap-Seal Primer Systems.
 - .23 Water Meters.
- .2 Sanitary Waste Piping Specialties
 - .1 Backwater Valves.
 - .2 Cleanouts.
 - .3 Channel Drainage Systems.
 - .4 Air-Admittance Valves.
 - .5 Roof Flashing Assemblies.
 - .6 Through-Penetration Firestop Assemblies.
 - .7 Motors.
 - .8 Miscellaneous sanitary drainage piping specialties.
- .3 Storm Drainage Piping Specialties
 - .1 Backwater Valves.
 - .2 Cleanouts.
 - .3 Through-Penetration Firestop Assemblies.
 - .4 Miscellaneous storm drainage piping specialties.

1.2 GENERAL REFERENCES

- .1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.
- .2 Division 20, including all Common Mechanical Requirements in Section 20 00 00, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.

1.3 RELATED REQUIREMENTS

- .1 Section 076200 "Sheet Metal Flashing and Trim" for penetrations of roofs.
- .2 Section 078413 "Penetration Firestopping" for firestopping roof penetrations.
- .3 Division 20 "Common Mechanical Work Results" for thermometers, pressure gages, and flow meters in domestic water piping.
- .4 Division 22 "Plumbing Piping" for water meters.
- .5 Division 22 "Domestic Water Filtration Equipment" for municipal water filters in domestic water piping.
- .6 Division 22 "Healthcare Plumbing Fixtures" for thermostatic mixing valves for sitz baths, thermostatic mixing-valve assemblies for hydrotherapy equipment, and outlet boxes for dialysis equipment.
- .7 Division 22 "Emergency Plumbing Fixtures" for water tempering equipment.
- .8 Division 22 "Drinking Fountains" for water filters for water coolers.
- .9 Division 22 "Pressure Water Coolers" for water filters for water coolers.
- .10 Division 22 "Remote Water Coolers" for water filters for water coolers.
- .11 Division 22 "Leak Detection Instruments" for leak detection devices related to HVAC applications.
- .12 Division 22 "Site Water Distribution Piping" for fire water-service backflow prevention devices.
- .13 Division 22 Section "Commercial Sinks" for hair interceptors.
- .14 Division 22 Section "Healthcare Plumbing Fixtures" for plaster sink interceptors.
- .15 Division 33 Section "Stormwater Conveyance" for storm drainage piping and piping specialties outside the building.

1.4 REFERENCE STANDARDS

- .1 ASME A112.1.2 - x.
- .2 ASME A112.3.1 - x.
- .3 ASME A112.14.1 - Backwater Valves.
- .4 ASME A112.18.1 - Plumbing Supply Fittings.
- .5 ASME A112.21.2M - x.
- .6 ASME A112.21.3M - x.
- .7 ASME A112.36.2M - Cleanouts.
- .8 ASME B1.20.7 - Hose Coupling Screw Threads (Inch).
- .9 ASSE 1001 - Performance Requirements for Atmospheric Type Vacuum Breakers.
- .10 ASSE 1010 - x.
- .11 ASSE 1011 - Performance Requirements for Hose Connection Vacuum Breakers.
- .12 ASSE 1012 - Performance Requirements for Backflow Preventers with an Intermediate Atmospheric Vent.
- .13 ASSE 1013 - Performance Requirements for Reduced Pressure Principle Backflow Prevention Assemblies.

- .14 ASSE 1015 - Performance Requirements for Double Check Backflow Prevention Assemblies.
- .15 ASSE 1016 - Performance Requirements for Automatic Compensating Valves for Individual Showers and Tub/Shower Combinations.
- .16 ASSE 1017 - Performance Requirements for Temperature Actuated Mixing Valves for Hot Water Distribution Systems.
- .17 ASSE 1018 - Performance Requirements for Trap Seal Primer Valves - Potable Water Supplied.
- .18 ASSE 1019 - Performance Requirements for Wall Hydrant with Backflow Protection and Freeze Resistance.
- .19 ASSE 1020 - Performance Requirements for Pressure Vacuum Breaker Assemblies.
- .20 ASSE 1022 - Performance Requirements for Backflow Preventer for Beverage Dispensing Equipment.
- .21 ASSE 1024 - Performance Requirements for Dual Check Backflow Preventers.
- .22 ASSE 1032 - Performance Requirements for Dual Check Valve Type Backflow Preventers for Carbonated Beverage Dispensers, Post Mix Type, and Non-Carbonated Beverage Dispenser.
- .23 ASSE 1035 - Performance Requirements for Laboratory Faucet Backflow Preventers.
- .24 ASSE 1044 - Performance Requirements for Trap Seal Primer – Drainage Types and Electric Design Types.
- .25 ASSE 1050 - x.
- .26 ASSE 1052 - Performance Requirements for Hose Connection Backflow Preventers.
- .27 ASSE 1056 - Performance Requirements for Spill Resistant Vacuum Breaker Assemblies.
- .28 ASSE 1057 - Performance Requirements for Freeze Resistant Sanitary Yard Hydrants with Backflow Protection.
- .29 ASSE 1070 - Performance Requirements for Water Temperature Limiting Devices.
- .30 ASTM A48/A48M - Standard Specification for Gray Iron Castings.
- .31 ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings.
- .32 ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- .33 ASTM A888 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
- .34 ASTM B32 - Standard Specification for Solder Metal.
- .35 ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings.
- .36 ASTM B88 - Standard Specification for Seamless Copper Water Tube.
- .37 ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric).
- .38 ASTM B152/B152M - Standard Specification for Copper Sheet, Strip, Plate, and Rolled Bar..
- .39 ASTM D4068 - Standard Specification for Chlorinated Polyethylene (CPE) Sheeting for Concealed Water-Containment Membrane.
- .40 ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems.
- .41 AWWA C550 - Protective Interior Coatings for Valves and Hydrants.
- .42 AWWA C700 - Cold-Water Meters -- Displacement Type, Metal Alloy Main Case.
- .43 AWWA C701 - Cold-Water Meters -- Turbine Type, for Customer Service.
- .44 AWWA C702 - Cold-Water Meters -- Compound Type.
- .45 AWWA C706 - x.
- .46 AWWA C707 - Encoder-Type Remote-Registration Systems for Cold-Water Meters.

- .47 AWWA M6 - Water Meters -- Selection, Installation, Testing, and Maintenance.
- .48 CISPI 301 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste and Vent Piping Applications; Cast Iron Soil Pipe Institute.
- .49 MSS SP-80 - Bronze Gate, Globe, Angle, and Check Valves.
- .50 MSS SP-110 - x.
- .51 NECA 1 - Standard for Good Workmanship in Electrical Construction.
- .52 NFPA 70 - National Electrical Code.
- .53 NSF 14 - x.
- .54 NSF 61 - Drinking Water System Components - Health Effects.
- .55 NSF 372 - Drinking Water System Components - Lead Content.
- .56 PDI-WH 201 - Water Hammer Arresters; Plumbing and Drainage Institute.
- .57 ASHRAE Std 189.1 - Standard for the Design of High-Performance Green Buildings.

1.5 ABBREVIATIONS AND ACRONYMS

- .1 AMI: Advanced Metering Infrastructure.
- .2 AMR: Automatic Meter Reading.

1.6 PERFORMANCE REQUIREMENTS

- .1 Domestic Water Piping Specialties
 - .1 Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig (860 kPa) unless otherwise indicated.

1.7 SUBMITTALS

- .1 Action Submittals
 - .1 Product Data: For each type of product. include rated capacities, operating characteristics, and accessories for the following:
 - .1 FOG disposal systems.
 - .2 Shop Drawings: For domestic water piping specialties.
 - .1 Include diagrams for power, signal, and control wiring as applicable.
 - .3 Shop Drawings:
 - .1 Wiring Diagrams: Power, signal, and control wiring.
- .2 Informational Submittals
 - .1 Seismic Qualification Data: For FOG disposal systems, accessories, and components, from manufacturer.
 - .1 Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - .2 Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - .3 Detailed description of equipment anchored to devices on which the certification is based and their installation requirements.
 - .4 Field quality-control reports.
- .3 Closeout Submittals
 - .1 Field quality-control reports.
- .4 LEED Submittals
 - .1 Sustainable Design Submittals: "Product Data" Subparagraph below applies to LEED 2009, LEED v4, IgCC, ASHRAE Std 189.1, and Green Globes for fixtures and equipment that consume water.

- .1 Product Data: For water consumption.
- .5 Operation and Maintenance Materials
 - .1 For domestic water piping specialties to include in emergency, operation, and maintenance manuals.
 - .2 Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - .1 Cultures: Provide 1-gal. bottles of bacteria culture recommended by manufacturer of FOG disposal systems equal to 200 percent of amount installed, but no fewer than 2 1-gal. bottles.
 - .3 For sanitary waste piping specialties to include in emergency, operation, and maintenance manuals.
- .6 Record Documents
 - .1 Project Record Documents: Record actual locations of equipment, cleanouts, backflow preventers, and water hammer arrestors.
- 1.8 QUALITY ASSURANCE**
 - .1 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.
 - .2 Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.
 - .3 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years documented experience.
- 1.9 DELIVERY, STORAGE AND HANDLING**
 - .1 Accept specialties on site in original factory packaging. Inspect for damage.
- 1.10 EXTRA MATERIALS**
 - .1 Extra Loose Keys for Outside Hose Bibbs: One.
 - .2 Extra Hose End Vacuum Breakers for Hose Bibbs: One.

PART 2 PRODUCTS

- 2.1 GENERAL**
 - .1 Domestic water piping specialties intended to convey or dispense water for human consumption are to comply with the SDWA, requirements of authorities having jurisdiction, and NSF 61 and NSF 372, or to be certified in compliance with NSF 61 and NSF 372 by an American National Standards Institute (ANSI)-accredited third-party certification body that the weighted average lead content at wetted surfaces is less than or equal to 0.25 percent.
 - .2 For plastic components: NSF 14, mark "NSF-pw" on plastic piping components.
 - .3 Source Limitations
 - .1 Obtain each type of specialty from single source and from a single manufacturer. Coordinate products across all applicable size ranges to be from the same manufacturer.
- 2.2 DOMESTIC WATER PIPING SPECIALTIES**
 - .1 Vacuum Breakers
 - .1 Pipe-Applied, Atmospheric-Type Vacuum Breakers:
 - .1 Manufacturers:

- .1 Ames Fire & Waterworks; a division of Watts Water Technologies, Inc.
 - .2 Conbraco Industries, Inc.
 - .3 FEBCO; a division of Watts Water Technologies, Inc.
 - .4 Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - .5 Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
 - .6 Cash Acme; a division of Reliance Worldwide Corporation.
- .2 Standard: ASSE 1001.
- .3 Size: NPS 1/4 to NPS 3 (DN 8 to DN 80) , as required to match connected piping.
- .4 Body: Bronze.
- .5 Inlet and Outlet Connections: Threaded.
- .6 Finish: Chrome plated for exposed finished areas. Rough bronze for unfinished areas.
- .2 Hose-Connection Vacuum Breakers:
 - .1 Manufacturers:
 - .1 Cash Acme; a division of Reliance Worldwide Corporation.
 - .2 Conbraco Industries, Inc.
 - .3 MIFAB, Inc.
 - .4 Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - .5 Woodford Manufacturing Company; a division of WCM Industries, Inc.
 - .6 Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
 - .2 Standard: ASSE 1011.
 - .3 Body: Bronze, nonremovable, with manual drain.
 - .4 Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
- .3 Pressure Vacuum Breakers:
 - .1 Manufacturers:
 - .1 Ames Fire & Waterworks; a division of Watts Water Technologies, Inc.
 - .2 Conbraco Industries, Inc.
 - .3 FEBCO; a division of Watts Water Technologies, Inc.
 - .4 Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - .5 Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
 - .2 Standard: ASSE 1020.
 - .3 Operation: Continuous-pressure applications.
 - .4 Pressure Loss: 5 psig (35 kPa) maximum, through middle third of flow range.
 - .5 Accessories:
 - .1 Valves: Ball type, on inlet and outlet.
- .4 Laboratory-Faucet Vacuum Breakers:
 - .1 Manufacturers:
 - .1 Conbraco Industries, Inc.

- .2 Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - .3 Woodford Manufacturing Company; a division of WCM Industries, Inc.
 - .4 Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
 - .2 Standard: ASSE 1035.
 - .3 Size: NPS 1/4 or NPS 3/8 (DN 8 or DN 10) matching faucet size.
 - .4 Body: Bronze.
 - .5 End Connections: Threaded.
 - .6 Finish: Chrome plated.
- .5 Spill-Resistant Vacuum Breakers:
 - .1 Manufacturers:
 - .1 Conbraco Industries, Inc.
 - .2 Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - .2 Standard: ASSE 1056.
 - .3 Operation: Continuous-pressure applications.
 - .4 Size: NPS 1/4 (DN 8).
 - .5 Accessories:
 - .1 Valves: Ball type, on inlet and outlet.
- .2 Backflow Preventers
 - .1 Intermediate Atmospheric-Vent Backflow Preventers:
 - .1 Manufacturers:
 - .1 Cash Acme; a division of Reliance Worldwide Corporation.
 - .2 Conbraco Industries, Inc.
 - .3 FEBCO; a division of Watts Water Technologies, Inc.
 - .4 Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - .5 Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
 - .6 Legend Valve.
 - .2 Standard: ASSE 1012.
 - .3 Operation: Continuous-pressure applications.
 - .4 Size: See Drawings.
 - .5 Body: Bronze.
 - .6 End Connections: See Drawings.
 - .2 Reduced-Pressure-Principle Backflow Preventers:
 - .1 Manufacturers:
 - .1 Ames Fire & Waterworks; a division of Watts Water Technologies, Inc.
 - .2 Conbraco Industries, Inc.
 - .3 FEBCO; a division of Watts Water Technologies, Inc.
 - .4 Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.

- .5 Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
- .2 Standard: ASSE 1013.
- .3 Operation: Continuous-pressure applications.
- .4 Pressure Loss: 12 psig (83 kPa) maximum, through middle third of flow range.
- .5 Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved for NPS 2-1/2 (DN 65) and larger.
- .6 End Connections: Threaded for NPS 2 (DN 20) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
- .7 Configuration: Designed for horizontal, straight-through flow.
- .8 Accessories:
 - .1 Valves NPS 2 (DN 50) and Smaller: Ball type with threaded ends on inlet and outlet.
 - .2 Valves NPS 2-1/2 (DN 65) and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
 - .3 Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.
- .3 Double-Check, Backflow-Prevention Assemblies:
 - .1 Manufacturers:
 - .1 Ames Fire & Waterworks; a division of Watts Water Technologies, Inc.
 - .2 Conbraco Industries, Inc.
 - .3 FEBCO; a division of Watts Water Technologies, Inc.
 - .4 Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - .5 Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
 - .2 Standard: ASSE 1015.
 - .3 Operation: Continuous-pressure applications unless otherwise indicated.
 - .4 Pressure Loss: 5 psig (35 kPa) maximum, through middle third of flow range.
 - .5 Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved for NPS 2-1/2 (DN 65) and larger.
 - .6 End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
 - .7 Configuration: Designed for horizontal, straight-through flow.
 - .8 Accessories:
 - .1 Valves NPS 2 (DN 50) and Smaller: Ball type with threaded ends on inlet and outlet.
 - .2 Valves NPS 2-1/2 (DN 65) and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
- .4 Beverage-Dispensing-Equipment Backflow Preventers:
 - .1 Manufacturers:
 - .1 Conbraco Industries, Inc.
 - .2 Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.

- .3 Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
 - .2 Standard: ASSE 1022.
 - .3 Operation: Continuous-pressure applications.
 - .4 Size: NPS 1/4 or NPS 3/8 (DN 8 or DN 10).
 - .5 Body: Stainless steel.
 - .6 End Connections: Threaded.
- .5 Dual-Check-Valve Backflow Preventers:
 - .1 Manufacturers:
 - .1 Cash Acme; a division of Reliance Worldwide Corporation.
 - .2 Conbraco Industries, Inc.
 - .3 FEBCO; a division of Watts Water Technologies, Inc.
 - .4 Mueller Co. Ltd.; a subsidiary of Mueller Water Products Inc.
 - .5 Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - .6 Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
 - .2 Standard: ASSE 1024.
 - .3 Operation: Continuous-pressure applications.
 - .4 Body: Bronze with union inlet.
- .6 Carbonated-Beverage-Dispenser, Dual-Check-Valve Backflow Preventers:
 - .1 Manufacturers:
 - .1 Cash Acme; a division of Reliance Worldwide Corporation.
 - .2 Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - .2 Standard: ASSE 1032.
 - .3 Operation: Continuous-pressure applications.
 - .4 Size: NPS 1/4 or NPS 3/8 (DN 8 or DN 10) .
 - .5 Body: Stainless steel.
 - .6 End Connections: Threaded.
- .7 Hose-Connection Backflow Preventers:
 - .1 Manufacturers:
 - .1 Conbraco Industries, Inc.
 - .2 Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - .3 Woodford Manufacturing Company; a division of WCM Industries, Inc.
 - .2 Standard: ASSE 1052.
 - .3 Operation: Up to 10-foot head of water (30-kPa) back pressure.
 - .4 Inlet Size: NPS 1/2 or NPS 3/4 (DN 15 or DN 20) .
 - .5 Outlet Size: Garden-hose thread complying with ASME B1.20.7.
 - .6 Capacity: At least 3-gpm (0.19-L/s) flow.
- .8 Backflow-Preventer Test Kits:
 - .1 Manufacturers:
 - .1 Conbraco Industries, Inc.

- .2 FEBCO; a division of Watts Water Technologies, Inc.
 - .3 Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - .4 Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
 - .2 Description: Factory calibrated, with gages, fittings, hoses, and carrying case with test-procedure instructions.
- .3 Water Pressure-Reducing Valves
 - .1 Water Regulators:
 - .1 Manufacturers:
 - .1 Cash Acme; a division of Reliance Worldwide Corporation.
 - .2 Conbraco Industries, Inc.
 - .3 Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - .4 Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
 - .2 Standard: ASSE 1003.
 - .3 Pressure Rating: Initial working pressure of 150 psig (1035 kPa) .
 - .4 Body: Bronze with chrome-plated finish for NPS 2 (DN 50) and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved for NPS 2-1/2 and NPS 3 (DN 65 and DN 80).
 - .5 Valves for Booster Heater Water Supply: Include integral bypass.
 - .6 End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 and NPS 3 (DN 65 and DN 80) .
 - .2 Water-Control Valves:
 - .1 Manufacturers:
 - .1 CLA-VAL.
 - .2 Watts; a division of Watts Water Technologies, Inc.; Control Valves (Watts ACV).
 - .3 Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
 - .2 Description: Pilot-operated, diaphragm-type, single-seated, main water-control valve.
 - .3 Pressure Rating: Initial working pressure of 150 psig (1035 kPa) minimum with AWWA C550 or FDA-approved, interior epoxy coating. Include small pilot-control valve, restrictor device, specialty fittings, and sensor piping.
 - .4 Main Valve Body: Cast- or ductile-iron body with AWWA C550 or FDA-approved, interior epoxy coating; or stainless-steel body.
 - .1 Pattern: Angle-valve design.
 - .2 Trim: Stainless steel.
 - .5 End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
- .4 Automatic Water Shutoff Valve Systems
 - .1 Manufacturers:
 - .1 Floodmaster.
 - .2 The Detection Group.

- .3 Zurn Plumbing Products Group.
- .2 Shutoff Control Ball Valves and Actuators:
 - .1 Size: Same as applied pipe size.
 - .2 Control Valve: Two-piece, full-port bronze ball valve, MSS SP-110.
 - .1 End Connections: Threaded, female.
 - .2 Fittings: One 3/8-by-1/2-inch (9.5-by-12.7-mm) male compression and one 3/8-by-1/2-inch (9.5-by-12.7-mm) female compression.
 - .3 Seats: PTFE.
 - .4 O-Rings: FKM.
 - .5 Stem: Low-lead brass. Blowout proof.
 - .6 CWP Rating: 600 psig (4140 kPa).
 - .3 Manual-override control turn-knob for emergency operation of valve.
 - .4 Valve Actuator: Motor operated, with or without gears, electric and electronic. Capable of closing valve against inlet pressure. Direct mount, fails closed.
 - .1 Power Supply: Battery with cord and plug.
 - .2 Manual Intervention: Allowed.
 - .3 Position Indicator: Standard.
 - .5 Actuator Enclosure: Suitable for ambient conditions encountered by application.
 - .6 Wireless Leak Detection System:
 - .1 Sensor-Water Flow Type: Pipe-mounted to detect water flow.
 - .2 Sensor-Rope Type: Absorbent water sensing rope constructed from twisted metal conductor wires insulated from one another and surrounded by polyethylene mesh braid jacket to detect water presence.
 - .3 Wireless Signal Range: 100 feet (30.5 m) minimum between sensors and receiver.
 - .4 Self-monitoring enabled system; faults for lost communication between receiver and sensor(s).
 - .5 Onboard Battery Backup: 48 hours of protection. Valve to close prior to backup failure.
 - .6 LED Indicators: Wireless signal strength, communication loss, water fault, low-temperature fault, and low battery.
 - .7 FCC-Approved Wireless Communication System: Between sensors, repeaters, and receivers.
 - .8 Output Contacts: Interface with home security or BAS, cellular text notification service, or auto dialer accessories.
 - .9 Wireless Signal Repeater: Boosts signal performance between wireless sensors and receiver.
 - .1 Push-button pairing and unpairing, into and out of the network.
 - .2 Visual indication of wireless signal strength, low battery, and lost communication.
 - .3 Standard wall outlet, 120 V ac, power.
 - .4 Battery Backup: Two (2) AA batteries for battery backup to maintain system integrity during a power outage.
 - .10 Wireless Water Switch: Allows manual override or wireless system functionality and closes the valve to shut off water flow.

- .11 Hard-Wired Water Switch: Allows manual override or wireless system functionality and closes the valve to shut off water flow.
- .7 Wired Leak Detection System:
 - .1 Power Supply: Class II transformer with cord and plug, 120 V ac, UL listed.
 - .2 Power Cord Length: 12 feet (3.66 m).
 - .3 Control Panel: LED power and LED valves indicator.
 - .4 Alarms: Audible alarm, with external output.
 - .5 Output Contacts: Interface with home security or BAS, cellular text notification service, or auto dialer accessories.
 - .6 Wired Sensors:
 - .1 Quantity Per Receiver: One.
 - .7 Cable Length: 8 feet (2.44 m).
 - .8 Cable Adder: 10 feet (3 m) in length.
- .3 Clothes Washer Shutoff Control Valve and Actuator:
 - .1 Brass or stainless steel ball valve.
 - .2 End Connections: Male hose connections, NPS 3/4 (DN 20) .
 - .3 Pressure Rating: 400 psi (2758 kPa) at 32 to 150 deg F (0 to 65.6 deg C) .
 - .4 Valve Actuator:
 - .1 Enclosure: Suitable for ambient conditions encountered by application.
 - .2 Power Supply: Battery with cord and plug.
 - .3 Position Indicator: Standard.
 - .5 Wired Leak Detection System:
 - .1 Water sensor with minimum 6-foot (1.8-m) length of wire.
 - .2 120 V ac step-down transformer with cord and plug.
 - .3 LED operation and leak notification.
 - .4 Audible alarm.
 - .5 Power failure or manual disconnection of power causes valves to close.
- .4 Accessories:
 - .1 Electrical Plug Interrupter: Plugs into standard 120 V ac wall outlet.
 - .2 Gas Flow Interrupter: ECO connector with female spade connectors. Factory prewired, 8 feet (2.44 m) .
 - .3 Gas Interface Cable: Interface cable with male and female connectors.
 - .4 Step-Down Transformer: 120 V ac to 24 V ac with mounting plate, 12-foot (3.66-m) plenum wire to power, and 8-foot (2.44-m) plenum wire to sensor.
 - .5 Liquid Level Sensors: Monitor fluid levels in addition to detecting plumbing leaks.
 - .6 Auto Dialer: Send and receive automatic alerts when a fault condition occurs. Standard output contacts trigger up to nine predetermined telephone number calls.
 - .1 Prerecord message for future playback.
 - .2 10-second recordable message.
 - .3 Built-in tamper switch.
 - .4 DC adaptor with battery backup.
 - .5 Programmable as a silent (dialer only) or audible (siren and dialer) alarm.

- .6 Easy "Stop Call Sequence" - push "#" on phone to acknowledge the alarm and stop the dialing sequence.
- .7 Cellular Text Notification System:
 - .1 Event SMS text notification to up to three cell phones.
 - .2 Battery Backup: Four (4) AA batteries.
 - .3 12-foot (3.66-m) interface cable to leak detection system.
 - .4 Customized messaging.
 - .5 _____.
- .5 Mechanical Balancing Valves
 - .1 Copper-Alloy Calibrated Balancing Valves:
 - .1 Manufacturers:
 - .1 Armstrong International, Inc.
 - .2 NIBCO Inc.
 - .3 TACO Incorporated.
 - .4 Jomar Valve.
 - .5 Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - .2 Type: Ball valve with two readout ports and memory-setting indicator.
 - .3 Body: Lead free brass or bronze.
 - .4 Size: Same as connected piping, but not larger than NPS 2 (DN 50).
 - .5 Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.
 - .2 Automatic Flow Control Balancing Valves:
 - .1 Manufacturers:
 - .1 Calefi North America.
 - .2 ThermOmegaTech.
 - .3 Hays Fluid Controls.
 - .4 Jomar Valve
 - .2 Flow Regulation: Plus or minus 5 percent over 95 percent of the working range.
 - .3 Pressure Rating: 200 psig (1380 kPa).
 - .4 Size: NPS 2 (DN 50) or smaller.
 - .5 Body: Stainless steel or brass.
 - .6 Flow Cartridge: Stainless steel or antiscaling polymer.
 - .7 End Connections: Threaded or solder joint
 - .3 Memory-Stop Balancing Valves:
 - .1 Manufacturers:
 - .1 Conbraco Industries, Inc.
 - .2 Crane Co.; Crane Valve Group; Crane Valves.
 - .3 Crane Co.; Crane Valve Group; Jenkins Valves.
 - .4 Crane Co.; Crane Valve Group; Stockham Div.
 - .5 Hammond Valve.
 - .6 Milwaukee Valve Company.
 - .7 NIBCO Inc.
 - .8 Red-White Valve Corp.

- .2 Standard: MSS SP-110 for two-piece, copper-alloy ball valves.
- .3 Pressure Rating: 400-psig (2760-kPa) minimum CWP.
- .4 Size: NPS 2 (DN 50) or smaller.
- .5 Body: Copper alloy.
- .6 Port: Standard or full port.
- .7 Ball: Chrome-plated brass.
- .8 Seats and Seals: Replaceable.
- .9 End Connections: Solder joint or threaded.
- .10 Handle: Vinyl-covered steel with memory-setting device.
- .6 Digital Balancing and Flushing Valves
 - .1 Master Control Boxes
 - .1 Manufacturer:
 - .1 Georg Fischer, LLC
 - .2 Master control panel shall comply with the following requirements:
 - .1 Control up to 50 controllers on two cable harnesses.
 - .1 Distance: Without the use of a power box, each cable harness is capable of a maximum distance from the master of 984 ft. / 300 m. With the use of a power box, each cable harness is capable of a maximum distance from the master of 1640 ft. / 500 m.
 - .2 Touchscreen Display: Home, running application, manual operation, settings, reports, context-sensitive help and additional displays.
 - .3 Connections: Potential-free contact connection, USB connection, USV connection, Ethernet connection, connection for building management system, two M12 communication cable connections, Bluetooth, power supply connection.
 - .4 Constant monitoring and control of individual valves and sensors.
 - .5 Automatic data logging.
 - .6 Automated valve maintenance.
 - .7 Export of reports in .pdf or .xml format.
 - .8 Wall-mounted.
 - .9 Electrical Requirements: 110V power supply connection. Master converts 110V supply power to 36V.
 - .2 Power Boxes
 - .1 Manufacturer:
 - .1 Georg Fischer, LLC
 - .2 The power box shall comply with the following requirements:
 - .1 Provides additional power for cable lengths in excess of 984 ft. / 300 m.
 - .2 LED indicating power on/off.
 - .3 Connections: Power supply connection, two M12 communication cable connections.
 - .4 Wall-mounted.
 - .5 Electrical Requirements: 110V power supply connection. Converts 110V supply power to 36V.
 - .3 Digital Balancing Valves
 - .1 Manufacturer:

- .1 Georg Fischer, LLC
- .2 The digital balancing valve shall comply with the following requirements:
 - .1 Fully automated dynamic balancing valve.
 - .2 Controller includes motor actuator with encoder.
 - .3 Connections: Two M12 plug, PT1000 plug, M8 plug.
 - .4 Maximum operating pressure up to 145 psi.
 - .5 Maximum temperature up to 194 deg F.
 - .6 Two calibration temperatures (normal operation/thermal disinfection).
 - .7 Factory temperature settings.
 - .1 Normal operation: 134 deg F (setting range 32 deg F – 194 deg F)
 - .2 Thermal disinfection: 167 deg F (setting range 140 deg F – 194 deg F)
 - .8 Control accuracy < ± 1.8 deg F.
 - .9 Completely emerged temperature sensor PT1000 integrated in the valve.
 - .10 On/off option of Bluetooth connection to external tablet/smartphone.
 - .11 Activity indicator (LED light ring).
 - .12 EPDM O-ring.
 - .13 Male threaded end connections.
- .3 Custom insulation block.
 - .1 Automated weekly maintenance.
 - .2 36V power supply.
- .4 Digital Flushing Valves
 - .1 Manufacturer:
 - .1 Georg Fischer, LLC
 - .2 The digital flushing valve shall comply with the following requirements:
 - .1 Fully automated flushing valve.
 - .2 Controller includes motor actuator with encoder.
 - .3 Connections: Two M12 plug, PT1000 plug, M8 plug.
 - .4 Adjustable lift: flow rate with open valve.
 - .5 Maximum operating pressure up to 145 psi.
 - .6 Maximum temperature up to 194 deg F.
 - .7 Two calibration modes (temperature or timed flushing).
 - .8 Factory temperature setting: 77 deg F (setting range 35 deg F – 194 deg F).
 - .9 Control accuracy < ± 1.8 deg F.
 - .10 Completely emerged temperature sensor PT1000 integrated in the valve.
 - .11 On/off option of Bluetooth connection to external tablet/smartphone.
 - .12 Activity indicator (LED light ring).
 - .13 EPDM O-ring.
 - .14 End Connections: Threaded.
 - .15 Custom insulation block.
 - .16 36V power supply.
- .7 Mechanical Temperature-Actuated Balancing Valves

- .1 Stainless Steel Self-Acting Thermostatic Recirculation Valve
 - .1 Manufacturers:
 - .1 Circuit Solver, a ThermOmegaTech Division
 - .2 Standards: NSF 61 and California AB1953 Certified.
 - .3 Pressure Rating: 300-psig (2068-kPa) maximum CWP.
 - .4 Size: NPS 2 (DN 50) or smaller.
 - .5 Body: Type 303 Stainless Steel.
 - .6 End Connections: threaded.
- .8 Flow-Splitter Valves
 - .1 Venturi Flow-Splitter: Lead-free, corrosion resistant red brass dual tee assembly valve with internal, self-adjusting flow regulator including factory loop line 1/4 turn shut off valves and factory insulation jacket.
 - .1 Manufacturers:
 - .1 Kemper Water Control Systems, IncL.
 - .2 Standards: NSF 61/NSF 372 certified
 - .3 Body: zinc resistant red brass.
 - .4 Sizes: 1/2" to 2" in the main flow portion of the valve.
 - .5 Features: Built-in, self-regulating, self-cleaning, flow diverting POM cartridge insert with SS spring and EPDM O-ring, 1/4 turn full bore stop valves on loop line connections
 - .6 End Connections: Threaded.
 - .7 Temperature Rating: Maximum operating temperature 194 deg F (90 deg C)
 - .8 Pressure Rating: 225-psig (2068-kPa) maximum
- .9 Temperature-Actuated, Water Mixing Valves
 - .1 Water-Temperature Limiting Devices (Point of use):
 - .1 Manufacturers:
 - .1 Armstrong International, Inc.
 - .2 Cash Acme; a division of Reliance Worldwide Corporation.
 - .3 Conbraco Industries, Inc.
 - .4 Leonard Valve Company.
 - .5 Powers; a division of Watts Water Technologies, Inc.
 - .6 Symmons Industries, Inc.
 - .7 Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - .8 Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
 - .2 Standard: ASSE 1070.
 - .3 Pressure Rating: 125 psig (860 kPa) .
 - .4 Type: Thermostatically controlled, water mixing valve.
 - .5 Material: Bronze body with corrosion-resistant interior components.
 - .6 Connections: Threaded union inlets and outlet.
 - .7 Accessories: Check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
 - .2 Primary, Thermostatic, Water Mixing Valves:

- .1 Manufacturers:
 - .1 Acorn Engineering Company.
 - .2 Apollo Valves; Conbraco Industries, Inc.
 - .3 Armstrong International, Inc.
 - .4 Lawler Manufacturing Company, Inc.
 - .5 Leonard Valve Company.
 - .6 POWERS; A WATTS Brand.
 - .7 Symmons Industries, Inc.
- .2 Standard: ASSE 1017.
- .3 Pressure Rating: 125 psig (860 kPa) minimum unless otherwise indicated.
- .4 Material: Bronze body with corrosion-resistant interior components.
- .5 Connections: Threaded inlets and outlet.
- .6 Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
- .7 Valve Finish: Chrome plated.
- .8 Piping Finish: Chrome plated.
- .9 Cabinet: Factory fabricated, stainless steel, for recessed mounting and with hinged, stainless-steel door.
- .3 Primary, Digital/Electronic, Water Mixing Valve Assemblies:
 - .1 Manufacturers:
 - .1 Acorn Engineering Company.
 - .2 Armstrong International, Inc.
 - .3 Lawler Manufacturing Company, Inc.
 - .4 Leonard Valve Company.
 - .5 POWERS; A WATTS Brand.
 - .2 Standard: ASSE 1017.
 - .3 Pressure Rating: 125 psig (860 kPa) minimum unless otherwise indicated.
 - .4 Type: Exposed, electronically controlled, water mixing valve.
 - .5 Material: Bronze body with corrosion-resistant interior components.
 - .6 Connections: Threaded or solder joint inlets and outlet.
 - .7 Accessories: Manual temperature override control, check stops on hot- and cold-water supplies, and automatic hot- and cold-water shutoff upon inlet supply failure.
 - .8 Tempered-Water Setting: See Drawings.
 - .9 Tempered-Water Design Flow Rate: See Drawings.
 - .10 Selected Valve Flow Rate at 45-psig (310-kPa) Pressure Drop: See Drawings.
 - .11 Pressure Drop at Design Flow Rate: See Drawings.
 - .12 Valve Finish: Bronze.
 - .13 Digital temperature control and monitoring module.
 - .1 Controls temperature within plus or minus 2 deg F (1 deg C) .
 - .2 User programmable at module or through BAS.
 - .3 Local and remote monitoring.
 - .4 BACNet protocol language(s).
 - .5 115 V ac, 60 Hz.

- .14 Battery backup.
- .4 Manifold, Thermostatic, Water Mixing-Valve Assemblies:
 - .1 Manufacturers:
 - .1 Leonard Valve Company.
 - .2 Powers; a division of Watts Water Technologies, Inc.
 - .3 Symmons Industries, Inc.
 - .2 Description: Factory-fabricated, exposed-mounted, thermostatically controlled, water mixing-valve assembly in two-valve parallel arrangement.
 - .3 Large-Flow Parallel: Thermostatic, water mixing valve and downstream-pressure regulator with pressure gages on inlet and outlet.
 - .4 Intermediate-Flow Parallel: Thermostatic, water mixing valve and downstream-pressure regulator with pressure gages on inlet and outlet.
 - .5 Small-Flow Parallel: Thermostatic, water mixing valve.
 - .6 Thermostatic Mixing Valves: Comply with ASSE 1017. Include check stops on hot- and cold-water inlets and shutoff valve on outlet.
 - .7 Water Regulator(s): Comply with ASSE 1003. Include pressure gage on inlet and outlet.
 - .8 Pressure Rating: 125 psig (860 kPa) minimum unless otherwise indicated.
 - .9 Cabinet: Factory fabricated, stainless steel, for recessed mounting and with hinged, stainless-steel door.
 - .10 Thermostatic Mixing Valve and Water Regulator Finish: Chrome plated.
 - .11 Piping Finish: Chrome plated.
- .5 Photographic-Process, Thermostatic, Water Mixing-Valve Assemblies :
 - .1 Manufacturers:
 - .1 Acorn Engineering Company.
 - .2 Apollo Valves; Conbraco Industries, Inc.
 - .3 Armstrong International, Inc.
 - .4 Lawler Manufacturing Company, Inc.
 - .5 Leonard Valve Company.
 - .6 POWERS; A WATTS Brand.
 - .7 Symmons Industries, Inc.
 - .2 Standard: ASSE 1017, thermostatically controlled, water mixing valve made for precise, process-water temperature control.
 - .3 Pressure Rating: 125 psig (860 kPa) minimum unless otherwise indicated.
 - .4 Body: Bronze with corrosion-resistant interior components.
 - .5 Connections: Threaded inlets and outlet.
 - .6 Accessories: Manual temperature control, check stops on hot- and cold-water supplies, thermometer, shutoff valve, and adjustable, temperature-control handle.
 - .7 Cabinet: Factory fabricated, stainless steel, for surface mounting; with controls and thermometer mounted on front.
- .6 Individual-Fixture, Water Tempering Valves:
 - .1 Manufacturers:
 - .1 Acorn Engineering Company.
 - .2 Apollo Valves; Conbraco Industries, Inc.

- .3 Armstrong International, Inc.
- .4 Lawler Manufacturing Company, Inc.
- .5 Leonard Valve Company.
- .6 POWERS; A WATTS Brand.
- .7 Symmons Industries, Inc
- .2 Standard: ASSE 1016, thermostatically controlled, water tempering valve.
- .3 Pressure Rating: 125 psig (860 kPa) minimum unless otherwise indicated.
- .4 Material: Bronze body with corrosion-resistant interior components.
- .5 Temperature Control: Adjustable.
- .6 Connections: Threaded inlets and outlet.
- .7 Finish: Chrome plated.
- .10 Strainers
 - .1 Y-Pattern Strainers:
 - .1 Manufacturers:
 - .1 Conbraco Industries, Inc; Apollo Valves
 - .2 Hammond Valve
 - .3 Milwaukee Valve Company: CL Series
 - .4 NIBCO INC
 - .5 Jomar Valve
 - .2 Pressure Rating: 125 psig (860 kPa) minimum unless otherwise indicated.
 - .3 Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved, epoxy coated and for NPS 2-1/2 (DN 65) and larger.
 - .4 End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
 - .5 Screen: Stainless steel with round perforations unless otherwise indicated.
 - .6 Perforation Size:
 - .1 Strainers NPS 2 (DN 50) and Smaller: 0.020 inch (0.51 mm).
 - .2 Strainers NPS 2-1/2 to NPS 4 (DN 65 to DN 100) : 0.045 inch (1.14 mm).
 - .3 Strainers NPS 5 (DN 125) and Larger: 0.10 inch (2.54 mm).
 - .7 Drain: Factory-installed, hose-end drain valve.
- .11 Outlet Boxes
 - .1 Clothes Washer Outlet Boxes:
 - .1 Manufacturers:
 - .1 Acorn Engineering Company.
 - .2 Guy Gray Manufacturing Co., Inc.
 - .3 Oatey.
 - .4 Symmons Industries, Inc.
 - .5 Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
 - .6 Whitehall Manufacturing; a div. of Acorn Engineering Company.
 - .7 Zurn Industries, LLC; Plumbing Products Group; Light Commercial Products.
 - .8 IPS Corporation.

- .2 Mounting: Recessed.
- .3 Material and Finish: Enameled-steel or epoxy-painted-steel box and faceplate.
- .4 Faucet: Combination valved fitting or separate hot- and cold-water valved fittings complying with ASME A112.18.1. Include garden-hose thread complying with ASME B1.20.7 on outlets.
- .5 Supply Shutoff Fittings: NPS 1/2 (DN 15) gate, globe, or ball valves and NPS 1/2 (DN 15) copper, water tubing.
- .6 Drain: NPS 1-1/2 (DN 40) standpipe and P-trap for direct waste connection to drainage piping.
- .7 Inlet Hoses: Two 60-inch- (1500-mm-) long, rubber household clothes washer inlet hoses with female, garden-hose-thread couplings. Include rubber washers.
- .8 Drain Hose: One 48-inch- (1200-mm-) long, rubber household clothes washer drain hose with hooked end.
- .2 Icemaker Outlet Boxes:
 - .1 Manufacturers:
 - .1 Acorn Engineering Company.
 - .2 Oatey.
 - .3 IPS Corporation.
 - .2 Cabinet: Stainless-steel enclosure with exposed valve handle, hose connection, and hose rack. Include thermometer in front.
 - .3 Mounting: Recessed.
 - .4 Material and Finish: Enameled-steel or epoxy-painted-steel box and faceplate.
 - .5 Faucet: Valved fitting complying with ASME A112.18.1. Include NPS 1/2 (DN 15) or smaller copper tube outlet.
 - .6 Supply Shutoff Fitting: NPS 1/2 (DN 15) gate, globe, or ball valve and NPS 1/2 (DN 15) copper, water tubing.
- .12 Hose Stations
 - .1 Manufacturers:
 - .1 Armstrong International, Inc.
 - .2 Leonard Valve Company.
 - .3 T & S Brass.
 - .4 Chicago Faucets
 - .2 Single-Temperature-Water Hose Stations:
 - .1 Standard: ASME A112.18.1.
 - .2 Hose-Rack Material: Stainless steel.
 - .3 Body Material: Bronze with stainless-steel wetted parts.
 - .4 Body Finish: Rough bronze, chrome plated.
 - .5 Mounting: Wall, with reinforcement.
 - .6 Supply Fittings: NPS 1/2 (DN 15) gate, globe, or ball valve and check valve and NPS 1/2 (DN 15) copper, water tubing. Omit check valve if check stop is included with fitting.
 - .7 Hose: Manufacturer's standard, for service fluid, temperature, and pressure; 25 feet (7.6 m) long.
 - .8 Nozzle: With hand-squeeze, on-off control.
 - .9 Vacuum Breaker:

- .1 Integral or factory-installed, nonremovable, manual-drain-type, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
 - .2 Garden-hose thread complying with ASME B1.20.7 on outlet.
 - .3 Hot- and Cold-Water Hose Stations:
 - .1 Standard: ASME A112.18.1.
 - .2 Faucet Type: Thermostatic mixing valve.
 - .3 Cabinet: Stainless-steel enclosure with exposed valve handles, hose connection, and hose rack. Include thermometer in front.
 - .4 Hose-Rack Material: Stainless steel.
 - .5 Body Material: Bronze with stainless-steel wetted parts.
 - .6 Body Finish: Rough bronze or chrome plated.
 - .7 Mounting: Wall, with reinforcement.
 - .8 Supply Fittings: Two NPS 1/2 (DN 15) gate, globe, or ball valves and check valves and NPS 1/2 (DN 15) copper, water tubing. Omit check valves if check stops are included with fitting.
 - .9 Hose: Manufacturer's standard, for service fluid, temperature, and pressure; 25 feet (7.6 m) long.
 - .10 Nozzle: With hand-squeeze, on-off control.
 - .11 Vacuum Breaker: Integral or factory-installed, nonremovable, manual-drain-type, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052; and garden-hose thread complying with ASME B1.20.7 on outlet.
 - .4 Cold-Water and Steam Hose Stations:
 - .1 Standard: ASME A112.18.1.
 - .2 Faucet Type: Thermostatic mixing valve.
 - .3 Cabinet: Stainless-steel enclosure with exposed valve handles, hose connection, and hose rack. Include thermometer in front.
 - .4 Hose-Rack Material: Stainless steel.
 - .5 Body Material: Bronze with stainless-steel wetted parts.
 - .6 Body Finish: Rough bronze or chrome plated.
 - .7 Mounting: Wall, with reinforcement.
 - .8 Supply Fittings: Two NPS 1/2 (DN 15) gate, globe, or ball valves and check valves and NPS 1/2 (DN 15) copper, water tubing. Omit check valves if check stops are included with fitting.
 - .9 Hose: Manufacturer's standard, for service fluid, temperature, and pressure; 25 feet (7.6 m) long.
 - .10 Nozzle: With hand-squeeze, on-off control.
 - .11 Vacuum Breaker:
 - .1 Integral or factory-installed, nonremovable, manual-drain-type, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
 - .2 Garden-hose thread complying with ASME B1.20.7 on outlet.
- .13 Hose Bibbs
 - .1 Hose Bibbs:
 - .1 Standard: ASME A112.18.1 for sediment faucets.

- .2 Body Material: Bronze.
- .3 Seat: Bronze, replaceable.
- .4 Supply Connections: NPS 1/2 or NPS 3/4 (DN 15 or DN 20) threaded or solder-joint inlet.
- .5 Outlet Connection: Garden-hose thread complying with ASME B1.20.7
- .6 Pressure Rating: 125 psig (860 kPa) .
- .7 Vacuum Breaker: Integral or field-installation, nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
- .8 Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
- .9 Finish for Service Areas: Rough bronze.
- .10 Finish for Finished Rooms: Chrome or nickel plated.
- .11 Operation for Equipment Rooms: Wheel handle or operating key.
- .12 Operation for Service Areas: Operating key.
- .13 Operation for Finished Rooms: Operating key.
- .14 Operation for Finished Rooms: Operating key.
- .15 Include operating key with each operating-key hose bibb.
- .16 Include integral wall flange with each chrome- or nickel-plated hose bibb.
- .14 Wall Hydrants
 - .1 Nonfreeze Wall Hydrants:
 - .1 Manufacturers:
 - .1 Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - .2 Watts.
 - .3 Woodford Manufacturing Company; a division of WCM Industries, Inc.
 - .4 Zurn Industries, LLC; Plumbing Products Group; Light Commercial Products.
 - .5 Prier Products, Inc.
 - .2 Inlet: NPS 3/4 or NPS 1 (DN 20 or DN 25) .
 - .3 Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.
 - .4 Pressure Rating: 125 psig (860 kPa) .
 - .5 Operation: Loose key.
 - .6 Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
 - .7 Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
 - .8 Box: Deep, flush mounted with cover.
 - .9 Box and Cover Finish: Polished nickel bronze.
 - .10 Outlet: Exposed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
 - .11 Nozzle and Wall-Plate Finish: Polished nickel bronze.
 - .12 Operating Keys(s): One with each wall hydrant.
 - .2 Nonfreeze, Hot- and Cold-Water Wall Hydrants :
 - .1 Manufacturers:
 - .1 Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - .2 Watts.

- .3 Woodford Manufacturing Company; a division of WCM Industries, Inc.
- .4 Zurn Industries, LLC.
- .2 Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.
- .3 Pressure Rating: 125 psig (860 kPa) .
- .4 Operation: Loose key.
- .5 Casing and Operating Rods: Of length required to match wall thickness. Include wall clamps.
- .6 Inlet: NPS 3/4 or NPS 1 (DN 20 or DN 25) .
- .7 Outlet: Concealed.
- .8 Box: Deep, flush mounted with cover.
- .9 Box and Cover Finish: Polished nickel bronze.
- .10 Vacuum Breaker:
 - .1 Nonremovable, manual-drain-type, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
 - .2 Garden-hose thread complying with ASME B1.20.7 on outlet.
- .11 Operating Keys(s): One with each wall hydrant.
- .3 Moderate-Climate Wall Hydrants:
 - .1 Manufacturers:
 - .1 Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - .2 Watts.
 - .3 Woodford Manufacturing Company; a division of WCM Industries, Inc.
 - .4 Zurn Industries, LLC.
 - .2 Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.
 - .3 Pressure Rating: 125 psig (860 kPa) .
 - .4 Operation: Loose key.
 - .5 Inlet: NPS 3/4 or NPS 1 (DN 20 or DN 25) .
 - .6 Concealed, with integral vacuum breaker or nonremovable hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
 - .7 Garden-hose thread complying with ASME B1.20.7.
 - .8 Box: Deep, flush mounted with cover.
 - .9 Box and Cover Finish: Polished nickel bronze.
 - .10 With integral vacuum breaker or nonremovable hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
 - .11 Garden-hose thread complying with ASME B1.20.7.
 - .12 Nozzle and Wall-Plate Finish: Polished nickel bronze.
 - .13 Operating Keys(s): One with each wall hydrant.
- .4 Vacuum Breaker Wall Hydrants:
 - .1 Manufacturers:
 - .1 Jay R. Smith Mfg. Co.
 - .2 Watts; a division of Watts Water Technologies, Inc.
 - .3 Woodford Manufacturing Company; a division of WCM Industries, Inc.

- .4 Zurn Industries, LLC.
- .2 Standard: ASSE 1019, Type A or Type B.
- .3 Type: Freeze-resistant, automatic draining with integral air-inlet valve.
- .4 Classification: Type A, for automatic draining with hose removed or Type B, for automatic draining with hose removed or with hose attached and nozzle closed.
- .5 Pressure Rating: 125 psig (860 kPa) .
- .6 Operation: Loose key or wheel handle.
- .7 Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
- .8 Inlet: NPS 1/2 or NPS 3/4 (DN 15 or DN 20) .
- .9 Outlet: Exposed with garden-hose thread complying with ASME B1.20.7.
- .15 Ground Hydrants
 - .1 Nonfreeze Ground Hydrants:
 - .1 Manufacturers:
 - .1 Smith, Jay R. Mfg.
 - .2 Watts.
 - .3 Woodford Manufacturing Company; a division of WCM Industries, Inc.
 - .4 Zurn Industries, LLC.
 - .2 Standard: ASME A112.21.3M.
 - .3 Type: Nonfreeze, concealed-outlet ground hydrant with box.
 - .4 Operation: Loose key.
 - .5 Casing and Operating Rod: Of at least length required for burial of valve below frost line.
 - .6 Inlet: NPS 3/4 (DN 20) .
 - .7 Outlet: Garden-hose thread complying with ASME B1.20.7.
 - .8 Drain: Designed with hole to drain into ground when shut off.
 - .9 Box: Standard pattern with cover.
 - .10 Box and Cover Finish: Rough bronze.
 - .11 Operating Key(s): One with each ground hydrant.
 - .12 Vacuum Breaker: ASSE 1011.
- .16 Post Hydrants
 - .1 Nonfreeze, Draining-Type Post Hydrants:
 - .1 Manufacturers:
 - .1 Smith, Jay R. Mfg. Co.
 - .2 Watts.
 - .3 Woodford Manufacturing Company; a division of WCM Industries, Inc.
 - .4 Zurn Industries, LLC.
 - .2 Standard: ASME A112.21.3M.
 - .3 Type: Nonfreeze, exposed-outlet post hydrant.
 - .4 Operation: Loose key.
 - .5 Casing and Operating Rod: Of at least length required for burial of valve below frost line.
 - .6 Casing: Bronze with casing guard.
 - .7 Inlet: NPS 3/4 (DN 20) .

- .8 Outlet: Garden-hose thread complying with ASME B1.20.7.
- .9 Drain: Designed with hole to drain into ground when shut off.
- .10 Vacuum Breaker:
 - .1 Nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
 - .2 Garden-hose thread complying with ASME B1.20.7 on outlet.
- .11 Operating Key(s): One with each loose-key-operation wall hydrant.
- .2 Nonfreeze Sanitary Yard Hydrants:
 - .1 Manufacturers:
 - .1 Jay R. Smith Mfg. Co.
 - .2 Josam Company.
 - .3 WATTS.
 - .4 Woodford Manufacturing Company.
 - .2 Zurn Plumbing Products
 - .3 Standard: ASSE 1057.
 - .4 Operation: Wheel handle or lever.
 - .5 Head: Cast iron or brass, with pail hook.
 - .6 Inlet: NPS 3/4 or NPS 1 (DN 20 or DN 25) threaded.
 - .7 Length: As required for burial of valve and canister below frost line.
 - .8 Canister: Stainless steel.
 - .9 Vacuum Breaker:
 - .1 Removable hose-connection backflow preventer complying with ASSE 1052.
 - .2 Garden-hose thread complying with ASME B1.20.7 on outlet for field installation.
- .17 Roof Hydrants
 - .1 Nonfreeze, Draining-Type Roof Hydrants:
 - .1 Manufacturers:
 - .1 Jay R. Smith Mfg. Co.
 - .2 Josam Company.
 - .3 WATTS.
 - .4 Woodford Manufacturing Company.
 - .5 Zurn Plumbing Products.
 - .2 Standard: ASME A112.21.3M.
 - .3 Type: Nonfreeze, exposed-outlet roof hydrant with coated cast-iron head and lift handle with lock option. Provide with deck flange and under deck clamp.
 - .4 Casing and Operating Rod: Bronze interior parts, galvanized-steel casing, and bronze valve housing designed with hole to drain.
 - .5 Inlet: NPS 3/4 (DN 20) .
 - .6 Outlet: Garden-hose thread complying with ASME B1.20.7.
 - .7 Vacuum Breaker:
 - .1 Nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
 - .2 Garden-hose thread complying with ASME B1.20.7 on outlet.

.18 Drain Valves

.1 Ball-Valve-Type, Hose-End Drain Valves:

- .1 Standard: MSS SP-110 for standard-port, two-piece ball valves.
- .2 Pressure Rating: 400-psig (2760-kPa) minimum CWP.
- .3 Size: NPS 3/4 (DN 20).
- .4 Body: Copper alloy.
- .5 Ball: Chrome-plated brass.
- .6 Seats and Seals: Replaceable.
- .7 Handle: Vinyl-covered steel.
- .8 Inlet: Threaded or solder joint.
- .9 Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

.2 Gate-Valve-Type, Hose-End Drain Valves:

- .1 Standard: MSS SP-80 for gate valves.
- .2 Pressure Rating: Class 125.
- .3 Size: NPS 3/4 (DN 20) .
- .4 Body: ASTM B62 bronze.
- .5 Inlet: NPS 3/4 (DN 20) threaded or solder joint.
- .6 Outlet: Garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

.3 Stop-and-Waste Drain Valves:

- .1 Standard: MSS SP-110 for ball valves or MSS SP-80 for gate valves.
- .2 Pressure Rating: 200-psig (1380-kPa) minimum CWP or Class 125.
- .3 Size: NPS 3/4 (DN 20) .
- .4 Body: Copper alloy or ASTM B62 bronze.
- .5 Drain: NPS 1/8 (DN 6) side outlet with cap.

.19 Water-Hammer Arresters

.1 Water-Hammer Arresters:

.1 Manufacturers:

- .1 Jay R. Smith Mfg. Co.
- .2 Mifab, Inc
- .3 Precision Plumbing Products.
- .4 Sioux Chief Manufacturing Company, Inc.
- .5 WATTS.
- .6 Zurn

.2 Standard: Certified ANSI/ASSE 1010-2004 or PDI-WH 201-2017, NSF 372.

.3 Type:

- .1 Body: Seamless Type-L Copper tube with piston.
- .2 Piston: Poly Piston with two EPDM O-Rings.
- .3 Piston Lubrication: Dow-Corning, 111 FDA Approved Silicone Compound.
- .4 Solder: Lead Free.
- .5 Male MIP Thread Fitting.

- .4 Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201-2017, Sizes A through F.
- .20 Air Vents
 - .1 Bolted-Construction Automatic Air Vents:
 - .1 Body: Bronze.
 - .2 Pressure Rating and Temperature: 125-psig (860-kPa) minimum pressure rating at 140 deg F (60 deg C) .
 - .3 Float: Replaceable, corrosion-resistant metal.
 - .4 Mechanism and Seat: Stainless steel.
 - .5 Size: NPS 3/8 (DN 10) minimum inlet.
 - .6 Inlet and Vent Outlet End Connections: Threaded.
 - .2 Welded-Construction Automatic Air Vents:
 - .1 Body: Stainless steel.
 - .2 Pressure Rating: 150-psig (1035-kPa) minimum pressure rating.
 - .3 Float: Replaceable, corrosion-resistant metal.
 - .4 Mechanism and Seat: Stainless steel.
 - .5 Size: NPS 3/8 (DN 10) minimum inlet.
 - .6 Inlet and Vent Outlet End Connections: Threaded.
- .21 Pressure Trap-Seal Primer Device
 - .1 Trap-Seal Primer Systems:
 - .1 Manufacturers:
 - .1 Precision Plumbing Products, Inc.
 - .2 MIFAB, Inc.
 - .3 Zurn.
 - .4 Smith, Jay R. Mfg. Co.
 - .2 Standard: ASSE 1018.
 - .3 Pressure Rating: 125 psig (860 kPa) minimum.
 - .4 Body: Bronze.
 - .5 Inlet and Outlet Connections: NPS 1/2 (DN 15) threaded, union, or solder joint.
 - .6 Gravity Drain Outlet Connection: NPS 1/2 (DN 15) threaded or solder joint.
 - .7 Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.
- .22 Electronic Trap-Seal Primer Systems
 - .1 Trap-Seal Primer Systems:
 - .1 Manufacturers:
 - .1 Precision Plumbing Products, Inc.
 - .2 MIFAB, Inc.
 - .3 Zurn.
 - .4 Smith, Jay R. Mfg. Co.
 - .2 Standard: ASSE 1044.
 - .3 Inlet Size: NPS 3/4, ASTM B88, Type L (DN 20, ASTM B88M, Type B); copper, water tubing.
 - .4 Cabinet: Recessed-mounted steel box with stainless-steel cover.

- .5 Electric Controls: 24-hour timer, solenoid valve, and manual switch for 120-V ac power.
- .1 Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- .6 Vacuum Breaker: ASSE 1001.
- .7 Number Outlets: Four.
- .8 Size Outlets: NPS 1/2 (DN 15).
- .23 Water Meters
 - .1 Displacement-Type Water Meters:
 - .1 Manufacturers:
 - .1 AALIANT; a Venture Measurement product line.
 - .2 ABB.
 - .3 Badger Meter, Inc.
 - .4 Carlon Meter.
 - .5 Mueller Co. Ltd.; a subsidiary of Mueller Water Products Inc.
 - .6 Schlumberger Limited; Water Services.
 - .7 Neptune Technology Group.
 - .8 Niagra Meters.
 - .2 Description:
 - .1 Standard: AWWA C700.
 - .2 Pressure Rating: 150-psig (1035-kPa) working pressure.
 - .3 Body Design: Nutating disc; totalization meter.
 - .4 Registration: In gallons (liters) or cubic feet (cubic meters).
 - .5 Case: Bronze.
 - .6 End Connections: Threaded or flanged.
 - .2 Turbine-Type Water Meters:
 - .1 Manufacturers:
 - .1 ABB.
 - .2 Badger Meter, Inc.
 - .3 Mueller Co. Ltd.; a subsidiary of Mueller Water Products Inc.
 - .4 Schlumberger Limited; Water Services.
 - .5 Neptune Technology Group.
 - .6 Niagra Meters.
 - .2 Description:
 - .1 Standard: AWWA C701.
 - .2 Pressure Rating: 150-psig (1035-kPa) working pressure.
 - .3 Body Design: Turbine; totalization meter.
 - .4 Registration: In gallons (liters) or cubic feet (cubic meters) as required by utility company.
 - .5 Case: Bronze.
 - .6 End Connections for Meters NPS 2 (DN 50) and Smaller: Threaded.
 - .7 End Connections for Meters NPS 2-1/2 (DN 65) and Larger: Flanged.
 - .3 Compound-Type Water Meters:

- .1 Manufacturers:
 - .1 ABB.
 - .2 Badger Meter, Inc.
 - .3 Master Meter, Inc.
 - .4 Mueller Co. Ltd.; a subsidiary of Mueller Water Products Inc.
 - .5 Schlumberger Limited; Water Services.
 - .6 Neptune Technology Group.
 - .7 Niagra Meters.
- .2 Description:
 - .1 Standard: AWWA C702.
 - .2 Pressure Rating: 150-psig (1035-kPa) working pressure.
 - .3 Body Design: With integral mainline and bypass meters; totalization meter.
 - .4 Registration: In gallons (liters) or cubic feet (cubic meters).
 - .5 Case: Bronze.
 - .6 Pipe Connections: Flanged.
- .4 Ultrasonic-Type Water Meters:
 - .1 Manufacturers:
 - .1 Badger Meter, INC
 - .2 Master Meter, INC.
 - .3 Neptune Technology Group
 - .2 Standard: Applicable portions of AWWA C700 .
 - .3 Pressure Rating: 150 psig (1035 kPa) working pressure.
 - .4 Body Design: Ultrasonic open flow tube; totalization meter.
 - .5 Registration: In gallons (liters) or cubic feet (cubic meters) as required by utility company.
 - .6 Case: Bronze.
 - .7 End Connections: Threaded or flanged
 - .8 Remote Registration System: Direct-reading type complying with AWWA C706; modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by utility company.
- .5 Remote Registration System: Encoder type complying with AWWA C707; modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by utility company.

2.3 SANITARY WASTE PIPING SPECIALTIES

- .1 Assembly Descriptions
 - .1 Sanitary waste piping specialties shall bear label, stamp, or other markings of specified testing agency.
 - .2 Comply with NSF 14 for plastic sanitary waste piping specialty components.
 - .3 Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing, and marked for intended location and application.
- .2 Backwater Valves
 - .1 Horizontal, Cast-Iron Backwater Valves:
 - .1 Manufacturers:

- .1 Josam Company.
 - .2 MIFAB, Inc.
 - .3 Smith, Jay R. Mfg. Co.
 - .4 Watts Water Technologies, Inc.
 - .5 Zurn Plumbing Products Group; Specification Drainage Operation.
- .2 Standard: ASME A112.14.1.
- .3 Size: Same as connected piping.
- .4 Body: Cast iron.
- .5 Cover: Cast iron with bolted access check valve.
- .6 End Connections: Hub and spigot or hubless.
- .7 Type Check Valve: Removable, bronze, swing check, factory assembled or field modified to hang closed.
- .8 Extension: ASTM A74, Service class; full-size, cast-iron, soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.
- .2 Manufacturers:
 - .1 Josam Company.
 - .2 Smith, Jay R. Mfg. Co.
 - .3 Watts Water Technologies, Inc.
 - .4 Zurn Plumbing Products Group; Specification Drainage Operation.
- .3 Standard: ASME A112.14.1.
- .4 Size: Same as floor drain outlet.
- .5 Body Material: Cast iron or bronze made for vertical installation in bottom outlet of floor drain.
- .6 Check Valve: Removable ball float.
- .7 Inlet: Threaded or no-hub.
- .8 Outlet: Threaded, no-hub, or spigot.
- .9 Horizontal, Plastic Backwater Valves:
 - .1 Manufacturers:
 - .1 Oatey.
 - .2 Sioux Chief Manufacturing Company, Inc.
 - .3 Zurn Plumbing Products Group; Light Commercial Products Operation.
 - .4 IPS Corporation.
 - .2 Standard: ASME A112.14.1.
 - .3 Size: Same as connected piping.
 - .4 Body: PVC.
 - .5 Cover: Same material as body with threaded access to check valve.
 - .6 Check Valve: Removable swing check.
 - .7 End Connections: Socket type.
 - .8 Stainless-Steel Exposed Cleanouts:
- .3 Cleanouts
 - .1 Exposed Metal Cleanouts:
 - .1 Manufacturers:
 - .1 Josam Company.
 - .2 MIFAB, Inc.

- .3 Smith, Jay R. Mfg. Co.
- .4 Tyler Pipe.
- .5 Watts Water Technologies, Inc.
- .6 Zurn Plumbing Products Group; Specification Drainage Operation.
- .2 Standard: ASME A112.36.2M.
- .3 Size: Same as connected drainage piping
- .4 Body Material: Hubless, cast-iron soil pipe test tee as required to match connected piping.
- .5 Closure: Countersunk or Raised-head, brass plug.
- .6 Closure Plug Size: Same as or not more than one size smaller than cleanout size.
- .7 Stainless-Steel Exposed Cleanouts:
 - .1 Manufacturers:
 - .1 Josam Company.
 - .2 Standard: ASME A112.3.1 for cleanout test tee.
 - .3 Size: Same as connected drainage piping
 - .4 Body Material: Stainless-steel tee with side cleanout as required to match connected piping.
 - .5 Closure: Stainless-steel plug with seal.
- .2 Cast-Iron Exposed Floor Cleanouts:
 - .1 Manufacturers:
 - .1 Josam Company.
 - .2 Smith, Jay R. Mfg. Co.
 - .3 Tyler Pipe.
 - .4 Watts Water Technologies, Inc.
 - .5 Zurn Plumbing Products Group; Specification Drainage Operation.
 - .2 Standard: ASME A112.36.2M for heavy-duty, adjustable housing cleanout.
 - .3 Size: Same as connected branch.
 - .4 Type: Heavy-duty, adjustable housing.
 - .5 Body or Ferrule Material: Cast iron.
 - .6 Clamping Device: Required.
 - .7 Outlet Connection: Spigot.
 - .8 Closure: Brass, bronze or plastic with tapered threads.
 - .9 Adjustable Housing Material: Cast iron with threads, set-screws or other device.
 - .10 Frame and Cover Material and Finish: Nickel-bronze, copper alloy. In finished areas provide a recessed cover for finished floor material.
 - .11 Frame and Cover Shape: Round.
 - .12 Top-Loading Classification: Extra-Heavy Duty.
 - .13 Riser: ASTM A74, Service class, cast-iron drainage pipe fitting and riser to cleanout.
- .3 Stainless-Steel Exposed Floor Cleanouts:
 - .1 Manufacturers:
 - .1 Josam Company.
 - .2 Zurn Industries, LLC.

- .3 Kusel Equipment Co.
- .2 Standard: ASME A112.3.1.
- .3 Size: Same as connected branch.
- .4 Housing: Stainless steel.
- .5 Closure: Stainless steel with seal.
- .6 Riser: ASTM A74, Service Extra-Heavy class, stainless-steel drainage pipe fitting and riser to cleanout.
- .7 Body or Ferrule Material: Stainless steel.
- .8 Clamping Device: Required.
- .9 Outlet Connection: Spigot.
- .10 Closure: Brass or plastic with tapered threads.
- .11 Adjustable Housing Material: Cast iron with threads, set-screws or other device.
- .12 Frame and Cover Material and Finish: Nickel-bronze, copper alloy. In finished areas provide a recessed cover for finished floor material.
- .13 Top-Loading Classification: Medium Duty.
- .4 Cast-Iron Wall Cleanouts:
 - .1 Manufacturers:
 - .1 Josam Company.
 - .2 MIFAB, Inc.
 - .3 Smith, Jay R. Mfg. Co.
 - .4 Tyler Pipe.
 - .5 Watts Water Technologies, Inc.
 - .6 Zurn Plumbing Products Group; Specification Drainage Operation.
 - .2 Standard: ASME A112.36.2M. Include wall access.
 - .3 Size: Same as connected drainage piping.
 - .4 Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
 - .5 Closure Plug:
 - .1 Brass.
 - .2 Countersunk head.
 - .3 Drilled and threaded for cover attachment screw.
 - .4 Size: Same as or not more than one size smaller than cleanout size.
 - .6 Wall Access: Round, deep, chrome-plated bronze cover plate with screw.
 - .7 Wall Access: Round, nickel-bronze, copper-alloy, or stainless steel wall-installation frame and cover.
- .5 Test Tees:
 - .1 Manufacturers:
 - .1 Jay R. Smith Mfg. Co.; a division of Morris Group International.
 - .2 Tyler Pipe; a subsidiary of McWane Inc.
 - .3 Watts Water Technologies; a Watts company.
 - .4 Zurn Industries, LLC.
 - .2 Standard: ASME A112.36.2M and ASTM A74, ASTM A888, or CISPI 301.
 - .3 Size: Same as connected drainage piping.

- .4 Body Material: Hub-and-spigot, cast-iron soil-pipe T-branch or no-hub, cast-iron soil-pipe test tee as required to match connected piping.
- .5 Closure Plug: Countersunk or raised head, brass.
- .6 Closure Plug Size: Same as, or not more than, one size smaller than cleanout size.
- .4 Channel Drainage Systems
 - .1 Stainless-Steel Channel Drainage Systems:
 - .1 Stainless-Steel Channel Drainage Systems:
 - .1 Manufacturers:
 - .1 Josam Company; Blucher-Josam Div.
 - .2 Mifab.
 - .3 Zurn Plumbing Products Group; Flo-Thru Operation.
 - .4 _____.
 - .2 Type: Modular system of stainless-steel channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
 - .1 Standard: ASME A112.3.1, for trench drains.
 - .2 Channel Sections: Interlocking-joint, stainless-steel with level invert.
 - .1 Dimensions: 5.8 inches wide. Include number of units required to form total lengths indicated.
 - .3 Grates: Manufacturer's designation "heavy duty," with slots or perforations, and of width and thickness that fit recesses in channels.
 - .1 Material: Ductile iron.
 - .2 Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.
 - .4 Covers: Solid ductile or gray iron, of width and thickness that fit recesses in channels, and of lengths indicated.
 - .5 Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
 - .6 Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.
 - .3 Manufacturers:
 - .1 ABT, Inc.
 - .2 ACO Polymer Products, Inc.
 - .3 Josam Company; Mea-Josam Div.
 - .4 Mifab.
 - .5 Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - .4 Type: Modular system of channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling.
 - .1 Channel Sections: Narrow, interlocking-joint, sloped-invert, polymer-concrete modular units with end caps. Include rounded bottom, with built-in invert slope of 0.6 percent and with outlets in number, sizes, and locations indicated. Include extension sections necessary for required depth.
 - .1 Dimensions: 4-inch (102-mm) inside width. Include number of units required to form total lengths indicated.

- .2 Frame: Gray-iron or galvanized steel for grates.
- .2 Grates: Manufacturer's designation "heavy duty," with slots or perforations, and of width and thickness that fit recesses in channel sections.
 - .1 Material: Ductile iron.
 - .2 Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.
- .3 Covers: Solid ductile or gray iron, of width and thickness that fit recesses in channel sections, and of lengths indicated.
- .4 Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
- .5 Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.
- .6 Channel Sections: Narrow, interlocking-joint, precast, polymer-concrete modular units with end caps. Include rounded bottom, with level invert and with NPS 4 (DN 100) outlets in number and locations indicated.
 - .1 Dimensions: 5-inch (127-mm) inside width and 9-3/4 inches (248 mm) deep. Include number of units required to form total lengths indicated.
 - .2 Frame: Gray-iron or galvanized steel for grates.
- .7 Grates: Manufacturer's designation "heavy duty," with slots or perforations, and of width and thickness that fit recesses in channel sections.
 - .1 Material: Ductile iron.
 - .2 Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.
- .8 Covers: Solid ductile or gray iron, of width and thickness that fit recesses in channel sections, and of lengths indicated.
- .9 Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
- .10 Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.
- .11 Channel Sections: Wide, interlocking-joint, precast, polymer-concrete modular units with end caps. Include flat or rounded bottom, with level invert and with outlets in number, sizes, and locations indicated.
 - .1 Dimensions: 8-inch (203-mm) inside width and 13-3/4 inches (350 mm) deep. Include number of units required to form total lengths indicated.
 - .2 Frame: Gray-iron or galvanized steel for grates.
- .12 Grates: Manufacturer's designation "heavy duty," with slots or perforations, and of width and thickness that fit recesses in channel sections.
 - .1 Material: Ductile iron.
 - .2 Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.
- .13 Covers: Solid ductile or gray iron, of width and thickness that fit recesses in channel sections, and of lengths indicated.

- .14 Supports, Anchors, and Setting Devices: Manufacturer's standard, unless otherwise indicated.
- .15 Channel-Section Joining and Fastening Materials: As recommended by system manufacturer.
- .2 Polymer-Concrete Sediment Interceptor :
 - .1 Description: 27-inch-square, precast, polymer-concrete body, with outlets in number and sizes indicated. Include 24-inch-square, gray-iron slotted grate.
 - .2 Frame: Gray-iron or galvanized steel for grates.
- .5 Air-Admittance Valves
 - .1 Fixture Air-Admittance Valves:
 - .1 Manufacturers:
 - .1 Oatey.
 - .2 Studor, Inc.
 - .3 Ayrlett, LLC.
 - .4 Durgo, Inc.
 - .5 ProSet Systems Inc.
 - .6 RectorSeal.
 - .2 Housing: Plastic.
 - .3 Operation: Mechanical sealing diaphragm.
 - .4 Size: Same as connected fixture or branch vent piping.
 - .2 Stack Air-Admittance Valves:
 - .1 Manufacturers:
 - .1 Oatey.
 - .2 Studor, Inc.
 - .3 Durgo, Inc.
 - .2 Standard: ASSE 1050 for vent stacks.
 - .3 Housing: Plastic.
 - .4 Operation: Mechanical sealing diaphragm.
 - .5 Size: Same as connected stack vent or vent stack.
 - .3 Wall Box:
 - .1 Manufacturers:
 - .1 Oatey.
 - .2 Studor, Inc.
 - .3 Zurn Industries, LLC.
 - .4 Durgo, Inc.
 - .5 RectorSeal.
 - .2 Description: White plastic housing with white plastic grille, made for recessed installation. Include bottom pipe connection and space to contain one air-admittance valve.
 - .3 Size: About 9 inches wide by 8 inches high by 4 inches deep.
- .6 Roof Flashing Assemblies
 - .1 Roof Flashing Assemblies:
 - .1 Manufacturers:
 - .1 Acorn Engineering Company.

- .2 Thaler Metal Industries Ltd.
 - .3 Zurn Industries, LLC.
 - .2 Description: Manufactured assembly made of 4.0-lb/sq. ft. (20-kg/sq. m), 0.0625-inch- (1.6-mm-) thick, lead flashing collar and skirt extending at least 6 inches (150 mm) from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.
 - .1 Open-Top Vent Cap: Without cap.
 - .2 Low-Silhouette Vent Cap: With vandal-proof vent cap.
 - .3 Extended Vent Cap: With field-installed, vandal-proof vent cap.
- .7 Flashing Materials
 - .1 Copper Sheet: ASTM B152/B152M, of the following minimum weights and thicknesses, unless otherwise indicated:
 - .1 General Applications: 12 oz./sq. ft..
 - .2 Zinc-Coated Steel Sheet: ASTM A653/A653M, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.
 - .3 Elastic Membrane Sheet: ASTM D4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.
 - .4 Fasteners: Metal compatible with material and substrate being fastened.
 - .5 Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.
 - .6 Solder: ASTM B32, lead-free alloy.
 - .7 Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.
- .8 Through-Penetration Firestop Assemblies
 - .1 Through-Penetration Firestop Assemblies:
 - .1 Manufacturers:
 - .1 ProSet Systems Inc.
 - .2 Standard: ASTM E814, for through-penetration firestop assemblies.
 - .3 Certification and Listing: Intertek Testing Service NA for through-penetration firestop assemblies.
 - .4 Size: Same as connected soil, waste, or vent stack.
 - .5 Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
 - .6 Stack Fitting: ASTM A48/A48M, 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.
 - .7 Special Coating: Corrosion resistant on interior of fittings.
- .9 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.
- .10 Miscellaneous sanitary drainage piping specialties
 - .1 Open Drains:
 - .1 Description: Shop or field fabricate from ASTM A74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C564, rubber gaskets.

- .2 Size: Same as connected waste piping with increaser fitting of size indicated.
- .2 Deep-Seal Traps:
 - .1 Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
 - .2 Size: Same as connected waste piping.
 - .1 NPS 2 (DN 50) : 4-inch- (100-mm-) minimum water seal.
 - .2 NPS 2-1/2 (DN 65) and Larger: 5-inch- (125-mm-) minimum water seal.
- .3 Floor-Drain, Trap-Seal Primer Fittings:
 - .1 Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
 - .2 Size: Same as floor drain outlet with NPS 1/2 (DN 15) side inlet.
- .4 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.
- .5 Sleeve Flashing Device:
 - .1 Description: Manufactured, cast-iron fitting, with clamping device, that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 1 inch (25 mm) above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
 - .2 Size: As required for close fit to riser or stack piping.
- .6 Stack Flashing Fittings:
 - .1 Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
 - .2 Size: Same as connected stack vent or vent stack.
- .7 Vent Caps:
 - .1 Size: Same as connected stack vent or vent stack.
- .8 Frost-Resistant Vent Terminals:
 - .1 Description: Manufactured or shop-fabricated assembly constructed of copper, lead-coated copper, or galvanized steel.
 - .2 Design: To provide 1-inch (25-mm) enclosed air space between outside of pipe and inside of flashing collar extension, with counterflashing.
- .9 Expansion Joints:
 - .1 Standard: ASME A112.21.2M.
 - .2 Body: Cast iron with bronze sleeve, packing, and gland.
 - .3 End Connections: Matching connected piping.
 - .4 Size: Same as connected soil, waste, or vent piping.

2.4 STORM DRAINAGE PIPING SPECIALTIES

- .1 Backwater Valves

- .1 Horizontal, Cast-Iron Backwater Valves:
 - .1 Manufacturers:
 - .1 Josam Company.
 - .2 MIFAB, Inc.
 - .3 Smith, Jay R. Mfg. Co.
 - .4 Watts Water Technologies, Inc.
 - .5 Zurn Plumbing Products Group; Specification Drainage Operation.
 - .2 Standard: ASME A112.14.1.
 - .3 Size: Same as connected piping.
 - .4 Body: Cast iron.
 - .5 Cover: Cast iron with bolted access check valve.
 - .6 End Connections: Hub and spigot or hubless.
 - .7 Type Check Valve: Removable, bronze, swing check, factory assembled or field modified to hang closed.
 - .8 Extension: ASTM A74, Service class; full-size, cast-iron, soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.
- .2 Horizontal, Plastic Backwater Valves:
 - .1 Manufacturers:
 - .1 Oatey.
 - .2 Sioux Chief Manufacturing Company, Inc.
 - .3 Zurn Plumbing Products Group; Light Commercial Products Operation.
 - .4 IPS Corporation.
 - .2 Standard: ASME A112.14.1.
 - .3 Size: Same as connected piping.
 - .4 Body: PVC.
 - .5 Cover: Same material as body with threaded access to check valve.
 - .6 Check Valve: Removable swing check.
 - .7 End Connections: Socket type.
- .2 Cleanouts
 - .1 Exposed Metal Cleanouts:
 - .1 Manufacturers:
 - .1 Josam Company.
 - .2 MIFAB, Inc.
 - .3 Smith, Jay R. Mfg. Co.
 - .4 Tyler Pipe.
 - .5 Watts Water Technologies, Inc.
 - .6 Zurn Plumbing Products Group; Specification Drainage Operation.
 - .2 Standard: ASME A112.36.2M.
 - .3 Size: Same as connected drainage piping
 - .4 Body Material: Hubless, cast-iron soil pipe test tee as required to match connected piping.
 - .5 Closure: Countersunk or Raised-head, brass plug.
 - .6 Closure Plug Size: Same as or not more than one size smaller than cleanout size.

- .7 Stainless-Steel Exposed Cleanouts:
 - .1 Manufacturers:
 - .1 Josam Company.
 - .2 Standard: ASME A112.3.1 for cleanout test tee.
 - .3 Size: Same as connected drainage piping
 - .4 Body Material: Stainless-steel tee with side cleanout as required to match connected piping.
 - .5 Closure: Stainless-steel plug with seal.
- .2 Cast-Iron Exposed Floor Cleanouts:
 - .1 Manufacturers:
 - .1 Josam Company.
 - .2 Smith, Jay R. Mfg. Co.
 - .3 Tyler Pipe.
 - .4 Watts Water Technologies, Inc.
 - .5 Zurn Plumbing Products Group; Specification Drainage Operation.
 - .2 Standard: ASME A112.36.2M for heavy-duty, adjustable housing cleanout.
 - .3 Size: Same as connected branch.
 - .4 Type: Heavy-duty, adjustable housing.
 - .5 Body or Ferrule Material: Cast iron.
 - .6 Clamping Device: Required.
 - .7 Outlet Connection: Spigot.
 - .8 Closure: Brass, bronze or plastic with tapered threads.
 - .9 Adjustable Housing Material: Cast iron with threads, set-screws or other device.
 - .10 Frame and Cover Material and Finish: Nickel-bronze, copper alloy. In finished areas provide a recessed cover for finished floor material.
 - .11 Frame and Cover Shape: Round.
 - .12 Top-Loading Classification: Extra-Heavy Duty.
 - .13 Riser: ASTM A74, Service class, cast-iron drainage pipe fitting and riser to cleanout.
- .3 Stainless-Steel Exposed Floor Cleanouts:
 - .1 Manufacturers:
 - .1 Josam Company.
 - .2 Zurn Industries, LLC.
 - .3 Kusel Equipment Co.
 - .2 Standard: ASME A112.3.1.
 - .3 Size: Same as connected branch.
 - .4 Housing: Stainless steel.
 - .5 Closure: Stainless steel with seal.
 - .6 Riser: ASTM A74, Service Extra-Heavy class, stainless-steel drainage pipe fitting and riser to cleanout.
 - .7 Body or Ferrule Material: Stainless steel.
 - .8 Clamping Device: Required.
 - .9 Outlet Connection: Spigot.
 - .10 Closure: Brass or plastic with tapered threads.

- .11 Adjustable Housing Material: Cast iron with threads, set-screws or other device.
- .12 Frame and Cover Material and Finish: Nickel-bronze, copper alloy. In finished areas provide a recessed cover for finished floor material.
- .13 Top-Loading Classification: Medium Duty.
- .4 Cast-Iron Wall Cleanouts:
 - .1 Manufacturers:
 - .1 Josam Company.
 - .2 MIFAB, Inc.
 - .3 Smith, Jay R. Mfg. Co.
 - .4 Tyler Pipe.
 - .5 Watts Water Technologies, Inc.
 - .2 Standard: ASME A112.36.2M. Include wall access.
 - .3 Size: Same as connected drainage piping.
 - .4 Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
 - .5 Closure Plug:
 - .1 Brass.
 - .2 Countersunk head.
 - .3 Drilled and threaded for cover attachment screw.
 - .4 Size: Same as or not more than one size smaller than cleanout size.
 - .6 Wall Access: Round, deep, chrome-plated bronze cover plate with screw.
 - .7 Wall Access: Round, nickel-bronze, copper-alloy, or stainless steel wall-installation frame and cover.
- .5 Test Tees:
 - .1 Manufacturers:
 - .1 Jay R. Smith Mfg. Co.; a division of Morris Group International.
 - .2 Tyler Pipe; a subsidiary of McWane Inc.
 - .3 Watts Water Technologies; a Watts company.
 - .4 Zurn Industries, LLC.
 - .2 Standard: ASME A112.36.2M and ASTM A74, ASTM A888, or CISPI 301.
 - .3 Size: Same as connected drainage piping.
 - .4 Body Material: Hub-and-spigot, cast-iron soil-pipe T-branch or no-hub, cast-iron soil-pipe test tee as required to match connected piping.
 - .5 Closure Plug: Countersunk or raised head, brass.
 - .6 Closure Plug Size: Same as, or not more than, one size smaller than cleanout size.
- .3 Through-Penetration Firestop Assemblies
 - .1 Through-Penetration Firestop Assemblies:
 - .1 Manufacturers:
 - .1 ProSet Systems Inc.
 - .2 Standard: ASTM E814, for through-penetration firestop assemblies.
 - .3 Certification and Listing: Intertek Testing Service NA for through-penetration firestop assemblies.
 - .4 Size: Same as connected soil, waste, or vent stack.

- .5 Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
- .6 Stack Fitting: ASTM A48/A48M, 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.
- .7 Special Coating: Corrosion resistant on interior of fittings.
- .4 Miscellaneous sanitary drainage piping specialties. Miscellaneous
 - .1 Downspout Adaptors:
 - .1 Description: Manufactured, gray-iron casting, for attaching to horizontal-outlet, parapet roof drain and to exterior, sheet metal downspout.
 - .2 Size: Inlet size to match parapet drain outlet.
 - .2 Downspout Boots:
 - .1 Manufacturers:
 - .1 Jay R. Smith Mfg Co; a division of Morris Group International.
 - .2 Wade; a subsidiary of McWane Inc.
 - .3 Watts Water Technologies; a Watts company.
 - .4 Zurn Industries, LLC.
 - .2 Description: Manufactured, ASTM A48/A48M, gray-iron casting, with strap or ears for attaching to building; NPS 4 (DN 100) outlet; and shop-applied bituminous coating.
 - .3 Size: Inlet size to match downspout and NPS 4 (DN 100) outlet.
 - .3 Metal Downspout Nozzles:
 - .1 Manufacturers:
 - .1 Jay R. Smith Mfg Co; a division of Morris Group International.
 - .2 Wade; a subsidiary of McWane Inc.
 - .3 Watts Water Technologies; a Watts company.
 - .4 Zurn Industries, LLC.
 - .2 Description: Nozzle with wall flange and mounting holes to cover rough opening and serve as anchor.
 - .3 Size: Same as connected downspout.
 - .4 Material: Cast bronze or nickel bronze nozzle and flange.
 - .5 Piping Connection Type: Threaded.
 - .6 Opening Protection: Birdscreen.
 - .4 Metal Downspout Nozzles with PVC Insert:
 - .1 Manufacturers:
 - .1 RectorSeal Plumbing; A CSW Industrials Company.
 - .2 Jay R. Smith Mfg Co; a division of Morris Group International.
 - .3 Wade; a subsidiary of McWane Inc.
 - .4 Watts Water Technologies; a Watts company.
 - .5 Zurn Industries, LLC.
 - .2 Description: Nozzle with wall flange and mounting holes to cover rough opening and serve as anchor.
 - .3 Size: Same as connected downspout.
 - .4 Material: Cast nickel brass, with integral PVC insert.
 - .5 Piping Connection Type: Solvent welded.

- .6 Finish: Nickel brass.
- .7 Opening Protection: Birdscreen.

PART 3 EXECUTION

3.1 INSTALLATION

- .1 Domestic Water Piping Specialties
 - .1 Refer to Division 22 Section "Plumbing Piping" for piping joining materials, joint construction, and basic installation requirements.
 - .2 Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
 - .1 Locate backflow preventers in same room as connected equipment or system.
 - .2 Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.
 - .3 Do not install bypass piping around backflow preventers.
 - .3 Install water regulators with inlet and outlet shutoff valves. Install pressure gages on inlet and outlet. When required, install water regulators in a 1/3 | 2/3 as the project requires.
 - .4 Install water-control valves with inlet and outlet shutoff valves. Install pressure gages on inlet and outlet. When required, install water regulators in a 1/3 | 2/3 as the project requires.
 - .5 Automatic Water Shutoff Valves: Test for signal strength before valve installation. Install automatic shutoff valve downstream from main domestic water shutoff valve. Install valve controller in an accessible location with sensors in areas where water is likely to accumulate.
 - .6 Install balancing valves in locations where they can easily be adjusted.
 - .7 Install potable water loop circulation system with Flow-Splitter in accordance with construction drawings and factory recommendations. Valve to be installed according to flow direction indicator.
 - .1 Circulation loop piping from primary hot water source at the Flow-Splitter shall be run to connection points of angle stops serving fixtures and to tub or tub/shower points of connection returning to the Flow-Splitter/hot water source piping. Non-circulation portions of piping shall be no more than allowed by applicable energy code.
 - .8 Install individual fixture temperature-actuated, water mixing valves on each lavatory/sink designated for hand washing.
 - .9 Install temperature-actuated, water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.
 - .1 Install thermometers and water regulators on inlets and outlets.
 - .2 Install cabinet-type units recessed in or surface mounted on wall as specified.
 - .10 Install Y-pattern strainers for water on supply side of each control valve, water pressure-reducing valve, solenoid valve, and pump.
 - .11 Install outlet boxes recessed in wall or surface mounted on wall. Install 2-by-4-inch (38-by-89-mm) fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Section

"Rough Carpentry."

- .12 Install hose stations with check stops or shutoff valves on inlets and with thermometer on outlet.
 - .1 Install cabinet-type units recessed in or surface mounted on wall as specified. Install 2-by-4-inch (38-by-89-mm) fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Section "Rough Carpentry."
- .13 Install ground hydrants with 1 cu. yd. (0.75 cu. m) of crushed gravel around drain hole. Set ground hydrants with box flush with grade.
- .14 Install draining-type post hydrants with 1 cu. yd. (0.75 cu. m) of crushed gravel around drain hole. Set post hydrants in concrete paving or in 1 cu. ft. (0.03 cu. m) of concrete block at grade.
- .15 Set nonfreeze, nondraining-type post hydrants in concrete or pavement.
- .16 Set non-freeze sanitary yard hydrants with riser pipe in concrete or pavement. Do not encase canister in concrete.
- .17 Install water-hammer arresters in water piping according to PDI-WH 201.
- .18 Install air vents at all high points of water piping, including at the top of any rises/falls in horizontal piping. Install drain piping and discharge onto floor drain.
- .19 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.
- .20 Install drainage-type, trap-seal primer valves as lavatory trap with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.
- .21 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.
- .22 Utility Water Meter Installation
 - .1 Rough-in domestic water piping for water meter installation according to utility company's requirements.
 - .2 Water meter(s) will be furnished and installed by utility company.
 - .3 Install water meters according to AWWA M6, utility company's requirements, and the following:
 - .4 Install displacement-type water meters with shutoff valve on water-meter inlet. Install valve on water-meter outlet.
 - .5 Install turbine-type water meters with shutoff valve on water-meter inlet. Install valve on water-meter outlet.
 - .6 Install compound-type water meters with shutoff valves on water-meter inlet and outlet.
 - .7 Support meters, valves, and piping on brick or concrete piers.
 - .8 Install remote registration system according to standards of utility company and of authorities having jurisdiction, at minimum remote registration system shall be encoder type complying with AWWA C707; modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by utility company.
 - .1 System shall be capable of transmitting data using AMR/AMI technology
 - .9 Unless prohibited by authorities having jurisdiction, install full size bypass around water meter. Bypass shall include two shut off valves, each valve within 6" of active water main to eliminate dead legs.

.2 Sanitary Waste Piping Specialties

- .1 Equipment Mounting: Install grease interceptors and solids interceptors on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases specified in Division 03 Section "Cast-in-Place Concrete."
 - .1 Coordinate sizes and locations of concrete bases with actual equipment provided.
 - .2 Construct bases to withstand, without damage to equipment, seismic force required by code.
 - .3 Construct concrete bases 4 inches (100 mm) high and extend base not less than 6 inches (150 mm) in all directions beyond the maximum dimensions of FOG disposal systems, unless otherwise indicated or unless required for seismic anchor support.
 - .4 Minimum Compressive Strength: 5000 psi (34.5 MPa) at 28 days.
 - .5 Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
 - .6 For supported equipment, install epoxy-coated anchor bolts that extend through concrete base, and anchor into structural concrete floor.
 - .7 Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - .8 Install anchor bolts to elevations required for proper attachment to supported equipment.
 - .9 Comply with requirements for vibration isolation and seismic control devices specified in Section 20 "Vibration and Seismic Controls"
- .2 Install backwater valves in building drain piping. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.
- .3 For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- .4 For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- .5 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:
 - .1 Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
 - .2 Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
 - .3 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.

- .6 Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface, unless otherwise indicated.
- .7 Assemble and install ASME A112.3.1, stainless-steel channel drainage systems according to ASME A112.3.1. Install on support devices so that top will be flush with surface.
- .8 Assemble non-ASME A112.3.1, stainless-steel channel drainage system components according to manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.
- .9 Install fixture air-admittance valves on fixture drain piping.
- .10 Install stack air-admittance valves at top of stack vent and vent stack piping.
- .11 Install air-admittance-valve wall boxes recessed in wall.
- .12 Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof. Comply with requirements in Division 07 Section "Sheet Metal Flashing and Trim."
- .13 Install flashing fittings on sanitary stack vents and vent stacks that extend through roof. Comply with requirements in Division 07 Section "Sheet Metal Flashing and Trim."
- .14 Install through-penetration firestop assemblies in plastic {CH#136675} at floor penetrations. Comply with requirements in Division 07 Section "Penetration Firestopping."
- .15 Install deep-seal traps on floor drains and other waste outlets, if indicated.
- .16 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.
- .17 Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- .18 Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.
- .19 Install vent caps on each vent pipe passing through roof.
- .20 Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain 1-inch (25-mm) clearance between vent pipe and roof substrate.
- .21 Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.
- .22 Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inch (25-mm) clearance between vent pipe and roof substrate.
- .23 Assemble components of FOG disposal systems and install on floor. Install trap, vent, fresh-air inlet, and flow-control fitting according to authorities having jurisdiction. Install shelf fastened to reinforcement in wall construction and adjacent to unit, unless otherwise indicated. Install culture bottle, culture metering pump, timer, and control on shelf. Install tubing between culture bottle, metering pump, and chamber.
- .24 Install grease interceptors, including trapping, venting, and flow-control fitting, according to authorities having jurisdiction and with clear space for servicing.
 - .1 Above-Floor Installation: Set unit with bottom resting on floor, unless otherwise indicated.
 - .2 Flush with Floor Installation: Set unit and extension, if required, with cover flush with finished floor.

- .3 Recessed Floor Installation: Set unit in receiver housing having bottom or cradle supports, with receiver housing cover flush with finished floor.
- .4 Install cleanout immediately downstream from interceptors not having integral cleanout on outlet.
- .25 Install grease removal devices on floor. Install trap, vent, and flow-control fitting according to authorities having jurisdiction. Install control panel adjacent to unit, unless otherwise indicated.
- .26 Install oil interceptors, including trapping, venting, and flow-control fitting, according to authorities having jurisdiction and with clear space for servicing. Coordinate oil-interceptor storage tank and gravity drain with Division 23 Section "Facility Fuel-Oil Piping."
- .27 Install solids interceptors with cleanout immediately downstream from interceptors that do not have integral cleanout on outlet. Install trap on interceptors that do not have integral trap and are connected to sanitary drainage and vent systems.
- .28 Install wood-blocking reinforcement for wall-mounting-type specialties.
- .29 Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.
- .30 Flashing Installation
 - .1 Comply with requirements in Division 07 Section "Sheet Metal Flashing and Trim."
 - .2 Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
 - .1 Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft., 0.0938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., 0.0625-inch thickness or thinner.
 - .2 Copper Sheets: Solder joints of copper sheets.
 - .3 Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
 - .1 Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches (250 mm) , and skirt or flange extending at least 8 inches (200 mm) around pipe.
 - .2 Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches (200 mm) around sleeve.
 - .3 Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches (200 mm) around specialty.
 - .4 Set flashing on floors and roofs in solid coating of bituminous cement.
 - .5 Secure flashing into sleeve and specialty clamping ring or device.
 - .6 Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Division 07 Section "Sheet Metal Flashing and Trim."
 - .7 Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.
 - .8 Fabricate and install flashing and pans, sumps, and other drainage shapes.
- .3 Storm Drainage Piping Specialties
 - .1 Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions.

- .1 Install flashing collar or flange of roof drain to prevent leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
- .2 Install expansion joints, if indicated, in roof drain outlets.
- .3 Position roof drains for easy access and maintenance.
- .2 Install downspout adapters on outlet of back-outlet parapet roof drains and connect to sheet metal downspouts.
- .3 Install downspout boots at grade with top 12 inches above grade. Secure to building wall.
- .4 Install conductor nozzles at exposed bottom of conductors where they spill onto grade.
- .5 Install cleanouts in aboveground piping and building drain piping according to the following instructions unless otherwise indicated:
 - .1 Use cleanouts the same size as drainage piping up to NPS 4 (DN 100) . Use NPS 4 (DN 100) for larger drainage piping unless larger cleanout is indicated.
 - .2 Locate cleanouts at each change in direction of piping greater than 45 degrees.
 - .3 Locate cleanouts at minimum intervals of 50 feet (15 m) for piping NPS 4 (DN 100) and smaller and 100 feet (30 m) for larger piping.
 - .4 Locate cleanouts at base of each vertical soil and waste stack.
- .6 For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- .7 For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- .8 Install horizontal backwater valves in floor with cover flush with floor.
- .9 Install drain-outlet backwater valves in outlet of drains.
- .10 Install test tees in vertical conductors and near floor.
- .11 Install wall cleanouts in vertical conductors. Install access door in wall if indicated.
- .12 Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface unless otherwise indicated.
- .13 Assemble channel drainage system components according to manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.
- .14 Install through-penetration firestop assemblies for penetrations of fire- and smoke-rated assemblies.
 - .1 Comply with requirements in Division 07 Section "Penetration Firestopping."
- .15 Install sleeve flashing device with each conductor passing through floors with waterproof membrane.

3.2 CONNECTIONS

- .1 Domestic Water Piping Specialties
 - .1 Piping Connections
 - .1 Drawings indicate general arrangement of piping, fittings, and specialties.
 - .2 When installing piping specialties adjacent to equipment and machines, allow space for service and maintenance.
 - .2 Electrical Connections
 - .1 Connect wiring in accordance with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

- .2 Ground equipment in accordance with Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- .3 Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.
- .3 Control Connections
 - .1 Connect control wiring in accordance with Section 26 05 23 "Control-Voltage Electrical Power Cables."
- .2 Sanitary Waste Piping Specialties
 - .1 Comply with requirements in Division 22 Section 22 22 13 16 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.
 - .2 Install piping adjacent to equipment to allow service and maintenance.
 - .3 FOG Disposal Systems: Connect inlet and outlet to unit, connect flow-control fitting and fresh-air inlet piping to unit inlet piping, and connect vent piping between trap and media chamber. Connect electrical power.
 - .4 Grease Interceptors: Connect inlet and outlet to unit, and connect flow-control fitting and vent to unit inlet piping. Install valve on outlet of automatic drawoff-type unit.
 - .5 Grease Removal Devices: Connect controls, electrical power, factory-furnished accessories, and inlet, outlet, and vent piping to unit.
 - .6 Oil Interceptors: Connect inlet, outlet, vent, and gravity drawoff piping to unit; flow-control fitting and vent to unit inlet piping; and gravity drawoff and suction piping to oil storage tank.
 - .7 Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
 - .8 Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- .3 Storm Drainage Piping Specialties
 - .1 Comply with requirements for piping specified in Division 22 Section "Plumbing Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

3.3 FIELD QUALITY CONTROL

- .1 Domestic Water Piping Specialties
 - .1 Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
 - .2 Perform the following tests and inspections with the assistance of a factory-authorized service representative.
 - .1 Test each pressure vacuum breaker according to authorities having jurisdiction and the device's reference standard.
 - .2 Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - .3 Operational Test: After electrical circuitry has been energized, start units to confirm unit operation.
 - .4 Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - .3 Domestic water piping specialties will be considered defective if they do not pass tests and inspections.
 - .4 Prepare test and inspection reports.
- .2 Sanitary Waste Piping Specialties

- .1 Perform tests and inspections and prepare test reports.
 - .1 Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled {CH#137632} and their installation, including piping and electrical connections, and to assist in testing.
- .2 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 Storm Drainage Piping Specialties
 - .1 Perform tests and inspections and prepare test reports.
 - .1 Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled {CH#137632} and their installation, including piping and electrical connections, and to assist in testing.
 - .2 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.
- .4 Protection
 - .1 Sanitary Waste Piping Specialties
 - .1 Place plugs in ends of uncompleted piping at end of each day or when work stops.
 - .2 Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
 - .2 Storm Drainage Piping Specialties
 - .1 Place plugs in ends of uncompleted piping at end of each day or when work stops.

3.4 IDENTIFICATION

- .1 Domestic Water Piping Specialties
 - .1 Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
 - .1 Pressure vacuum breakers.
 - .2 Intermediate atmospheric-vent backflow preventers.
 - .3 Reduced-pressure-principle backflow preventers.
 - .4 Double-check, backflow-prevention assemblies.
 - .5 Carbonated-beverage-machine backflow preventers.
 - .6 Dual-check-valve backflow preventers.
 - .7 Reduced-pressure-detector, fire-protection, backflow-preventer assemblies.
 - .8 Double-check, detector-assembly backflow preventers.
 - .9 Water pressure-reducing valves.
 - .10 Calibrated balancing valves.
 - .11 Primary, thermostatic, water mixing valves.
 - .12 Manifold, thermostatic, water mixing-valve assemblies.
 - .13 Photographic-process, thermostatic, water mixing-valve assemblies.

- .14 Primary water tempering valves.
 - .15 Outlet boxes.
 - .16 Hose stations.
 - .17 Supply-type, trap-seal primer valves.
 - .18 Trap-seal primer systems.
- .2 Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 20 Section "Mechanical Identification."
- .2 Sanitary Waste Piping Specialties
 - .1 Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
 - .1 FOG disposal systems.
 - .2 Grease interceptors.
 - .3 Solids interceptors.
 - .2 Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 20 Section "Identification for Piping and Equipment."
- .3 Storm Drainage Piping Specialties
 - .1 Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
 - .1 FOG disposal systems.
 - .2 Grease interceptors.
 - .3 Solids interceptors.
 - .2 Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 20 Section "Identification for Piping and Equipment."

3.5 ADJUSTING

- .1 Domestic Water Piping Specialties
 - .1 Set field-adjustable pressure set points of water pressure-reducing valves.
 - .2 Set field-adjustable flow set points of balancing valves.
 - .3 Set field-adjustable temperature set points of temperature-actuated, water mixing valves.
 - .4 Adjust each pressure vacuum breaker in accordance with manufacturer's written instructions, authorities having jurisdiction and the device's reference standard.

3.6 DEMONSTRATION AND TRAINING

- .1 Sanitary Waste Piping Specialties
 - .1 Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain FOG disposal systems. Refer to Division 01 Section "Demonstration and Training."
 - .1 Oil interceptors.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- .1 This section provides General, Product, and Execution Requirements for Plumbing Fixtures and Trim.
- .2 Provide all required Plumbing Fixtures and Trim as indicated, including, but not limited to:
 - .1 Plumbing fixtures
 - .2 Equipment Connection Box (ECB)
 - .3 Faucets and valves, including mixing valves
 - .4 Connections to equipment specified elsewhere or provided by the Owner, such as kitchen and laundry equipment, lab equipment, etc.

1.2 GENERAL REFERENCES

- .1 Read this section in conjunction with Division 01 General Requirements, Conditions of Contract, all related Technical Specifications and associated drawings of this Contract.

1.3 RELATED REQUIREMENTS

- .1 Refer to and comply with the following sections:
 - .1 General Requirements - Division 01
 - .2 Common Work for Mechanical Systems – Division 20
 - .3 Fire Suppression Systems - Division 21
 - .4 Plumbing Systems - Division 22
 - .5 Controls and Instrumentation - Division 25
 - .6 Electrical - Division 26/27/28
 - .7 Excavating, Trenching and Backfilling – Division 31
 - .8 Utilities - Division 33

1.4 REFERENCE STANDARDS

- .1 ANSI 358.1 - American National Standard for Emergency Eyewash and Shower Equipment.
- .2 ASSE 1017 - Performance Requirements for Temperature Actuated Mixing Valves for Hot Water Distribution Systems.
- .3 CSA B45 Series - Plumbing Fixtures.
- .4 CSA B125.1 - Plumbing Supply Fittings.
- .5 CSA B125.2 - Plumbing Waste Fittings.
- .6 CSA B125.14 - Manually Operated Valves for Use in Plumbing Systems.
- .7 NSF 61 - Drinking Water System Components - Health Effects.
- .8 NSF 372 - Drinking Water System Components - Lead Content.

1.5 APPLICABLE CODES AND STANDARDS

- .1 This project is deemed to be a post-disaster design.
- .2 Refer to Section 20 05 01 , Codes, Bylaws and Standards.
- .3 All equipment, materials, installation, and testing shall conform to the following standards as a minimum:

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- .1 Provincial Building Code
 - .2 Local Building By-Laws
 - .3 Provincial Safety Authority
 - .4 All pipe, pipe fittings, valves and accessories that come in contact with drinking water shall be lead-free and compliant with NSF 61 Annex G and Section 9.
 - .5 All fixtures shall display CSA (Canadian Standards Association) approval where a CSA standard is available and in effect.
 - .6 Plumbing supply fittings shall conform to CSA B125.1
 - .7 Plumbing waste fittings shall conform to CSA B125.2
 - .8 Plumbing valves of less than 100 mm (4 inch) shall conform to CSA B125.14
 - .9 Plumbing fixtures shall conform to CSA B45 Series
 - .10 Emergency showers and eye washes shall conform to ANSI 358.1 American National Standard for Emergency Eyewash and Shower Equipment.
 - .11 Combustible plumbing fixtures including acrylic and / or fiberglass bathtubs and shower bases / shower enclosures shall not exceed the limitations of the flame spread rating (FSR) or smoke development classification (SDC) permitted for the building construction in which they are installed.

1.6 SUSTAINABILITY

- .1 Refer to Section 20 02 00 - General Provisions for Mechanical, Sustainability
- .2 Submissions (Shop Drawings) and other documentation shall include all Adhesives and Sealants Material Safety Data Sheets (MSDS) highlighting the materials Volatile Organic Compound (VOC) levels.
- .3 All pipe, pipe fittings, valves, faucets, accessories, or any other system components that contact drinking water shall be certified as "lead-free" as required by NSF 372, and NSF 61 Annex G Section 9 for applicable hot and cold water temperature ratings.

1.7 SUBMITTALS

- .1 Comply with Division 01 and Section 20 05 05 - Documentation and Submittals.
 - .2 Refer to Section 20 99 60 - Mechanical Forms and submit all documentation therein that is applicable to Division 22.
 - .3 Shop Drawings
 - .1 Submit shop drawings in accordance with Division 01 and Section 20 05 05 - Documentation and Submittals.
 - .2 Shop drawings are required for all materials and equipment.
 - .4 Product Options and Substitutions
 - .1 Refer to Division 01 and Section 20 02 00 - General Provisions for Mechanical for requirements pertaining to product options and substitutions.
 - .5 Record Drawings
 - .1 Refer to Division 01 and Section 20 05 05 - Documentation and Submittals.
 - .6 Maintenance Data
 - .1 Refer to Division 01 and Section 20 05 05 - Documentation and Submittals.
 - .2 Submit manufacturer's recommended maintenance tasks for a one-year period. Include maintenance schedules and lubrication products.
 - .3 Submit operating and maintenance data for inclusion into the manuals.
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- .4 Submit WHMIS MSDS in accordance with Division 01.
 - .7 Occupancy Documentation Requirements
 - .1 Refer to Division 01 and Section 20 05 05 - Documentation and Submittals.
 - 1.8 QUALITY ASSURANCE**
 - .1 Refer to Section 20 02 00 - General Provisions for Mechanical, Quality Assurance, for additional details.
 - .2 Follow manufacturer's recommended installation details and procedures for equipment, supplemented by requirements of Contract Documents.
 - .3 Installation shall be in accordance with well-established practice and standards accepted and recognized by the Consultant and the Trade.
 - .4 Similar plumbing fixtures shall be of one manufacturer.
 - .5 Plumbing fixture supply brass shall be of one manufacturer unless indicated otherwise.
 - .6 Fixtures shall be free from flaws or blemishes. Surfaces shall be clear, smooth and bright and have dimensional stability.
 - .7 Plumbing fixtures and trim shall be new and unused unless indicated otherwise.
 - .8 All visible or exposed parts, trim, supplies, traps, tubing, nipples escutcheons, check valves on diverter supply lines and valves to sanitary and/or kitchen fixtures shall be chrome plated finish unless otherwise noted.
 - .9 All fittings shall have heavy duty stems.
 - .10 Colour and Finish
 - .1 Vitreous china fixtures shall be white unless otherwise noted.
 - .2 Stainless steel fixtures shall be satin and/or mirror finish or a combination thereof.
 - .3 Exposed plumbing brass and metal work shall be heavy triple chromium plated.
 - .11 Laboratory Brass Trim
 - .1 Laboratory brass fittings shall be of one manufacturer, shall have corrosion resistant finish where specified and shall be colour-coded and indexed.
 - .2 Laboratory water faucets with gooseneck spouts shall be protected by vacuum breakers meeting the requirements of ANSI Standard ANSI/ASSE 1001, Pipe Applied Atmospheric Type Vacuum Breakers.

PART 2 PRODUCTS

2.1 SYSTEM PRESSURE RATINGS

- .1 The proposed building is a high-rise with pumps located at a lower level.
 - .1 The pressure rating of all pipe and fittings shall be suitable for the working pressures that could be encountered.

2.2 PLUMBING FIXTURES GENERAL

- .1 Plumbing fixtures in this sub-section tagged as WC-x, LAV-x, S -x, etc. (other than T-x or -x) shall be provided, installed, and connected by the Division 22 Contractor.

2.3 EMERGENCY EYE WASHES

- .1 Emergency Eye Wash EW-1: Swing Down Emergency Eye/Face Wash
 - .1 Above Sink
 - .2 Standard of Acceptance: Haws 7610 with Haws 9201 Axion Valve

- .3 All-stainless steel eye/face wash for mounting on wall/sink.
- .4 Spray head swings down from storage to operational position, activating water flow.
- .5 Spray Head Assembly: One spray head. Each head with has a flip top dust cover, internal flow control and filter to remove impurities from the water flow.
- .6 Valve: 1/2 IPS stainless steel plug-type valve with PTFE coated O-ring seals. Swinging head assembly don from storage to operational position opens orifice and activates water flow.
- .7 Unit remains in operation until head assembly is returned to storage position.
- .8 Mounting: Valve is installed in Type 316 stainless steel housing. Mount housing on wall using anchors or using other mounting hardware.
- .9 Construction: Type 316 stainless steel.
- .10 Include Haws 9201 Guardian G6020 thermostatic mixing valve which precisely blends hot and cold water to deliver tepid water as required by ANSI 358.1.
- .11 Sign: ANSI-compliant identification sign.
- .12 P-trap shall be cast brass or tubular brass complete with either a cleanout or possess slip joint connections. Assembly shall be chrome plated where not concealed in millwork. Plastic drain and trap assemblies are not acceptable.

2.4 SIN S

- .1 Provide braided stainless-steel flexible supplies for sinks.
 - .1 Supplies for sinks shall incorporate 12 mm (1/2") chrome plated lead-free quarter turn mini ball valve stop.
- .2 Sink S -1: Stainless-steel single compartment drop-in sink.
 - .1 Sink:
 - .1 Standard of Acceptance: Franke LBS7308P-1
 - .2 Single compartment, self rimming, top mount sink with faucet ledge back, 1.2mm [18 gauge], type 304 stainless-steel, three-hole drilling suitable for a widespread sink faucet.
 - .3 560 x 651 mm overall, 432 x 584 x 203 deep bowl [22-1/16 x 25-5/8 overall], 17 x 23 x 8 deep bowl. (FB x LR x D).
 - .4 Exposed surfaces will be 4 satin finished.
 - .5 Undercoated to reduce condensation and resonance.
 - .6 Include waste fitting, factory applied rim seal, cutout template, and factory installed fasteners.
 - .7 Certified to ASME A112.19.3-2008 / CSA B45.4-08
 - .8 Centre waste location. Includes 89 mm [3 1/2] crumb cup strainer with 38mm [1-1/2] brass tailpiece.
 - .2 Faucet
 - .1 Standard of Acceptance: American Standard 786-GN8FC ABCP
 - .2 Two handle widespread sink faucet, polished chrome plated finish
 - .3 Lead-free compliant
 - .4 8.3 LPM [2.2 USgpm] flow rate
 - .5 metal hold-down package
 - .6 1/4 turn ceramic structures

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- .7 Spout: Gooseneck spout 202mm [8.0] spout reach, 379 mm [14.875] total height
 - .8 LS Limited swing rigid/swivel field installation
 - .9 Vandal resistant
 - .10 Outlet : 2- Vandal resistant laminar outlet
 - .11 Handle : 4 - 102mm [4] blade handles with sanitary hoods
 - .12 Metal color indexed vandal resistant screws
 - .3 Thermostatic Mixing Valve: Provide lead-free thermostatic mixing valve located below faucet.
 - .1 Standard of Acceptance: American Standard 605 TMV1070
 - .2 NSF/ANSI 61-9 compliant
 - .3 Low Lead Cast Bronze body
 - .4 Low Lead Brass internals
 - .5 Polysufone piston
 - .6 Noryl GFN2 guide tube
 - .7 300 Series Stainless Steel spring and screen
 - .8 Viton seals
 - .9 Noryl GFN2 checks
 - .3 Lavatory LAV-1: Vitreous China Wall-Hung Lavatory.
 - .1 Sink:
 - .1 Standard of Acceptance: Murro 0954.904EC/0059.020EC
 - .2 Single compartment, self rimming, top mount sink with faucet ledge back, 1.2mm [18 gauge], Vitreous China, three-hole drilling suitable for a widespread sink faucet.
 - .3 560 x 651 mm overall, 432 x 584 x 203 deep bowl [22-1/16 x 25-5/8 overall], 17 x 23 x 8 deep bowl. (FB x LR x D).
 - .4 Undercoated to reduce condensation and resonance.
 - .5 Include waste fitting, factory applied rim seal, cutout template, and factory installed fasteners.
 - .6 Certified to ASME A112.19.3-2008 / CSA B45.4-08
 - .7 Centre waste location. Includes 89 mm [3 1/2] crumb cup strainer with 38mm [1-1/2] brass tailpiece.
 - .2 Faucet
 - .1 Standard of Acceptance: American Standard 590T0128TR
 - .2 Deckmount hi-rise spout with integral sensor
 - .3 Lead-free compliant
 - .4 8.3 LPM [2.2 USgpm] flow rate
 - .5 metal hold-down package
 - .6 1/4 turn ceramic structures
 - .7 Vandal resistant
 - .3 Thermostatic Mixing Valve: Provide lead-free thermostatic mixing valve located below faucet.
 - .1 Standard of Acceptance: American Standard 605 TMV1070
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- .2 NSF/ANSI 61-9 compliant
- .3 Low Lead Cast Bronze body
- .4 Low Lead Brass internals
- .5 Polysufone piston
- .6 Noryl GFN2 guide tube
- .7 300 Series Stainless Steel spring and screen
- .8 Viton seals
- .9 Noryl GFN2 checks

2.5 HAND HYGIENE SINKS

- .1 Hand Hygiene Sink HHS-1
 - .1 Standard of Acceptance: American Standard ICU 6056193.002 with Selectronic Faucet
 - .2 Sink:
 - .1 Vitreous China, permanent Everclean surface to inhibit the growth of stain odor causing bacteria, mold mildew, deep basin sloped ledges minimize splashing
 - .2 Sink drain shall be offset so that the water stream does not fall directly on the grid drain, sink is designed with sealed overflow to eliminate an area for water to pool.
 - .3 Include removable acrylic lower shroud (with mounting hardware) to allow access to the faucet electronics, includes offset grid drain P-Trap with Saniguard coating
 - .3 Faucet
 - .1 Standard of Acceptance: American Standard
 - .2 Hygienic hands-free operation, rigid gooseneck spout with 137 mm [5-3/8] each, 7.6 LPM [2.0 USgpm] laminar flow restrictor in spout shank, no air and water, plain spout end so nothing on the end of the spout to collect lime debris
 - .3 The fixture shall be lead-free compliant with NSF 61 Annex G Section 9, or NSF 372.
 - .4 Hardwired electronic proximity sensor, 120VAC
 - .4 Provide lead-free thermostatic mixing valve located below faucet
 - .1 Standard of Acceptance: urn W1070 L
 - .2 NSF/ANSI 61-9 compliant
 - .3 Low Lead Cast Bronze body
 - .4 Low Lead Brass internals
 - .5 Polysufone piston
 - .6 Noryl GFN2 guide tube
 - .7 300 Series Stainless Steel spring and screen
 - .8 Viton seals
 - .9 Noryl GFN2 checks

- .5 Provide braided stainless-steel flexible supplies for connection to mixing valve. Supplies shall incorporate 9 mm [3/8] chrome plated quarter turn mini ball valve stop before flex.
- .6 Solid top, open-grid P.O. plugs 8743-PC
- .7 P-traps shall be 8700-PC semi-cast brass complete with either a cleanout or possess slip joint connections. Assembly shall be chrome plated where not concealed in millwork. Plastic drain and trap assemblies are not acceptable.
- .8 Provide floor mounted fixture support with vertical steel members, wall plate and mounting studs.
 - .1 Standard of Acceptance: Smith SQ-0-4437 floor mounted sink support

2.6 WATER CLOSETS TOILETS

- .1 Wall Mounted Water Closet WC-1
 - .1 Staff and Public Use
 - .2 Standard of Acceptance: American Standard AFWALL MILLENIUM 3351.101
 - .3 Bowl:
 - .1 Vitreous China, elongated bowl, for flush valve applications
 - .2 Concealed back outlet, concealed 38 mm [1-1/2"] back inlet spud
 - .3 High efficiency, low water consumption, universal design operates with a maximum flush rate of 6.0 Lpf [1.6 USgpf]
 - .4 Permanent antimicrobial surface glaze additive to inhibit the growth of stain and odor-causing bacteria, mold mildew, deep basin sloped ledges minimize splashing
 - .5 Siphon jet flush action
 - .6 Fully glazed 50 mm [2"] trapway, 300 mm x 250 mm [12" x 10"] water surface area
 - .7 38 mm [1-1/2"] inlet spud
 - .8 Condensation channel
 - .9 140 mm [5-1/2"] bolt hole spacing for seat mounting
 - .10 Complete with 4 bolt caps
 - .11 Static weight load of 454 kg [1,000 lbs.]
 - .4 Seat
 - .1 Standard of Acceptance: Centoco 500STSCC.001
 - .2 White, elongated, open front, heavy duty toilet seat without cover
 - .3 Solid polypropylene and resistant to staining, fading, chipping, and peeling
 - .4 Ergonomic contour
 - .5 Integrated lift handle
 - .6 140 mm [5-1/2"] bolt holt spacing for seat mounting
 - .7 Check hinge
 - .5 Flush Valve
 - .1 Standard of Acceptance: Sloan Manual Flush Valve
 - .2 Diaphragm flush valve for back spud toilet with vacuum breaker and renewable seat
 - .3 Chloramine resistant diaphragm attached to guide with metal retainer

- .4 Vandal resistant "non hold open" oscillating handle control can be located and installed anywhere within 6 m [20'] of flush valve. Refer to Architectural elevations for handle location.
- .5 Check angle stop with wheel handle.
- .6 Polished chrome plated finish on exposed trim.
- .7 External water conserving flush adjustment: Factory set to 6 Litre [1.6 US gal]
- .6 Wall Carrier
 - .1 Standard of Acceptance: Watts ISCA-101-M11-Single
 - .2 Horizontal adjustable toilet carrier
 - .3 With vertical offset fittings for siphon jet water closets
 - .4 Rear floor support lug and anchor foot assembly
 - .5 Closet outlet connection to suit
 - .6 Integral vent connection

2.7 MIXING VALVES

- .1 General
 - .1 Mixing valves shall be thermostatic in operation, not mechanical mixing valves.
 - .1 This includes individual mixing valves at single fixtures or groups of fixtures including lavatories, sinks, showers, emergency fixtures etc.
 - .2 On both the up-stream hot and cold supplies, in an accessible location, provide isolation valves, positive swing check valves and strainers.
 - .1 This requirement does not apply when such components are supplied with or integral to the mixing valves itself.
 - .2 Where required, provide an access panel to the isolation valves, check valves and strainers.
- .2 Mixing Valve MV-1:
 - .1 Valve:
 - .1 Standard of Acceptance: Watts HydroGuard LFLM490
 - .2 Factory assembled and tested lead-free components mounted in a white painted steel cabinet.
 - .1 Valve shall comply with ASSE 1017 and CSA B125.14.
 - .3 Thermostatic control valve, fast response paraffin-based actuation, certified lead-free cast brass construction, all components in rough brass finish, dirt and lime resistant.
 - .4 Provide triple duty strainer check stops, dial thermometer reading 18oC to 46oC (65oF to 115oF) on tempered supply to reverse osmosis unit, quarter turn ball valve on outlet for shut off and volume control.
 - .5 Flow capacity of 0.48 litres per second (7.6 USgpm) at 35 kPa (5 psig) differential.
 - .6 Optional equipment:
 - .1 stainless steel cabinet
 - .2 powder coated steel cabinet
 - .3 inlet pressure/temperature gauges
 - .4 vacuum breaker

- .5 cold water by-pass
- .6 high-temperature alarm

2.8 EQUIPMENT CONNECTION BOX ECB

- .1 Standard of Acceptance:
 - .1 Oatey Reversible Drain Metal Washing Machine Outlet Boxes
- .2 Washing Machine style box with one or two water outlets as required for the equipment, and 50 mm (2") bottom drain outlet where required.
- .3 Water outlets complete with ☐ turn brass valves, colour indexed handles.
- .4 Provide water hammer arrestor option on supply lines to quick closing valves.
- .5 Constructed of 20-gauge box with support straps, 18-gauge faceplate for wall finishing, white baked enamel finish.

PART 3 EXECUTION

3.1 FIXTURE INSTALLATION

- .1 Connect fixtures complete with specified trim, supplies, drains accessory piping, vented traps, stops or valves, reducers, escutcheons, and fittings for the proper installation of all fixtures and their respective supply fittings.
- .2 Provide necessary hangers, supports, brackets, reinforcement, steel back-up plates and floor flanges to set fixtures level and square.
 - .1 Mount fixtures so that 90 kilogram (200 pound) mass will not loosen or distort mounting.
- .3 Provide minimum 18-gauge circular stainless-steel shrouds for concealing all services dropping to island or bench fixtures from ceiling spaces complete with all necessary ceiling and counter flanges.
 - .1 Diameter shall be as necessary to accommodate services however, all shrouds shall be of the same diameter in any one room or area.
- .4 Provide chrome plated quarter turn mini ball valves for all lavatories, sinks and tank type water closets.
- .5 ABS p-traps and waste arms are not permitted.
- .6 Lavatories and Sinks
 - .1 Provide braided stainless-steel flexible supplies for sinks, drinking fountains and lavatories.
 - .1 Supplies for drinking fountains and lavatories shall incorporate 9 mm (3/8") chrome plated lead-free quarter turn mini ball valve stop.
 - .2 Supplies for sinks shall incorporate 12 mm (1/2") chrome plated quarter turn mini ball valve stop.
 - .3 Plastic handles are not acceptable.
 - .2 PE or other plastic supplies are not acceptable.
 - .3 Double waste fittings for lavatories and sinks shall be a double sanitary tee.
 - .4 Control handles for all two handle mixing faucets shall be positioned with the cold control on the right and the hot control on the left.
 - .1 Activation shall be accomplished by rotating the cold control handle clockwise and the hot control handle counterclockwise.
 - .5 Faucets shall be complete with nuts and tailpieces.

- .6 Provide appropriate gaskets and/or sealing washers that will prevent the entry of water into fixture trim or faucet holes or punchings in millwork.
- .7 Gooseneck spouts shall have a clearance of 200 mm (8 ") 200 mm [8 "] from nozzle tip to countertop, unless otherwise specified.
- .8 Plastic control handles and spouts are unacceptable.
- .9 Lavatory and sink P-traps shall be cast brass or tubular brass complete with either a cleanout or possess slip joint connections.
 - .1 Assembly shall be chrome plated where not concealed in millwork. Plastic drain and trap assemblies are not acceptable.
- .10 Lavatory and sink P-traps shall be complete with either a cleanout or possess slip joint connections.
- .11 See drawings for sinks where P-traps are not required as a result of being indirectly connected to waste.
- .12 Cleanouts serving fixtures in Healthcare Facilities, Mortuaries, Laboratories, and similar occupancies, where contamination by bodily fluids is likely, shall be located a minimum of 150 mm (6") above the flood level rim of the fixture.

3.2 ACOUSTICAL REQUIREMENTS

- .1 The minimum pipe size to faucets or mixing valves of each fixture shall be 12 mm (½ "). The use of 9 mm (¾ ") pipes is prohibited.
- .2 All pipe (bare or insulated) shall be clear of contact with studs or gypsum wallboard.
- .3 Bathtubs: A layer of RSI-1.76 (R-10) insulation shall be placed under bathtubs.
- .4 Mixing Valves and Faucets:
 - .1 Quiet cartridge shall be used at mixing faucets and shower valves.
 - .2 Any which subsequently become noisy during the warranty period shall be replaced at no extra charge to the owner.
- .5 Back-to-back Fixtures:
 - .1 Drain line and water supply lines shall be divided at the riser.
 - .2 Tee takeoffs serving back-to-back fixtures are not permitted.
- .6 Quick Acting Valves:
 - .1 All solenoid operated, or other quick acting valves shall be equipped with water hammer arresters located as close to the valves as possible.
- .7 Waste Disposal Units:
 - .1 Waste disposal units shall be resiliently isolated from the sink and waste piping and a limp loop of flexible conduit shall be installed for all electrical connections.
 - .1 Compliance with local codes per installation of flexible connectors shall be checked.
- .8 Piping shall not contact any framing stud or wall surface or any other conduit, electrical or ventilation fixture that is connected to any wall or ceiling surface.
- .9 Piping shall not be fastened to a partition which forms part of an adjacent room not served by the pipe in question.
 - .1 Do not secure piping to gypsum wallboard or its supporting frame.
- .10 Riser clamps shall be isolated from the structure using an approved resilient material between the support collar and the floor structure (Vibro-Acoustics type SN, 30 durometer, 57.15 mm (2¼ ") x 57.15 mm (2¼ ") in size, or an approved equal).

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- .1 An alternate method is to wrap the pipe with neoprene prior to clamping.
 - .11 Pipe hangers shall be oversized to suit the insulation and shall have a protection shield between the insulation and the hanger.
 - .12 Pipe hangers shall contain 50 durometer, 3.2 mm (1/8) thick neoprene pads inserted between the hanger saddle and pipe.
- 3.3 FIXTURE TRIM HOLES OR PUNCHINGS**
- .1 Fixture punchings for faucets or other trim shall not contain more punchings than necessary for the specified trim.
 - .2 Provide fixture and templates to the applicable trades for holes and cut outs required in all countertops.
- 3.4 ALLS AND FLOORS**
- .1 Fixtures mounted on glazed tile surfaces shall have ground faces to finished surface.
 - .2 Where plumbing fixtures come in contact with walls and floors, joints shall be sealed with Dow Corning anti-mildew 786 building sealant, made watertight and beaded smooth in a neat and workmanlike manner.
- 3.5 ATER HAMMER ARRESTORS**
- .1 Provide water hammer arrestors on fixtures with flush valves and/or quick closing valves.
- 3.6 BARRIER FREE FIXTURES**
- .1 Lavatories and Sinks
 - .1 Install offset P-traps with the run of the P-trap parallel to and close to wall.
 - .2 Supplies on barrier-free lavatories shall be offset to accommodate the offset P-trap.
 - .3 Insulate P-traps and waste arms at all barrier-free lavatories and sinks with a manufactured insulation kit or 12 mm (\square) of fiberglass insulation and finished with a polyvinyl chloride jacket in a neat and workmanlike manner.
 - .4 Acceptable Manufactured Products: Truebro Handi Lav-Guard , Brocar Products Inc. Trap Wrap , Sexauer Handi Lav-Guard Plumberex Handy Shield .
- 3.7 EMERGENCY SHOWERS AND EYE WASHES**
- .1 Emergency Showers and Eye Washes shall be field tested for compliance with ANSI 358.1
 - .1 Provide documentation certifying the test results and compliance with the noted standard.

END OF SECTION 22 40 00

PART 1 GENERAL

1.1 SECTION INCLUDES

- .1 Pipe and Fittings.
- .2 Valves and Regulators.
- .3 Piping Accessories.
- .4 Outlets.
- .5 Medical Compressed Air System.
- .6 Medical Vacuum System.
- .7 Oxygen Manifold.
- .8 Alarm Systems.

1.2 GENERAL REFERENCES

- .1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.
- .2 Division 20, including all Common Mechanical Requirements in Section 20 00 00, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.

1.3 RELATED REQUIREMENTS

- .1 Section 07 84 00 - Firestopping.
- .2 Section 22 05 48 - Vibration and Seismic Controls for Plumbing Piping and Equipment.
- .3 Section 22 05 53 - Identification for Plumbing Piping and Equipment.
- .4 Section 22 07 19 - Plumbing Piping Insulation.
- .5 Section 25 15 00 - Integrated Automation Software.
- .6 Section 25 35 00 - Integrated Automation Instrumentation and Terminal Devices for HVAC.
- .7 Section 26 05 83 - Wiring Connections: Electrical characteristics and wiring connections.
- .8 Section 31 23 16 - Excavation.
- .9 Section 31 23 23 - Fill.

1.4 SUBMITTALS

- .1 Action Submittals
 - .1 Product Data: Provide manufacturers literature and illustrations for all components indicating size, dimensions and configuration.
 - .2 Shop Drawings: Indicate general assembly of components, mounting and installation details, and general layout of control and alarm panels. Submit detailed medical wall assembly drawings.
 - .3 Independent Testing Agency Reports: Indicate systems are complete, zone valves installed, alarm systems functional, and pressure and cross connections tests performed. Document tests.
 - .4 Manufacturer's Instructions: Indicate installation requirements for equipment and systems.
 - .5 Manufacturer's Field Reports: Indicate systems are complete, zone valves installed, and alarm systems functional.
 - .6 Operation Data: Include installation instructions, assembly views, lubrication instructions, and assembly views.

- .2 Informational Submittals
 - .1 Certificates: Certify that products meet or exceed specified requirements.
- .3 Operation and Maintenance Materials
 - .1 Maintenance Data: Include maintenance and inspection data, replacement part numbers and availability, and service depot location and telephone.
- .4 Record Documents
 - .1 Project Record Documents: Record actual locations of piping, valving, and outlets.

1.5 WARRANTIES

- .1 Provide five year manufacturer warranty for all components.
- .2 Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.6 QUALITY ASSURANCE

- .1 Select products and execute work in compliance with NFPA 99 and ICC (IPC).
- .2 Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with at least three years of documented experience.
- .3 Installer Qualifications: Company specializing in performing work of type specified and with at least three years of documented experience.
- .4 Testing Laboratory: Company specializing in performing testing of the type specified in this section, with minimum 10 years of documented experience.
- .5 Comply with applicable codes for medical gas systems.
- .6 Provide certificate of compliance from authorities having jurisdiction, indicating approval of systems.
- .7 Provide certificate of compliance from Authority Having Jurisdiction, indicating approval of systems.
- .8 Products Requiring Electrical Connection: Listed and classified by UL (DIR) as suitable for the purpose specified and indicated.

1.7 MOCK-UPS AND SAMPLES

- .1 Provide mock-up of outlets in typical patient head wall unit.
- .2 Locate where directed.
- .3 Mock-up may remain as part of the Work.
- .4 Samples: Submit two of each outlet.

1.8 DELIVERY, STORAGE AND HANDLING

- .1 Accept material on-site in factory containers and packing. Inspect for damage.
- .2 Protect from damage and contamination by maintaining factory packaging and caps in place until installation.

1.9 EXTRA MATERIALS

- .1 Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - .1 Extra Valves: One of each type and size.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- .1 Allied Healthcare Products
- .2 Amico Corporation

- .3 BeaconMedaes
- .4 Tri-Tech Medical

2.2 PIPE AND FITTINGS

- .1 Factory Preparation: Wash inside of copper pipe and copper fitting with hot solution of sodium carbonate or trisodium phosphate mixed 1 lb to 3 gal (1 kg to 25 L) of water; rinse with water, and blow dry with oil-free dry nitrogen or compressed air.
- .2 Oxygen, Compressed Air Systems, Aboveground:
 - .1 Copper Alloy, Corrugated Medical Tubing: Comply with ANSI LC 1/CSA 6.26.
 - .1 Maximum Operating Pressure: 185 psig (1275.5 kPa).
 - .2 Maximum Operating Temperature: 250 degrees F (121 degrees C).
 - .3 Medical Tubing: Comply with ASTM B103/B103M, copper alloy UNS No.C51000.
 - .4 Jacket Material: Low-density FR polyethylene, plenum rated, with maximum flame spread index of 25 and smoke development index of 50. Comply with NFPA 99.
 - .5 Fitting Construction: Yellow brass; copper alloy No.CA360 or equivalent, clean to comply with CGA G-4.1.
 - .6 Fittings: Provided by piping system manufacturer.
 - .7 Manufacturers:
 - .1 OmegaFlex, Inc; MediTrac:
 - .2 Copper Tube: Listed, ASTM B88 (ASTM B88M), Type K (A), annealed.
 - .1 Fittings: ASME B16.18 cast copper or ASME B16.22 wrought copper.
 - .2 Joints: Compression connection or AWS A5.8M/A5.8, BCuP silver braze.
 - .3 Mechanical Press Sealed Fittings: Double-pressed type and approved or certified, utilizing EPDM, nontoxic, synthetic rubber sealing elements.
 - .1 Manufacturers:
 - .1 FNW; Copper Press
 - .3 Copper Tube: ASTM B88 (ASTM B88M), Type K (A), drawn.
 - .4 Copper Tube: ASTM B819, Type K, H58 (drawn general purpose) temper.
 - .5 Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper.
 - .6 Joints: AWS A5.8M/A5.8 Classification BCuP-3 or BCuP-4 silver braze.
- .3 Vacuum Systems, Aboveground:
 - .1 Copper Alloy, Corrugated Medical Tubing: Comply with ANSI LC 1/CSA 6.26.
 - .1 Maximum Operating Pressure: 185 psig (1275.5 kPa).
 - .2 Maximum Operating Temperature: 250 degrees F (121 degrees C).
 - .3 Medical Tubing: Comply with ASTM B103/B103M, copper alloy UNS No.C51000.
 - .4 Jacket Material: Low-density FR polyethylene, plenum rated, with maximum flame spread index of 25 and smoke development index of 50. Comply with NFPA 99.
 - .5 Fitting Construction: Yellow brass; copper alloy No.CA360 or equivalent, clean to comply with CGA G-4.1.
 - .6 Fittings: Provided by piping system manufacturer.
 - .7 Manufacturers:
 - .2 Copper Tube: Listed, ASTM B88 (ASTM B88M), Type K (A), annealed.

- .1 Fittings: ASME B16.18 cast copper or ASME B16.22 wrought copper.
- .2 Joints: Compression connection or AWS A5.8M/A5.8, BCuP silver braze.
- .3 Mechanical Press Sealed Fittings: Double-pressed type and approved or certified, utilizing EPDM, nontoxic, synthetic rubber sealing elements.
 - .1 Manufacturers:
 - .1 FNW; Copper Press
- .3 Copper Tube: ASTM B88 (ASTM B88M), Type L (B), drawn.
- .4 Copper Tube: ASTM B819, Type K, H58 (drawn, general purpose) temper.
- .5 Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper.
- .6 Joints: AWS A5.8M/A5.8 Classification BCuP-3 or BCuP-4 silver braze or {rs\#1}, solder, Grade Sn95.

2.3 VALVES AND REGULATORS

- .1 Factory Preparation for Oxygen Service: Disassemble, clean, degrease, seal, and pack for shipping.
- .2 Ball Valves:
 - .1 Manufacturers:
 - .1 Tri-Tech Medical; _____
 - .2 Requirements: Comply with MSS SP-110; bronze body, three piece, double-seal ball valves with replaceable neoprene or teflon seat and stem seals, for minimum 600 psi (4140 kPa) cold working pressure, flange or union mounting, labeled for intended service.
- .3 Diaphragm Valves (Oxygen, Nitrous Oxide and Nitrogen):
 - .1 MSS SP-88, brass-bodied, packless, diaphragm type with regrinding or renewable seats and disks, for minimum 300 psi (2070 kPa) working pressure.
- .4 Gas Pressure Regulators:
 - .1 Patient Gas Service: Medical air.
 - .1 Adjustable Delivery Pressure: 0 to 100 psi (0 to 690 kPa).
 - .2 Preset Delivery Pressure: 50 to 55 psi (345 to 380 kPa).
 - .2 Non-Patient Gas Service: Instrument air.
 - .1 Adjustable Delivery Pressure: 0 to 200 psi (0 to 1380 kPa).
 - .2 Preset Delivery Pressure: 160 to 185 psi (1103 to 1275 kPa).
 - .3 Maximum Inlet Pressure: 3,000 psi (20684 kPa).
 - .4 Inlet Connection: Nut and nipple.
 - .5 Inlet and Outlet Gages: Dual scale, 2 inch (51 mm) diameter.
 - .6 High pressure chamber with inlet filter and internal re-seating relief valve.
- .5 Gas Flow Regulators:
 - .1 Manufacturers:
 - .1 Tri-Tech Medical; _____:
 - .2 Gas Service: Medical air.
 - .3 Adjustable Delivery Flow: 1/2 to 7 lpm at 50 psi (345 kPa) inlet.
 - .4 Maximum Inlet Pressure: 3,000 psi (20684 kPa).
 - .5 Inlet Gauge: Dual scale flow rate column-indicator.
 - .6 Outlet Gauge: Dual scale, 2 inch (51 mm) diameter flow rate gauge.
 - .7 High pressure chamber with inlet filter and internal re-seating relief valve.

- .8 Provide with integral, flush-mounted control panel.
- .6 Gate Valves (Vacuum, Medical Air, and Anesthesia Gas Evacuation System):
 - .1 MSS SP-80; Class 150 bronze body, bronze trim, rising stem, handwheel, inside screw, solid wedge disc, solder ends.

2.4 PIPING ACCESSORIES

- .1 Hangers and Supports: MSS SP-58 with types as required.
- .2 Pressure Gauges:
 - .1 ASME B40.100, white dials and black lettering with restrictor.
 - .2 Oxygen and nitrous oxide systems: Manufactured and labeled expressly for intended service; UL labeled.
- .3 Vacuum Bottle Brackets: Stainless steel, chrome-plated metal, or aluminum with finish matching adjacent outlet.
- .4 Flexible Connectors: Corrugated flexible, single ply, seamless or seam-welded tubing of stainless steel or bronze or reinforced teflon bellows or hose.
- .5 Valve Cabinets:
 - .1 Extruded aluminum, flush-mounted and rigidly assembled to accommodate valves and fittings, punched or drilled sides to receive tubing, anchors to secure to wall construction.
 - .2 Cover Plates: Extruded aluminum, with replaceable plastic windows with pull ring to remove window.
 - .3 Cabinet Labels: labeled and color coded for intended service and area served.
 - .4 Valves: Pre-assemble and mount chrome plated valves and tubing extensions.
- .6 Piping Identification: Pressure sensitive adhesive tape and decals, color and labeling to comply with Section 22 05 53.

2.5 OUTLETS

- .1 Outlet Units:
 - .1 Manufacturers:
 - .1 Allied Healthcare Products, Inc; _____
 - .2 Amico Corporation; _____
 - .3 BeaconMedaes; _____
 - .4 Tri-Tech Medical; _____
 - .2 CGA V-5 Diameter-Index Safety System (DISS) non-interchangeable connectors, automatic valves, secondary check valves (except vacuum and evacuation outlets), and capped 3/8 inch (8 mm) tubing stubs for supply connections, color coded and labeled for intended service.
- .2 Faceplates:
 - .1 Flush Outlets: Mount in galvanized steel boxes with stainless steel faceplate with polycarbonate cover, color coded with embossed labeling.
 - .2 Surface Outlets: Surface mount with color coded plastic cover and stainless steel faceplate with polycarbonate cover, color coded with embossed labeling.

2.6 MEDICAL COMPRESSED AIR SYSTEM

2.7 MEDICAL VACUUM SYSTEM

2.8 OXYGEN MANIFOLD

2.9 ALARM SYSTEMS

- .1 Manufacturers:
 - .1 Allied Healthcare Products, Inc; _____
 - .2 Amico Corporation; _____
 - .3 BeaconMedaes; _____
 - .4 Tri-Tech Medical; _____
- .2 High-Low Pressure Alarm Panel:
 - .1 Closed circuit, self-monitoring type to monitor single gas such as oxygen, vacuum, compressed air, nitrous oxide, or nitrogen.
 - .2 Green light for system normal.
 - .3 High or low pressure warning:
 - .1 Green light extinguishes.
 - .2 Audible warning device sounds.
 - .3 Red light energizes.
 - .4 Gauge indicates pressure or vacuum.
 - .5 Switch silences warning device.
 - .6 Test switch to test light bulbs and audible warning device.
 - .7 Provide system with internal switches, gauge, control unit, and transformer.
- .3 Multi-Signal High-Low Pressure Alarm Panel:
 - .1 Closed circuit, self-monitoring type to monitor multiple gases such as oxygen, vacuum, compressed air, nitrous oxide, and nitrogen piping systems pressure or liquid level.
 - .2 Green light for systems normal.
 - .3 For abnormal condition:
 - .1 Green light extinguishes.
 - .2 Audible warning device sounds.
 - .3 Red light energizes.
 - .4 Switch silences warning device.
 - .5 Test switch to test light bulbs and audible warning device.
 - .6 Provide system with internal switches, gauges, control unit, and transformer.
 - .7 Design system such that one, two or more monitors may be connected to a single pressure switch.
 - .8 Monitor following abnormal conditions:
 - .1 Oxygen reserve supply in use.
 - .2 Oxygen line pressure high.
 - .3 Oxygen line pressure low.
 - .4 Air line pressure high.
 - .5 Air line pressure low.
 - .6 Air lag pump on.
 - .7 Vacuum line pressure above normal.
 - .8 Vacuum line pressure below normal.
 - .9 High-Low Pressure Switch: Dual circuit with two single pole, double throw, snap action switches, tested at 180 psi (1240 kPa) with adjustable range of 4 psi (26 kPa), preset at 40 psi (276 kPa) and 60 psi (414 kPa).

- .10 Vacuum Switch: _____.
- .4 Zone Pressure Annunciator:
 - .1 Panel with pressure gauge per gas line.
 - .2 Panel with digital pressure gauge with sensor per gas line.
 - .1 LED-based numeric display with alarm buzzer.
 - .2 Self-component test, silence, and programming controls.
 - .3 Internal power supply for digital gauges and sensors.
 - .3 Gas Line:
 - .1 Medical air.
 - .2 Oxygen.
 - .3 Vacuum.
 - .4 Accessories: Backbox, front cover, and customizable color-coded gas labels.
- .5 Digital Gas Pressure Monitor:
 - .1 Type: Display-module with hardwired pressure sensor.
 - .2 Base Module Interface:
 - .1 Numeric display with alarm buzzer.
 - .2 Self-test, silence, and programming controls.
 - .3 Up to six digital numeric-display modules.
 - .3 LED-based alarm level indicator, low to normal, and high.
 - .4 Pressure Modules with Externally Wired Sensors:
 - .1 Medical air.
 - .2 Oxygen.
 - .3 Vacuum.
 - .5 Communications: RS-485.
 - .6 Accessories: Backbox, power supply, and color-coded labels per gas type with units.
- .6 Graphic Gas Pressure Monitor:
 - .1 Display: 10 inch (25.4 cm) minimum, color touchscreen.
 - .2 Capacity: Up to eight gases using hardwired pressure sensors.
 - .3 Audio Alarm: Built-in buzzer with silencing capability.
 - .4 Configurable Display Settings:
 - .1 Date and time using adjustable internal clock.
 - .2 Self-test, silence, and programming controls.
 - .3 Adjustable background with sleep mode.
 - .4 Specific gas name, location, level, and alarm status.
 - .5 Customizable gas engineering units.
 - .6 Alarm event storage memory with filtering controls.
 - .5 Remote Pressure Sensors:
 - .1 Patient Gas Service:
 - .1 Medical air.
 - .2 Proportioned air.
 - .3 Oxygen.
 - .2 Vacuum Service:
 - .1 Medical vacuum.

- .6 Master Alarm Events:
 - .1 Gas manifold changeover status.
 - .2 Gas manifold or supply source changeover early warning.
 - .3 Liquid oxygen system reaches average daily supply level.
 - .4 Line pressure above or below 20 percent supply pressure setting.
- .7 Alarm routing to cell phone, email, and text message.
- .8 Communications: Ethernet (10 Mbps) per IEEE 802.3 using external module.
- .9 Accessories: Backbox, power supply, and computer interface port.
- .10 Interconnectivity: Provide unit ready for remote access using integrated automation system linked using compatible communication protocol, see Section 25 15 00.

PART 3 EXECUTION

3.1 INSTALLATION

- .1 Install in accordance with NFPA 99 applying system specific piping service font and tag colors.
- .2 Pre-Installation Cleaning: Disassemble positive pressure gas systems pipe, fittings, valves, and components, except those supplied cleaned and prepared for intended service, and thoroughly wash in hot solution of sodium carbonate or trisodium phosphate mixed 1 lb to 3 gal (1 kg to 25 L) of water. After washing, rinse with water, dry and cap until installation.
- .3 Braze joints in pipe and tubing. Avoid leaving excess flux inside of pipe and fittings. During brazing of pipe connections, purge interior of pipe continuously with nitrogen.
- .4 Effect changes in size with reducing fittings. Make changes in direction of required turns or offsets with fittings or tubing shaped by bending tools. Make bends free of flattening, buckling or thinning of tube wall.
- .5 Cut pipe and tubing accurately and install without springing or forcing.
- .6 Install exposed oxygen piping in wall-mounted sheet steel raceways and junction boxes.
- .7 Encase buried oxygen piping in cast-iron pipe. Provide with FM listed heat trace with fixed temperature regulation, set for 80 degrees F (27 degrees C) maximum, and terminating at junction box, mounted near main oxygen supply shut-off valve. Insulate buried oxygen lines and heat trace with insulation; see Section 22 07 19.
- .8 Grade piping down in direction of flow.
- .9 Provide pipe sleeves where pipes and tubing pass through walls, floors, roofs, and partitions. Finish flush at both ends. Extend 2 inches (50 mm) above finished floors. Pack space between pipe or tubing and sleeve, and caulk.
- .10 Identify piping with tape and decals. Provide piping identification code and schematic for installation under provisions of Section 22 05 53. Install labeling on pipe at intervals of not more than 20 feet (6 m) and at least once in each room and each story traversed by pipeline.
- .11 Excavate and backfill pipe trenches; see Section 31 23 16 and Section 31 23 23. Coordinate provision of utility warning and identification tape with backfill operation. Provide utility warning and identification tape above buried lines at depth of 8 to 12 inches (200 to 300 mm) below finish grade.
- .12 Pipe Support; Space pipe hangers horizontally by pipe size or vertically as follows:
 - .1 1/4 inch (8 mm, DN) 5 feet (1520 mm).
 - .2 3/8 inch (10 mm, DN) 6 feet (1830 mm).
 - .3 1/2 inch (15 mm, DN) 6 feet (1830 mm).
 - .4 3/4 inch (20 mm, DN) 7 feet (2130 mm).
 - .5 1 inch (25 mm, DN) 8 feet (2440 mm).

- .6 1-1/4 inch (32 mm, DN) 9 feet (2740 mm).
- .7 1-1/2 inch (40 mm, DN) and larger 10 feet (3050 mm).
- .8 Vertical risers, any size, every floor 15 feet (4070 mm), do not exceed listed spacing.
- .13 Except where indicated or in flush wall mounted cabinets, install manual shut off valves with stem vertical and accessible for operation and maintenance.
- .14 Install strainers on inlet side of pressure-reducing valves. Provide pressure-reducing or flow-control gas valves with bypasses and isolation valves to permit maintenance without interruption of gas.
- .15 Provide valved bypass around receivers.
- .16 Vibration and Noise Isolation: See Section 22 05 48.
- .17 Medical Air Compressor Systems: Isolate systems including receivers, dryers, and filters until after completion and approval of purity tests for compressed air system. Tie-in at flange or union joint.
- .18 Provide electric motor drive, equipment and associated wiring; see Section 26 05 83.

3.2 CONNECTIONS

3.3 FIELD QUALITY CONTROL

- .1 Independent testing agency to certify system is complete, zone valves installed, alarm systems functional, and tests performed. Document tests and submit.
- .2 Reduce pressure in piping systems other than system under investigation to atmospheric.
- .3 Test system with dry compressed air or dry nitrogen with test pressure in piping system at 50 psi (345 kPa).
- .4 Check each station outlet of every piping system to determine test gas is dispensed only from outlet of system under investigation. Measure pressure with gauge attached to specific adaptor. Do not use universal adaptors.
- .5 Disconnect test gas and connect proper gas to each system. Purge entire system to remove test gas. Check with analyzer suitable for gas installed.

3.4 PIPING SYSTEMS CLEANING AND PRESSURE TESTING

- .1 After erection of pipe and tubing but prior to installation of service outlet valves, blow systems clear of free moisture and foreign matter with nitrogen gas.
- .2 Install service outlet valves; subject system to test pressure of 150 psi (1034 kPa) with nitrogen or dry compressed air. Check with soapy water. Provide 24-hour standing pressure test.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- .1 Area Alarm Panels.
- .2 Local Alarm Panels.
- .3 Computer-Interface Cabinet.

1.2 GENERAL REFERENCES

- .1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.
- .2 Division 20, including all Common Mechanical Requirements in Section 20 00 00, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.

1.3 RELATED REQUIREMENTS

1.4 DEFINITIONS

- .1 Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

1.5 SUBMITTALS

- .1 Action Submittals
 - .1 Product Data: For each type of product.
 - .2 Shop Drawings: Include diagrams for power, signal, and control wiring.
 - .3 Qualification Data: For Installer.
 - .4 Product Test Reports: For each alarm panel, for tests performed by a qualified testing agency.
 - .5 Field quality-control reports.
- .2 Operation and Maintenance Materials
 - .1 Operation and Maintenance Data: For alarm panels and computer-interface cabinet to include in emergency, operation, and maintenance manuals.

1.6 WARRANTIES

1.7 QUALITY ASSURANCE

- .1 Installer Qualifications: Qualify Installers for air, vacuum, and gas piping systems for healthcare facilities according to ASSE 6010 for medical-gas-system installers.
- .2 Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the air, vacuum, and gas piping testing indicated, that is a member of the Medical Gas Professional Healthcare Organization or is an NRTL, and that is acceptable to authorities having jurisdiction.
 - .1 Qualify testing personnel for air, vacuum, and gas piping systems for healthcare facilities according to ASSE 6020 for medical-gas-system inspectors and ASSE 6030 for medical-gas-system verifiers.

PART 2 PRODUCTS

2.1 GENERAL

- .1 System Description

- .1 Gas and Vacuum Systems Monitored:
 - .1 Medical compressed air, designated "medical air."
 - .2 Medical-surgical vacuum, designated "medical vacuum."
 - .3 Oxygen, designated "medical oxygen."
- .2 Manufacturers
 - .1 Allied Healthcare Products Inc.
 - .2 Amico Corporation.
 - .3 BeaconMedaes.
 - .4 Ohio Medical Corporation.
 - .5 Tri-Tech Medical.
 - .6 Source Limitations: Obtain medical alarm systems and components from single manufacturer.
- .3 General Requirements for Alarm Panels
 - .1 Description: Factory wired with audible and color-coded visible signals to indicate specified functions.
 - .1 Mounting: Exposed, surface installation.
 - .2 Enclosures: Fabricated from minimum 0.047 inch (1.2 mm) thick steel or minimum 0.05 inch (1.27 mm) thick aluminum, with knockouts for electrical and piping connections.
 - .2 Components: Designed for continuous service and to operate on power supplied from 120 -V ac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices. Include step-down transformers if required.
 - .3 Dew Point Monitors: Continuous line monitoring, having panel with gage or digital display, pipeline sensing element, electrical connections for alarm system, factory- or field-installed valved bypass, and visual and cancelable audio signal for dryer site and master alarm panels. Alarm signals when pressure dew point rises above 39 deg F (4 deg C) at 55 psig (380 kPa) .
 - .1 Operation: Chilled-mirror method.
 - .4 Pressure Switches or Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.
 - .1 Low-Pressure Operating Range: 0 to 100 psig (0 to 690 kPa) .
 - .2 High-Pressure Operating Range: Up to 250 psig (1725 kPa).
 - .5 Carbon-Monoxide Monitors: Panel with gage or digital display, pipeline sensing element, electrical connections for alarm system, and factory- or field-installed valved bypass. Alarm signals when carbon-monoxide level rises above 10 ppm.
 - .6 Vacuum Switches or Pressure Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.
 - .1 Vacuum Operating Range: 0 to 30 in. Hg (0 to 760 mm Hg) .

2.2 AREA ALARM PANELS

- .1 Area Alarm Panels: Separate trouble alarm signals and indicators for each system.
 - .1 Standards: Comply with NFPA 99 and UL 544.
 - .2 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.
 - .3 Include alarm signals when the following condition exists:

- .1 Medical Air: Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa).
- .2 Medical Vacuum: Vacuum drops below 12 in. Hg (305 mm Hg) .
- .3 Medical Oxygen: Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa) .

2.3 LOCAL ALARM PANELS

- .1 Local Alarm Panels: Separate trouble alarm signals and indicators for each system.
 - .1 Standards: Comply with NFPA 99 and UL 544.
 - .2 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.
 - .3 Include alarm signals when the following conditions exist:
 - .1 Medical Air: Pressure drops below 40 psig (275 kPa) or rises above 60 psig (415 kPa) , backup air compressor is in operation, pressure drop across filter assembly increases more than 2 psig (13.8 kPa) , dew point rises above 39 deg F (3.9 deg C) at 55 psig (380 kPa), carbon-monoxide level rises above 10 ppm, and the following:
 - .2 Medical Vacuum: Vacuum drops below 12 in. Hg (305 mm Hg) , backup vacuum producer is in operation, and high water level is in receiver.

2.4 COMPUTER-INTERFACE CABINET

- .1 Description:
 - .1 Wall-mounted, welded-steel, control cabinet with gasketed door.
 - .2 Mounting brackets.
 - .3 Grounding device.
 - .4 White-enamel finish.
 - .5 Factory-installed signal circuit boards.
 - .6 Power transformer.
 - .7 Circuit breaker.
 - .8 Wiring terminal board, and internal wiring capable of interfacing 20 alarm signals.

PART 3 EXECUTION

3.1 ALARM-PANEL INSTALLATION

- .1 Install alarm panels in locations required by and according to NFPA 99.
- .2 Install computer-interface cabinet with connection to alarm panels and facility computer.

3.2 CONNECTIONS

- .1 Comply with requirements for piping specified in Division 22 Section 22 61 13 "Compressed-Air Piping for Laboratory and Healthcare Facilities," Division 22 Section 22 61 13 "Vacuum Piping for Laboratory and Healthcare Facilities," and Division 22 Section 22 63 13 "Gas Piping for Laboratory and Healthcare Facilities." Drawings indicate general arrangement of piping, fittings, and specialties.
- .2 Where installing piping adjacent to alarm panels, allow space for service and maintenance.

3.3 FIELD QUALITY CONTROL

- .1 Testing Agency: Engage a qualified testing agency to perform tests and inspections.

- .2 Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- .3 Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - .1 Perform each visual and mechanical inspection.
 - .2 Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.
 - .3 Test and adjust controls and safeties. Replace damaged and malfunctioning panels and equipment.
- .4 Alarm panels will be considered defective if they do not pass tests and inspections.
- .5 Prepare test and inspection reports.

3.4 START UP SERVICE

- .1 Engage a factory-authorized service representative to perform Perform startup service.
 - .1 Complete installation and startup checks according to manufacturer's written instructions.

3.5 IDENTIFICATION

- .1 Identify system components. Comply with requirements for identification specified in Division 20 Section 20 05 53 "Mechanical Identification" and according to NFPA 99.

3.6 ADJUSTING

- .1 Adjust initial alarm panel pressure and vacuum set points.

3.7 DEMONSTRATION AND TRAINING

- .1 Engage a factory-authorized service representative to Train Owner's maintenance personnel to adjust, operate, and maintain alarm panels.

END OF SECTION

PART 1 GENERAL

1.1 GENERAL REFERENCES

- .1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.
- .2 Division 20, including all Common Mechanical Requirements in Section 20 00 00, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.

1.2 COORDINATION

- .1 Divisions 20, 21, 22 and 23 are used to communicate the requirements for the total Mechanical scope of work. It is intended for these four Divisions to serve as a single document, communicating the Mechanical scope of work.
- .2 Division 20 Specifications serve as common Mechanical requirements that apply to all Division 21, 22, and 23 Specifications and Scope of Work.
- .3 All requirements of Division 20 Specifications shall apply to all Division 23 Specifications and Scope of Work, unless noted otherwise.

1.3 SCOPE OF WORK

- .1 It is intended for the Division 20 Specifications to serve as common requirements that apply to all Division 21, 22, and 23 Specifications and Scope of Work. All requirements of the Division 20 Specifications shall apply to all Division 23 Specifications and Scope of Work, unless noted otherwise.
- .2 It is intended for the Division 20, 21, 22, 23 scope of work to include complete and functional Mechanical systems - including all required materials, labor, equipment, and services necessary to achieve the desired final product. It is further intended for the Division 23 scope of work to include coordination with Divisions 21 and 22 for complete Fire Protection, Plumbing, and HVAC systems.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- .1 HVAC Cleaning Agents.
- .2 Antimicrobial Surface Treatment.

1.2 GENERAL REFERENCES

- .1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.
- .2 Division 20, including all Common Mechanical Requirements in Section 20 00 00, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.

1.3 RELATED REQUIREMENTS

- .1 Section 20 05 00 - Common Work Results for Mechanical.
- .2 Division 20 Section 20 05 93 "Testing, Adjusting, Balancing for HVAC" for system flow documentation before cleaning and balancing and following cleaning and restoration.
- .3 Division 23 Section 23 31 13 "Metal Ducts" for cleaning newly installed metal ducts.
- .4 Division 23 Section 23 31 16 "Nonmetal Ducts" for cleaning newly installed nonmetal ducts.
- .5 Division 23 Section 23 33 00 "Air Duct Accessories" for restoration of opened ducts and plenums with access doors.

1.4 ABBREVIATIONS AND ACRONYMS

- .1 ACAC: American Council for Accredited Certification.
- .2 AIHA-LAP: American Industrial Hygiene Association Lab Accreditation Program
- .3 ASCS: Air systems cleaning specialist.
- .4 CESB: Council of Engineering and Scientific Specialty Boards.
- .5 CMI: Certified Microbial Investigator.
- .6 CMC: Certified Microbial Consultant.
- .7 CMR: Certified Microbial Remediator.
- .8 CMRS: Certified Microbial Remediation Supervisor.
- .9 EMLAP: Environmental Microbiology Laboratory Accreditation Program.
- .10 IEP: Indoor Environmental Professional.
- .11 IICRC: Institute of Inspection, Cleaning, and Restoration Certification.
- .12 NADCA: National Air Duct Cleaners Association.

1.5 SUBMITTALS

- .1 Action Submittals
 - .1 Product Data:
 - .1 Cleaning agents
 - .2 Antimicrobial surface treatments
 - .3 Adhesives and sealants
 - .2 Qualification Data:
 - .1 For an ASCS.
 - .2 For an IEP.
 - .3 For a CMR and a CMRS.

- .3 Field Quality-Control Reports:
 - .1 Project's existing conditions.
 - .2 Evaluations and recommendations, including cleanliness verification.
 - .3 Strategies and procedures plan.
- .4 Post-Project report.
- .2 LEED Submittals
 - .1 Product Data: For adhesives and sealants, indicating VOC content.
 - .2 Laboratory Test Reports: For adhesives and sealants, indicating compliance with requirements for low-emitting materials.

1.6 QUALITY ASSURANCE

- .1 ASCS Qualifications: A certified member of NADCA ACR .
 - .1 Certification: Employ an ASCS certified by NADCA on a full-time basis.
 - .2 Supervisor Qualifications: Certified as an ASCS by NADCA ACR.
- .2 IEP Qualifications: CMI who is certified by ACAC and accredited by CESB.
- .3 IEP Qualifications: CMC who is certified by ACAC and accredited by CESB.
- .4 CMR Qualifications: Certified by ACAC and accredited by CESB.
- .5 CMRS Qualifications: Certified by ACAC and accredited by CESB.
- .6 UL Compliance: Comply with UL 181 and UL 181A for fibrous-glass ducts.
- .7 Cleaning Conference: Conduct conference at Project site.
 - .1 Review methods and procedures related to HVAC air-distribution system cleaning, including, but not limited to, review of the cleaning strategies and procedures plan.

1.7 SUMMARY DESCRIPTION

- .1 Section includes cleaning existing HVAC air-distribution equipment, ducts, plenums, and system components.

PART 2 PRODUCTS

2.1 HVAC CLEANING AGENTS

- .1 Manufacturers:
 - .1 Apex Engineering Products Corporation.
 - .2 BBJ Environmental Solutions.
 - .3 Goodway Technologies Corporation.
 - .4 Nu-Calgon.
 - .5 QuestVapco Corporation.
- .2 Description:
 - .1 Formulated for each specific soiled coil condition that needs remedy.
 - .2 Will not corrode or tarnish aluminum, copper, or other metals.

2.2 ANTIMICROBIAL SURFACE TREATMENT

- .1 Manufacturers:
 - .1 Bio-Cide International, Inc.
 - .2 Contec, Inc.
 - .3 Ecolab, Inc.
- .2 Description: Specific product selected shall be as recommended by the IEP based on the specific antimicrobial needs of the specific Project conditions.

- .1 Formulated to kill and inhibit growth of microorganisms.
- .2 EPA-registered for use in HVAC systems and for the specific application in which it will be used.
- .3 Have no residual action after drying, with zero VOC off-gassing.
- .4 OSHA compliant.
- .5 Treatment shall dry clear to allow continued visual observation of the treated surface.

PART 3 EXECUTION

3.1 EXAMINATION

- .1 Inspect HVAC air-distribution equipment, ducts, plenums, and system components to determine appropriate methods, tools, and equipment required for performance of the Work.
- .2 Perform "Project Evaluation and Recommendation" according to NADCA ACR.
- .3 Cleaning Plan: Prepare a written plan for air-distribution system cleaning that includes strategies and step-by-step procedures. At a minimum, include the following:
 - .1 Supervisor contact information.
 - .2 Work schedule, including location, times, and impact on occupied areas.
 - .3 Methods and materials planned for each HVAC component type.
 - .4 Required support from other trades.
 - .5 Equipment and material storage requirements.
 - .6 Exhaust equipment setup locations.
- .4 Existing Conditions Report: Prepare a written report that documents existing conditions of the systems and equipment. Include documentation of existing conditions, including inspection results, photo images, laboratory results, and interpretations of the laboratory results by an IEP.
 - .1 Prepare written report listing conditions detrimental to performance of the Work.
- .5 Proceed with work only after conditions detrimental to performance of the Work have been corrected.
- .6 Use the existing service openings, as required for proper cleaning, at various points of the HVAC system for physical and mechanical entry and for inspection.
- .7 Comply with NADCA ACR, "Guidelines for Constructing Service Openings in HVAC Systems" Section.
- .8 Mark the position of manual volume dampers and air-directional mechanical devices inside the system prior to cleaning.

3.2 CLEANING

- .1 Comply with NADCA ACR, including items identified as "recommended," "advised," and "suggested."
- .2 Perform electrical lockout and tagout according to Owner's standards or authorities having jurisdiction.
- .3 Remove non-adhered substances and deposits from within the HVAC system.
- .4 Complete cleaning in accordance with Owner-Contractor agreed-upon scope of work.
- .5 Systems and Components to Be Cleaned: All air-moving and -distribution equipment.
- .6 Systems and Components to Be Cleaned:
 - .1 Air devices for supply and return air.
 - .2 Air-terminal units and connections.
 - .1 VAV boxes.

- .2 Chilled beams.
- .3 Fan coil units.
- .4 Unit ventilators.
- .5 Flexible connectors.
- .3 Ductwork:
 - .1 Supply-air ducts, including turning vanes and reheat coils, to the air-handling unit.
 - .2 Return-air ducts to the air-handling unit.
 - .3 Exhaust-air ducts.
 - .4 Transfer ducts.
- .4 Casings.
- .5 Duct-mounted coils.
- .6 Air-Handling Units:
 - .1 Interior surfaces of the unit casing.
 - .2 Coil surfaces compartment.
 - .3 Condensate drain pans.
 - .4 Fans, fan blades, and fan housings.
- .7 Exhaust fans and power ventilators.
- .8 Filters and filter housings.
- .9 Gravity ventilators.
- .10 Air-to-air heat exchangers.
- .7 Collect debris removed during cleaning. Ensure that debris is not dispersed outside the HVAC system during the cleaning process.
- .8 Particulate Collection:
 - .1 For particulate collection equipment, include adequate filtration to contain debris removed. Locate equipment downwind and away from all air intakes and other points of entry into the building.
 - .2 HEPA filtration with 99.97 percent collection efficiency for particles sized 0.3 micrometer or larger shall be used where the particulate collection equipment is exhausting inside the building,
- .9 Control odors and mist vapors during the cleaning and restoration process.
- .10 Mark the position of manual volume dampers and air-directional mechanical devices inside the system prior to cleaning. Restore them to their marked position on completion of cleaning.
- .11 System components shall be cleaned so that all HVAC system components are visibly clean. On completion, all components must be returned to those settings recorded just prior to cleaning operations.
- .12 Clean all air-distribution devices, registers, grilles, and diffusers.
- .13 Clean non-adhered substance deposits according to NADCA ACR and the following:
 - .1 Clean air-handling units, airstream surfaces, components, condensate collectors, and drains.
 - .2 Ensure that a suitable operative drainage system is in place prior to beginning wash-down procedures.
 - .3 Clean evaporator coils, reheat coils, and other airstream components.
- .14 Air-Distribution Systems:
 - .1 Create service openings in the HVAC system as necessary to accommodate cleaning.

- .2 Mechanically clean air-distribution systems specified to remove all visible contaminants, so that the systems are capable of passing the HVAC System Cleanliness Tests (see NADCA ACR).
- .15 Debris removed from the HVAC system shall be disposed of according to applicable Federal, state, and local requirements.
- .16 Mechanical Cleaning Methodology:
 - .1 Source-Removal Cleaning Methods: The HVAC system shall be cleaned using source-removal mechanical cleaning methods designed to extract contaminants from within the HVAC system and to safely remove these contaminants from the facility. No cleaning method, or combination of methods, shall be used that could potentially damage components of the HVAC system or negatively alter the integrity of the system.
 - .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.
 - .2 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.
 - .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).
 - .3 Fibrous materials that become wet shall be discarded and replaced.
- .17 Coil Cleaning:
 - .1 See NADCA ACR, "Coil Surface Cleaning" Section. Type 1, or Type 1 and Type 2, cleaning methods shall be used to render the coil visibly clean and capable of passing coil cleaning verification.
 - .2 Coil drain pans shall be subject to NADCA ACR, "Non-Porous Surfaces Cleaning Verification." Ensure that condensate drain pans are operational.
 - .3 Electric-resistance coils shall be de-energized, locked out, and tagged before cleaning.
 - .4 Cleaning methods shall not cause any appreciable damage to, cause displacement of, inhibit heat transfer, or cause erosion of the coil surface or fins, and shall comply with coil manufacturer's written recommendations.
 - .5 Rinse thoroughly with clean water to remove any latent residues.
- .18 Application of Antimicrobial Treatment:
 - .1 Apply antimicrobial agents and coatings if active fungal growth is determined by the IEP to be at Condition 2 or Condition 3 status according to IICRC S520, as analyzed by a laboratory accredited by AIHA-LAP with an EMLAP certificate, and with results interpreted by an IEP. Apply antimicrobial agents and coatings according to manufacturer's written recommendations and EPA registration listing after the removal of surface deposits and debris.
 - .2 Apply antimicrobial treatments and coatings after the system is rendered clean.
 - .3 Apply antimicrobial agents and coatings directly onto surfaces of interior ductwork.

- .4 Microbial remediation shall be performed by a qualified CMR and CMRS.

3.3 CLEANLINESS VERIFICATION

- .1 Verify cleanliness according to NADCA ACR, "Verification of HVAC System Cleanliness" Section.
- .2 Verify HVAC system cleanliness after mechanical cleaning and before applying any treatment or introducing any treatment-related substance to the HVAC system, including biocidal agents and coatings.
- .3 Surface-Cleaning Verification: Perform visual inspection for cleanliness. If no contaminants are evident through visual inspection, the HVAC system shall be considered clean. If visible contaminants are evident through visual inspection, those portions of the system where contaminants are visible shall be re-cleaned and subjected to re-inspection for cleanliness.
- .4 Verification of Coil Cleaning:
- .1 Measure static-pressure differential across each coil.
- .2 Coil will be considered clean if cleaning restored the coil static-pressure differential within 10 percent of the differential when the coil was first installed.
- .5 Verification of Coil Cleaning: Coil will be considered clean if the coil is free of foreign matter and chemical residue, based on a thorough visual inspection.
- .6 Additional Verification:
- .1 Perform surface comparison testing or NADCA vacuum test.
- .2 Conduct NADCA vacuum gravimetric test analysis for nonporous surfaces.
- .7 Prepare a written cleanliness verification report. At a minimum, include the following:
- .1 Written documentation of the success of the cleaning.
- .2 Site inspection reports, initialed by supervisor, including notation on areas of inspection, as verified through visual inspection.
- .3 Surface comparison test results if required.
- .4 Gravimetric analysis (nonporous surfaces only).
- .5 System areas found to be damaged.
- .8 Photographic Documentation: Comply with requirements in Division 01 Section 01 32 33 "Photographic Documentation."

3.4 RESTORATION

- .1 Restore and repair HVAC air-distribution equipment, ducts, plenums, and components according to NADCA ACR, "Restoration and Repair of Mechanical Systems" Section.
- .2 Restore service openings capable of future reopening. Comply with requirements in Division 23 Section 23 31 13 "Metal Ducts."
- .3 Reseal fibrous-glass ducts. Comply with requirements in Division 23 Section 23 31 16 "Nonmetal Ducts."
- .4 Replace fibrous-glass materials that cannot be restored by cleaning or resurfacing. Comply with requirements in Division 23 Section 23 31 16 "Nonmetal Ducts."
- .5 Replace damaged insulation according to Division 20 Section 20 07 00 "Mechanical Insulation."
- .6 Ensure that closures do not hinder or alter airflow.
- .7 New closure materials, including insulation, shall match opened materials and shall have removable closure panels fitted with gaskets and fasteners.
- .8 Restore manual volume dampers and air-directional mechanical devices inside the system to their marked position on completion of cleaning.
- .9 Measure air flows through air-distribution system.

- .10 Measure static-pressure differential across each coil.

3.5 PROJECT CLOSEOUT

- .1 Post-Project Report:
 - .1 Post-cleaning laboratory results if any.
 - .2 Post-cleaning photo images.
 - .3 Post-cleaning verification summary.
- .2 Drawings:
 - .1 Deviations of existing system from Owner's record drawings.
 - .2 Location of service openings.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- .1 Bronze Angle Valves.
 - .1 Class 125 with Bronze Disc.
 - .2 Class 125 with Nonmetallic Disc.
 - .3 Class 150 with Bronze Disc.
 - .4 Class 150 with Nonmetallic Disc.
- .2 Brass Ball Valves.
 - .1 One-Piece, Reduced-Port with Brass Trim.
 - .2 Two-Piece, Full-Port with Brass Trim.
 - .3 Two-Piece, Full-Port with Stainless-Steel Trim.
 - .4 Two-Piece, Regular-Port with Brass Trim.
 - .5 Two-Piece, Regular-Port with Stainless-Steel Trim.
 - .6 Three-Piece, Full-Port with Brass Trim.
 - .7 Three-Piece, Full-Port with Stainless-Steel Trim.
- .3 Bronze Ball Valves
 - .1 One-Piece, Reduced-Port with Bronze Trim.
 - .2 One-Piece, Reduced-Port with Stainless-Steel Trim.
 - .3 Two-Piece, Full-Port with Bronze Trim.
 - .4 Two-Piece, Full-Port with Stainless-Steel Trim.
 - .5 Two-Piece, Regular-Port with Bronze Trim.
 - .6 Two-Piece, Regular-Port with Stainless-Steel Trim.
 - .7 Three-Piece, Full-Port with Bronze Trim.
 - .8 Three-Piece, Full-Port with Stainless-Steel Trim.
- .4 Iron Ball Valves.
 - .1 Class 125.
- .5 Iron, Single-Flange Butterfly Valves.
 - .1 150 CWP with EPDM Seat and Aluminum-Bronze Disc.
 - .2 150 CWP with NBR Seat and Aluminum-Bronze Disc.
 - .3 150 CWP with EPDM Seat and Ductile-Iron Disc.
 - .4 150 CWP with NBR Seat and Ductile-Iron Disc.
 - .5 150 CWP with EPDM Seat and Stainless-Steel Disc.
 - .6 150 CWP with NBR Seat and Stainless-Steel Disc.
 - .7 200 CWP with EPDM Seat and Aluminum-Bronze Disc.
 - .8 200 CWP with EPDM Seat and Aluminum-Bronze Disc.
 - .9 200 CWP with EPDM Seat and Ductile-Iron Disc.
 - .10 200 CWP with NBR Seat and Ductile-Iron Disc.
 - .11 200 CWP with EPDM Seat and Stainless-Steel Disc.
 - .12 200 CWP with NBR Seat and Stainless-Steel Disc.
- .6 Iron, Grooved-End Butterfly Valves.
 - .1 175 CWP.
 - .2 300 CWP.

- .7 High-Performance Butterfly Valves.
 - .1 Class 150, Single-Flange.
 - .2 Class 300, Single-Flange.
- .8 Bronze Lift Check Valves.
 - .1 Class 125 with Bronze Disc.
 - .2 Class 125 with Nonmetallic Disc.
- .9 Bronze Swing Check Valves.
 - .1 Class 125 with Bronze Disc.
 - .2 Class 125 with Nonmetallic Disc.
 - .3 Class 150 with Bronze Disc.
 - .4 Class 150 with Nonmetallic Disc.
- .10 Iron Swing Check Valves.
 - .1 Class 125 with Metal Seats.
 - .2 Class 125 with Nonmetallic-to-Metal Seats.
 - .3 Class 250 with Metal Seats.
- .11 Iron Swing Check Valves with Closure Control.
 - .1 Class 125 with Lever- and Spring-Closure Control.
 - .2 Class 125 with Lever- and Weight-Closure Control.
- .12 Iron, Grooved-End Swing Check Valves.
 - .1 300 CWP.
- .13 Iron, Center-Guided Check Valves.
 - .1 Class 125, Compact-Wafer, with Metal Seat.
 - .2 Class 125, Globe, with Metal Seat.
 - .3 Class 150, Compact-Wafer, with Metal Seat.
 - .4 Class 150, Globe, with Metal Seat.
 - .5 Class 250, Compact-Wafer, with Metal Seat.
 - .6 Class 250, Globe, with Metal Seat.
 - .7 Class 300, Compact-Wafer, with Metal Seat.
 - .8 Class 300, Globe, with Metal Seat.
 - .9 Class 125, Compact-Wafer, with Resilient Seat.
 - .10 Class 125, Globe, with Resilient Seat.
 - .11 Class 150, Compact-Wafer, with Resilient Seat.
 - .12 Class 150, Globe, with Resilient Seat.
 - .13 Class 250, Compact-Wafer, with Resilient Seat.
 - .14 Class 250, Globe, with Resilient Seat.
 - .15 Class 300, Compact-Wafer, with Resilient Seat.
 - .16 Class 300, Globe, with Resilient Seat.
- .14 Iron, Plate-Type Check Valves.
 - .1 Class 125, Dual-Plate with Metal Seat.
 - .2 Class 150, Dual-Plate with Metal Seat.
 - .3 Class 250, Dual-Plate with Metal Seat.
 - .4 Class 300, Dual-Plate with Metal Seat.
 - .5 Class 125, Single-Plate with Resilient Seat.

- .6 Class 125, Dual-Plate with Resilient Seat.
- .7 Class 150, Dual-Plate with Resilient Seat.
- .8 Class 250, Wafer, Single-Plate with Resilient Seat.
- .9 Class 250, Dual-Plate with Resilient Seat.
- .10 Class 300, Dual-Plate with Resilient Seat.
- .15 Bronze Gate Valves.
 - .1 Class 125, NRS.
 - .2 Class 125, RS.
 - .3 Class 150, NRS.
 - .4 Class 150, RS.
- .16 Iron Gate Valves.
 - .1 Class 125, NRS.
 - .2 Class 125, OS&Y.
 - .3 Class 250, NRS.
 - .4 Class 250, OS&Y.
- .17 Bronze Globe Valves.
 - .1 Class 125 with Bronze Disc.
 - .2 Class 125 with Nonmetallic Disc.
 - .3 Class 150 with Nonmetallic Disc.
- .18 Iron Globe Valves.
 - .1 Class 125.
 - .2 Class 250.
- .19 Lubricated Plug Valves.
 - .1 Class 125, Regular-Gland with Threaded Ends.
 - .2 Class 125, Regular-Gland with Flanged Ends.
 - .3 Class 125, Cylindrical with Threaded Ends.
 - .4 Class 125, Cylindrical with Flanged Ends.
 - .5 Class 250, Regular-Gland with Threaded Ends.
 - .6 Class 250, Regular-Gland with Flanged Ends.
 - .7 Class 250, Cylindrical with Threaded Ends.
 - .8 Class 250, Cylindrical with Flanged Ends.
- .20 Eccentric Plug Valves.
 - .1 175 CWP with Resilient Seating.
- .21 Drain Valves.
- .22 Chainwheels.

1.2 GENERAL REFERENCES

- .1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.
- .2 Division 20, including all Common Mechanical Requirements in Section 20 00 00, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.

1.3 RELATED REQUIREMENTS

- .1 Section 07 84 00 - Firestopping.
- .2 Section 08 31 00 - Access Doors and Panels.
- .3 Section 23 05 48 - Vibration and Seismic Controls for HVAC.
- .4 Section 23 05 53 - Identification for HVAC Piping and Equipment.
- .5 Section 23 07 16 - HVAC Equipment Insulation.
- .6 Section 23 07 19 - HVAC Piping Insulation.
- .7 Section 23 21 13 - Hydronic Piping.
- .8 Section 23 22 13 - Steam and Condensate Heating Piping.

1.4 ABBREVIATIONS AND ACRONYMS

- .1 CWP: Cold working pressure.
- .2 EPDM: Ethylene propylene copolymer rubber.
- .3 NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- .4 NRS: Nonrising stem.
- .5 OS&Y: Outside screw and yoke.
- .6 PTFE: Polytetrafluoroethylene.
- .7 RS: Rising stem.
- .8 TFE: Tetrafluoroethylene.
- .9 WOG: Water, oil, and gas.
- .10 WSP: Working steam pressure.

1.5 SUBMITTALS

- .1 Action Submittals
 - .1 Product Data: Provide data on valves including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.
- .2 Operation and Maintenance Materials
 - .1 Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts listings.

1.6 QUALITY ASSURANCE

- .1 Welding Materials and Procedures: Comply with ASME BPVC-IX.

1.7 DELIVERY, STORAGE AND HANDLING

- .1 Prepare valves for shipping as follows:
 - .1 Minimize exposure of operable surfaces by setting plug and ball valves to open position.
 - .2 Protect valve parts exposed to piped medium against rust and corrosion.
 - .3 Valve Actuator Types:
 - .4 Protect valve piping connections such as grooves, weld ends, threads, and flange faces.
 - .5 Adjust globe, gate, and angle valves to the closed position to avoid clattering.
 - .6 Secure check valves in either the closed position or open position.
 - .7 Adjust butterfly valves to closed or partially closed position.
- .2 Use the following precautions during storage:
 - .1 Maintain valve end protection and protect flanges and specialties from dirt.

- .1 Provide temporary inlet and outlet caps.
 - .2 Maintain caps in place until installation.
- .2 Store valves in shipping containers and maintain in place until installation.
 - .1 Store valves indoors in dry environment.
 - .2 Store valves off the ground in watertight enclosures when indoor storage is not an option.
- .3 Exercise the following precautions for handling:
 - .1 Handle large valves with sling, modified to avoid damage to exposed parts.
 - .2 Avoid the use of operating handles or stems as rigging or lifting points.

1.8 EXTRA MATERIALS

- .1 Furnish Owner with one wrench for every five plug valves, in each size of square plug valve head.

PART 2 PRODUCTS

2.1 GENERAL

- .1 Refer to valve schedule articles for applications of valves.
- .2 Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- .3 If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.
- .4 Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.
- .5 Valve Sizes: Same as upstream piping unless otherwise indicated.
- .6 Valve Actuator Types:
 - .1 Gear Actuator: For quarter-turn valves NPS 8 (DN 200) and larger.
 - .2 Handwheel: For valves other than quarter-turn types.
 - .3 Handlever: For quarter-turn valves NPS 6 (DN 150) and smaller except plug valves.
 - .4 Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 5 plug valves, for each size square plug-valve head.
 - .5 Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.
- .7 Valves in Insulated Piping: With 2 inch (50 mm) stem extensions and the following features:
 - .1 Gate Valves: With rising stem.
 - .2 Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
 - .3 Butterfly Valves: With extended neck.
- .8 Valve-End Connections:
 - .1 Flanged: With flanges according to ASME B16.1 for iron valves.
 - .2 Grooved: With grooves according to AWWA C606 .
 - .3 Solder Joint: With sockets according to ASME B16.18.
 - .1 Caution: Disassemble valves when soldering, as recommended by the manufacturer, to prevent damage to internal parts.
 - .4 Threaded: With threads according to ASME B1.20.1.
- .9 Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE ANGLE VALVES

- .1 Class 125, Bronze Angle Valves with Bronze Disc:
 - .1 Manufacturers
 - .1 Hammond Valve.
 - .2 Milwaukee Valve Company.
 - .2 Description:
 - .1 Standard: MSS SP-80, Type 1.
 - .2 CWP Rating: 200 psig (1380 kPa).
 - .3 Body Material: ASTM B62, bronze with integral seat and screw-in bonnet.
 - .4 Ends: Threaded.
 - .5 Stem and Disc: Bronze.
 - .6 Packing: Asbestos free.
 - .7 Handwheel: Malleable iron, bronze or aluminum.
- .2 Class 125, Bronze Angle Valves with Nonmetallic Disc:
 - .1 Manufacturers
 - .1 American Valve, Inc.
 - .2 NIBCO INC.
 - .2 Description:
 - .1 Standard: MSS SP-80, Type 2.
 - .2 CWP Rating: 200 psig (1380 kPa).
 - .3 Body Material: ASTM B62, bronze with integral seat and screw-in bonnet.
 - .4 Ends: Threaded.
 - .5 Stem: Bronze.
 - .6 Disc: PTFE or TFE.
 - .7 Packing: Asbestos free.
 - .8 Handwheel: Malleable iron, bronze or aluminum.
- .3 Class 150, Bronze Angle Valves with Bronze Disc:
 - .1 Manufacturers
 - .1 Crane Co.
 - .2 Kitz Corporation.
 - .2 Description:
 - .1 Standard: MSS SP-80, Type 1.
 - .2 CWP Rating: 300 psig (2070 kPa).
 - .3 Body Material: ASTM B62, bronze with integral seat and union-ring bonnet.
 - .4 Ends: Threaded.
 - .5 Stem and Disc: Bronze.
 - .6 Packing: Asbestos free.
 - .7 Handwheel: Malleable iron, bronze or aluminum.
- .4 Class 150, Bronze Angle Valves with Nonmetallic Disc:
 - .1 Manufacturers
 - .1 Crane Valve Group; Crane Valves.
 - .2 Crane Valve Group; Jenkins Valves.
 - .3 Crane Valve Group; Stockham Division.

- .4 Hammond Valve.
- .5 Milwaukee Valve Company.
- .6 Nibco.
- .7 Powell Valves.
- .2 Description:
 - .1 Standard: MSS SP-80, Type 2.
 - .2 CWP Rating: 300 psig (2070 kPa).
 - .3 Body Material: ASTM B62, bronze with integral seat and union-ring bonnet.
 - .4 Ends: Threaded.
 - .5 Stem: Bronze.
 - .6 Disc: PTFE or TFE.
 - .7 Packing: Asbestos free.
 - .8 Handwheel: Malleable iron, bronze or aluminum.

2.3 BRASS BALL VALVES

- .1 One-Piece, Reduced-Port, Brass Ball Valves with Brass Trim:
 - .1 Manufacturers
 - .1 Kitz Corporation.
 - .2 Description:
 - .1 Standard: MSS SP-110.
 - .2 CWP Rating: 400 psig (2760 kPa).
 - .3 Body Design: One piece.
 - .4 Body Material: Forged brass.
 - .5 Ends: Threaded.
 - .6 Seats: PTFE or TFE.
 - .7 Stem: Brass.
 - .8 Ball: Chrome-plated brass.
 - .9 Port: Reduced.
- .2 Two-Piece, Full-Port, Brass Ball Valves with Brass Trim:
 - .1 Manufacturers
 - .1 Crane Co.; Crane Valve Group; Crane Valves.
 - .2 Crane Co.; Crane Valve Group; Jenkins Valves.
 - .3 DynaQuip Controls.
 - .4 Flow-Tek, Inc.
 - .5 Hammond Valve.
 - .6 Jamesbury; a subsidiary of Metso Automation.
 - .7 Jomar Valve.
 - .8 Kitz Corporation.
 - .9 Legend Valve.
 - .10 Marwin Valve.
 - .11 Milwaukee Valve Company.
 - .12 NIBCO.
 - .13 Red-White Valve Corporation.
 - .14 RuB.

- .2 Description:
 - .1 Standard: MSS SP-110.
 - .2 SWP Rating: 150 psig (1035 kPa).
 - .3 CWP Rating: 600 psig (4140 kPa).
 - .4 Body Design: Two piece.
 - .5 Body Material: Forged brass.
 - .6 Ends: Threaded.
 - .7 Seats: PTFE or TFE.
 - .8 Stem: Brass.
 - .9 Ball: Chrome-plated brass.
 - .10 Port: Full.
- .3 Two-Piece, Full-Port, Brass Ball Valves with Stainless-Steel Trim:
 - .1 Manufacturers
 - .1 Crane Co.; Crane Valve Group; Crane Valves.
 - .2 Crane Co.; Crane Valve Group; Jenkins Valves.
 - .3 Flow-Tek, Inc.
 - .4 Hammond Valve.
 - .5 Jamesbury.
 - .6 Kitz Corporation.
 - .7 Marwin Valve.
 - .8 Milwaukee Valve Company.
 - .9 RuB.
 - .2 Description:
 - .1 Standard: MSS SP-110.
 - .2 SWP Rating: 150 psig (1035 kPa).
 - .3 CWP Rating: 600 psig (4140 kPa) .
 - .4 Body Design: Two piece.
 - .5 Body Material: Forged brass.
 - .6 Ends: Threaded.
 - .7 Seats: PTFE or TFE.
 - .8 Stem: Stainless steel.
 - .9 Ball: Stainless steel, vented.
 - .10 Port: Full.
- .4 Two-Piece, Regular-Port, Brass Ball Valves with Brass Trim:
 - .1 Manufacturers
 - .1 Hammond Valve.
 - .2 Jamesbury.
 - .3 Legend Valve.
 - .4 Marwin Valve.
 - .5 Milwaukee Valve Company.
 - .2 Description:
 - .1 Standard: MSS SP-110.
 - .2 SWP Rating: 150 psig (1035 kPa).

- .3 CWP Rating: 600 psig (4140 kPa).
 - .4 Body Design: Two piece.
 - .5 Body Material: Forged brass.
 - .6 Ends: Threaded.
 - .7 Seats: PTFE or TFE.
 - .8 Stem: Brass.
 - .9 Ball: Chrome-plated brass.
 - .10 Port: Regular.
- .5 Two-Piece, Regular-Port, Brass Ball Valves with Stainless-Steel Trim:
 - .1 Manufacturers
 - .1 Jamesbury.
 - .2 Marwin Valve.
 - .2 Description:
 - .1 Standard: MSS SP-110.
 - .2 SWP Rating: 150 psig (1035 kPa).
 - .3 CWP Rating: 600 psig (4140 kPa).
 - .4 Body Design: Two piece.
 - .5 Body Material: Brass or bronze.
 - .6 Ends: Threaded.
 - .7 Seats: PTFE or TFE.
 - .8 Stem: Stainless steel.
 - .9 Ball: Stainless steel, vented.
 - .10 Port: Regular.
- .6 Three-Piece, Full-Port, Brass Ball Valves with Brass Trim:
 - .1 Manufacturers
 - .1 Jomar Valve.
 - .2 Kitz Corporation.
 - .3 Red-White Valve Corporation.
 - .4 Watts.
 - .2 Description:
 - .1 Standard: MSS SP-110.
 - .2 SWP Rating: 150 psig (1035 kPa).
 - .3 CWP Rating: 600 psig (4140 kPa).
 - .4 Body Design: Three piece.
 - .5 Body Material: Forged brass.
 - .6 Ends: Threaded.
 - .7 Seats: PTFE or TFE.
 - .8 Stem: Brass.
 - .9 Ball: Chrome-plated brass.
 - .10 Port: Full.
- .7 Three-Piece, Full-Port, Brass Ball Valves with Stainless-Steel Trim:
 - .1 Manufacturers
 - .1 Jomar Valve.

- .2 Kitz Corporation.
- .3 Marwin Valve.
- .4 Watts.
- .2 Description:
 - .1 Standard: MSS SP-110.
 - .2 SWP Rating: 150 psig (1035 kPa).
 - .3 CWP Rating: 600 psig (4140 kPa).
 - .4 Body Design: Three piece.
 - .5 Body Material: Forged brass.
 - .6 Ends: Threaded.
 - .7 Seats: PTFE or TFE.
 - .8 Stem: Stainless steel.
 - .9 Ball: Stainless steel, vented.
 - .10 Port: Full.

2.4 BRONZE BALL VALVES

- .1 One-Piece, Reduced-Port, Bronze Ball Valves with Bronze Trim:
 - .1 Manufacturers
 - .1 American Valve.
 - .2 Conbraco Industries; Apollo Valves.
 - .3 Nibco.
 - .2 Description:
 - .1 Standard: MSS SP-110.
 - .2 CWP Rating: 400 psig (2760 kPa).
 - .3 Body Design: One piece.
 - .4 Body Material: Bronze.
 - .5 Ends: Threaded.
 - .6 Seats: PTFE or TFE.
 - .7 Stem: Bronze.
 - .8 Ball: Chrome-plated brass.
 - .9 Port: Reduced.
- .2 One-Piece, Reduced-Port, Bronze Ball Valves with Stainless-Steel Trim:
 - .1 Manufacturers:
 - .1 Conbraco Industries; Apollo Valves.
 - .2 Nibco.
 - .2 Description:
 - .1 Standard: MSS SP-110.
 - .2 CWP Rating: 600 psig (4140 kPa).
 - .3 Body Design: One piece.
 - .4 Body Material: Bronze.
 - .5 Ends: Threaded.
 - .6 Seats: PTFE or TFE.
 - .7 Stem: Stainless steel.
 - .8 Ball: Stainless steel, vented.

- .9 Port: Reduced.
- .3 Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:
 - .1 Manufacturers
 - .1 American Valve.
 - .2 Conbraco Industries; Apollo Valves.
 - .3 Crane Co.; Crane Valve Group; Crane Valves.
 - .4 Hammond Valve.
 - .5 Lance Valves.
 - .6 Legend Valve.
 - .7 Milwaukee Valve Company.
 - .8 Nibco.
 - .9 Red-White Valve Corporation.
 - .10 Watts.
 - .2 Description:
 - .1 Standard: MSS SP-110.
 - .2 SWP Rating: 150 psig (1035 kPa).
 - .3 CWP Rating: 600 psig (4140 kPa).
 - .4 Body Design: Two piece.
 - .5 Body Material: Bronze.
 - .6 Ends: Threaded.
 - .7 Seats: PTFE or TFE.
 - .8 Stem: Bronze.
 - .9 Ball: Chrome-plated brass.
 - .10 Port: Full.
- .4 Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:
 - .1 Manufacturers
 - .1 Conbraco Industries.; Apollo Valves.
 - .2 Crane Co.; Crane Valve Group; Crane Valves.
 - .3 Hammond Valve.
 - .4 Lance Valves.
 - .5 Milwaukee Valve Company.
 - .6 Nibco.
 - .7 Watts.
 - .2 Description:
 - .1 Standard: MSS SP-110.
 - .2 SWP Rating: 150 psig (1035 kPa).
 - .3 CWP Rating: 600 psig (4140 kPa).
 - .4 Body Design: Two piece.
 - .5 Body Material: Bronze.
 - .6 Ends: Threaded.
 - .7 Seats: PTFE or TFE.
 - .8 Stem: Stainless steel.
 - .9 Ball: Stainless steel, vented.

- .10 Port: Full.
- .5 Two-Piece, Regular-Port, Bronze Ball Valves with Bronze Trim:
 - .1 Manufacturers
 - .1 American Valve.
 - .2 Conbraco Industries.; Apollo Valves.
 - .3 Crane Co.; Crane Valve Group; Jenkins Valves.
 - .4 Crane Co.; Crane Valve Group; Stockham Division.
 - .5 DynaQuip Controls.
 - .6 Hammond Valve.
 - .7 Lance Valves.
 - .8 Milwaukee Valve Company.
 - .9 Nibco.
 - .2 Description:
 - .1 Standard: MSS SP-110.
 - .2 SWP Rating: 150 psig (1035 kPa).
 - .3 CWP Rating: 600 psig (4140 kPa).
 - .4 Body Design: Two piece.
 - .5 Body Material: Bronze.
 - .6 Ends: Threaded.
 - .7 Seats: PTFE or TFE.
 - .8 Stem: Bronze.
 - .9 Ball: Chrome-plated brass.
 - .10 Port: Regular.
- .6 Two-Piece, Regular-Port, Bronze Ball Valves with Stainless-Steel Trim:
 - .1 Manufacturers
 - .1 Conbraco Industries.; Apollo Valves.
 - .2 Crane Co.; Crane Valve Group; Jenkins Valves.
 - .3 Hammond Valve.
 - .4 Milwaukee Valve Company.
 - .2 Description:
 - .1 Standard: MSS SP-110.
 - .2 SWP Rating: 150 psig (1035 kPa).
 - .3 CWP Rating: 600 psig (4140 kPa).
 - .4 Body Design: Two piece.
 - .5 Body Material: Bronze.
 - .6 Ends: Threaded.
 - .7 Seats: PTFE or TFE.
 - .8 Stem: Stainless steel.
 - .9 Ball: Stainless steel, vented.
 - .10 Port: Regular.
- .7 Three-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:
 - .1 Manufacturers
 - .1 Conbraco Industries.; Apollo Valves.

- .2 DynaQuip Controls.
 - .3 Hammond Valve.
 - .4 Milwaukee Valve Company.
 - .5 Nibco.
 - .6 Red-White Valve Corporation.
- .2 Description:
 - .1 Standard: MSS SP-110.
 - .2 SWP Rating: 150 psig (1035 kPa).
 - .3 CWP Rating: 600 psig (4140 kPa).
 - .4 Body Design: Three piece.
 - .5 Body Material: Bronze.
 - .6 Ends: Threaded.
 - .7 Seats: PTFE or TFE.
 - .8 Stem: Bronze.
 - .9 Ball: Chrome-plated brass.
 - .10 Port: Full.
- .8 Three-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:
 - .1 Manufacturers
 - .1 Conbraco Industries; Apollo Valves.
 - .2 Hammond Valve.
 - .3 Milwaukee Valve Company.
 - .4 Nibco.
 - .2 Description:
 - .1 Standard: MSS SP-110.
 - .2 SWP Rating: 150 psig (1035 kPa).
 - .3 CWP Rating: 600 psig (4140 kPa).
 - .4 Body Design: Three piece.
 - .5 Body Material: Bronze.
 - .6 Ends: Threaded.
 - .7 Seats: PTFE or TFE.
 - .8 Stem: Stainless steel.
 - .9 Ball: Stainless steel, vented.
 - .10 Port: Full.

2.5 IRON BALL VALVES

- .1 Class 125, Iron Ball Valves:
 - .1 Manufacturers
 - .1 American Valve.
 - .2 Conbraco Industries; Apollo Valves.
 - .3 Kitz Corporation.
 - .4 Sure Flow Equipment.
 - .5 Watts.
 - .2 Description:
 - .1 Standard: MSS SP-72.

- .2 CWP Rating: 200 psig (1380 kPa).
- .3 Body Design: Split body.
- .4 Body Material: ASTM A126, gray iron.
- .5 Ends: Flanged.
- .6 Seats: PTFE or TFE.
- .7 Stem: Stainless steel.
- .8 Ball: Stainless steel.
- .9 Port: Full.

2.6 IRON, SINGLE-FLANGE BUTTERFLY VALVES

.1 150 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:

.1 Manufacturers:

- .1 ABZ Valve and Controls.
- .2 Bray Controls.
- .3 Conbraco Industries; Apollo Valves.
- .4 Cooper Cameron Valves.
- .5 Crane Co.; Crane Valve Group; Jenkins Valves.
- .6 Crane Co.; Crane Valve Group; Stockham Division.
- .7 DeZurik Water Controls.
- .8 Hammond Valve.
- .9 Kitz Corporation.
- .10 Milwaukee Valve Company.
- .11 Nibco.
- .12 Norriseal.
- .13 Red-White Valve Corporation.
- .14 Spence Strainers International.
- .15 Tyco Valves & Controls.
- .16 Watts.

.2 Description:

- .1 Standard: MSS SP-67, Type I.
- .2 CWP Rating: 150 psig (1035 kPa).
- .3 Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
- .4 Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
- .5 Seat: EPDM.
- .6 Stem: One- or two-piece stainless steel.
- .7 Disc: Aluminum bronze.

.2 150 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Aluminum-Bronze Disc:

.1 Manufacturers:

- .1 ABZ Valve and Controls.
- .2 Bray Controls.
- .3 Conbraco Industries.; Apollo Valves.
- .4 Cooper Cameron Valves.
- .5 Crane Co.; Crane Valve Group; Jenkins Valves.

- .6 Crane Co.; Crane Valve Group; Stockham Division.
- .7 DeZurik Water Controls.
- .8 Hammond Valve.
- .9 Kitz Corporation.
- .10 Milwaukee Valve Company.
- .11 Nibco.
- .12 Norriseal.
- .13 Red-White Valve Corporation.
- .14 Spence Strainers International.
- .15 Tyco Valves & Controls.
- .16 Watts.
- .2 Description:
 - .1 Standard: MSS SP-67, Type I.
 - .2 CWP Rating: 150 psig (1035 kPa).
 - .3 Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - .4 Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
 - .5 Seat: NBR.
 - .6 Stem: One- or two-piece stainless steel.
 - .7 Disc: Aluminum bronze.
- .3 150 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Ductile-Iron Disc:
 - .1 Manufacturers:
 - .1 ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
 - .2 Bray Controls; a division of Bray International.
 - .3 Conbraco Industries, Inc.; Apollo Valves.
 - .4 Cooper Cameron Valves; a division of Cooper Cameron Corp.
 - .5 Crane Co.; Crane Valve Group; Center Line.
 - .6 Crane Co.; Crane Valve Group; Stockham Division.
 - .7 DeZurik Water Controls.
 - .8 Hammond Valve.
 - .9 Kitz Corporation.
 - .10 Milwaukee Valve Company.
 - .11 Mueller Steam Specialty; a division of SPX Corporation.
 - .12 NIBCO INC.
 - .13 Norriseal; a Dover Corporation company.
 - .14 Spence Strainers International; a division of CIRCOR International.
 - .15 Sure Flow Equipment Inc.
 - .16 Tyco Valves & Controls; a unit of Tyco Flow Control.
 - .17 Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - .2 Description:
 - .1 Standard: MSS SP-67, Type I.
 - .2 CWP Rating: 150 psig (1035 kPa).

- .3 Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
- .4 Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
- .5 Seat: EPDM.
- .6 Stem: One- or two-piece stainless steel.
- .7 Disc: Nickel-plated or -coated ductile iron.
- .4 150 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Ductile-Iron Disc:
 - .1 Manufacturers:
 - .1 ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
 - .2 Bray Controls; a division of Bray International.
 - .3 Conbraco Industries, Inc.; Apollo Valves.
 - .4 Cooper Cameron Valves; a division of Cooper Cameron Corp.
 - .5 Crane Co.; Crane Valve Group; Center Line.
 - .6 Crane Co.; Crane Valve Group; Stockham Division.
 - .7 DeZurik Water Controls.
 - .8 Hammond Valve.
 - .9 Kitz Corporation.
 - .10 Milwaukee Valve Company.
 - .11 Mueller Steam Specialty; a division of SPX Corporation.
 - .12 NIBCO INC.
 - .13 Norriseal; a Dover Corporation company.
 - .14 Spence Strainers International; a division of CIRCOR International.
 - .15 Sure Flow Equipment Inc.
 - .16 Tyco Valves & Controls; a unit of Tyco Flow Control.
 - .17 Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - .2 Description:
 - .1 Standard: MSS SP-67, Type I.
 - .2 CWP Rating: 150 psig (1035 kPa).
 - .3 Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - .4 Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
 - .5 Seat: NBR.
 - .6 Stem: One- or two-piece stainless steel.
 - .7 Disc: Nickel-plated or -coated ductile iron.
- .5 150 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Stainless-Steel Disc:
 - .1 Manufacturers:
 - .1 ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
 - .2 Bray Controls; a division of Bray International.
 - .3 Conbraco Industries, Inc.; Apollo Valves.
 - .4 Cooper Cameron Valves; a division of Cooper Cameron Corp.
 - .5 Crane Co.; Crane Valve Group; Jenkins Valves.
 - .6 Crane Co.; Crane Valve Group; Stockham Division.
 - .7 DeZurik Water Controls.

- .8 Hammond Valve.
- .9 Kitz Corporation.
- .10 Milwaukee Valve Company.
- .11 Mueller Steam Specialty; a division of SPX Corporation.
- .12 NIBCO INC.
- .13 Norriseal; a Dover Corporation company.
- .14 Red-White Valve Corporation.
- .15 Spence Strainers International; a division of CIRCOR International.
- .16 Sure Flow Equipment Inc.
- .17 Tyco Valves & Controls; a unit of Tyco Flow Control.
- .18 Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- .2 Description:
 - .1 Standard: MSS SP-67, Type I.
 - .2 CWP Rating: 150 psig (1035 kPa).
 - .3 Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - .4 Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
 - .5 Seat: EPDM.
 - .6 Stem: One- or two-piece stainless steel.
 - .7 Disc: Stainless steel.
- .6 150 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Stainless-Steel Disc:
 - .1 Manufacturers:
 - .1 ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
 - .2 Bray Controls; a division of Bray International.
 - .3 Conbraco Industries, Inc.; Apollo Valves.
 - .4 Cooper Cameron Valves; a division of Cooper Cameron Corp.
 - .5 Crane Co.; Crane Valve Group; Jenkins Valves.
 - .6 Crane Co.; Crane Valve Group; Stockham Division.
 - .7 DeZurik Water Controls.
 - .8 Hammond Valve.
 - .9 Kitz Corporation.
 - .10 Milwaukee Valve Company.
 - .11 Mueller Steam Specialty; a division of SPX Corporation.
 - .12 NIBCO INC.
 - .13 Norriseal; a Dover Corporation company.
 - .14 Red-White Valve Corporation.
 - .15 Spence Strainers International; a division of CIRCOR International.
 - .16 Sure Flow Equipment Inc.
 - .17 Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - .2 Description:
 - .1 Standard: MSS SP-67, Type I.
 - .2 CWP Rating: 150 psig (1035 kPa).

- .3 Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
- .4 Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
- .5 Seat: NBR.
- .6 Stem: One- or two-piece stainless steel.
- .7 Disc: Stainless steel.
- .7 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:
 - .1 Manufacturers:
 - .1 ABZ Valve and Controls; a division of ABZ Manufacturing.
 - .2 Conbraco Industries; Apollo Valves.
 - .3 Cooper Cameron Valves; a division of Cooper Cameron Corp.
 - .4 Crane Valve Group; Jenkins Valves.
 - .5 Crane Valve Group; Stockham Division.
 - .6 DeZurik Water Controls.
 - .7 Flo Fab.
 - .8 Hammond Valve.
 - .9 Kitz Corporation.
 - .10 Legend Valve.
 - .11 Milwaukee Valve Company.
 - .12 Nibco.
 - .13 Norriseal; a Dover Corporation company.
 - .14 Red-White Valve Corporation.
 - .15 Spence Strainers International; a division of CIRCOR International.
 - .16 Watts Regulator Co.; a division of Watts Water Technologies.
 - .2 Description:
 - .1 Standard: MSS SP-67, Type I.
 - .2 CWP Rating: 200 psig (1380 kPa).
 - .3 Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - .4 Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
 - .5 Seat: EPDM.
 - .6 Stem: One- or two-piece stainless steel.
 - .7 Disc: Aluminum bronze.
- .8 200 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Aluminum-Bronze Disc:
 - .1 Manufacturers:
 - .1 ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
 - .2 Conbraco Industries, Inc.; Apollo Valves.
 - .3 Cooper Cameron Valves; a division of Cooper Cameron Corp.
 - .4 Crane Co.; Crane Valve Group; Jenkins Valves.
 - .5 Crane Co.; Crane Valve Group; Stockham Division.
 - .6 DeZurik Water Controls.
 - .7 Flo Fab Inc.
 - .8 Hammond Valve.

- .9 Kitz Corporation.
- .10 Legend Valve.
- .11 Milwaukee Valve Company.
- .12 NIBCO INC.
- .13 Norriseal; a Dover Corporation company.
- .14 Red-White Valve Corporation.
- .15 Spence Strainers International; a division of CIRCOR International.
- .16 Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- .2 Description:
 - .1 Standard: MSS SP-67, Type I.
 - .2 CWP Rating: 200 psig (1380 kPa).
 - .3 Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - .4 Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
 - .5 Seat: NBR.
 - .6 Stem: One- or two-piece stainless steel.
 - .7 Disc: Aluminum bronze.
- .9 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Ductile-Iron Disc:
 - .1 Manufacturers:
 - .1 ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
 - .2 American Valve, Inc.
 - .3 Conbraco Industries, Inc.; Apollo Valves.
 - .4 Cooper Cameron Valves; a division of Cooper Cameron Corp.
 - .5 Crane Co.; Crane Valve Group; Center Line.
 - .6 Crane Co.; Crane Valve Group; Stockham Division.
 - .7 DeZurik Water Controls.
 - .8 Flo Fab Inc.
 - .9 Hammond Valve.
 - .10 Kitz Corporation.
 - .11 Legend Valve.
 - .12 Milwaukee Valve Company.
 - .13 Mueller Steam Specialty; a division of SPX Corporation.
 - .14 NIBCO INC.
 - .15 Norriseal; a Dover Corporation company.
 - .16 Spence Strainers International; a division of CIRCOR International.
 - .17 Sure Flow Equipment Inc.
 - .18 Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - .2 Description:
 - .1 Standard: MSS SP-67, Type I.
 - .2 CWP Rating: 200 psig (1380 kPa).
 - .3 Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - .4 Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.

- .5 Seat: EPDM.
- .6 Stem: One- or two-piece stainless steel.
- .7 Disc: Nickel-plated or -coated ductile iron.
- .10 200 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Ductile-Iron Disc:
 - .1 Manufacturers:
 - .1 ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
 - .2 American Valve, Inc.
 - .3 Conbraco Industries, Inc.; Apollo Valves.
 - .4 Cooper Cameron Valves; a division of Cooper Cameron Corp.
 - .5 Crane Co.; Crane Valve Group; Center Line.
 - .6 Crane Co.; Crane Valve Group; Stockham Division.
 - .7 DeZurik Water Controls.
 - .8 Flo Fab Inc.
 - .9 Hammond Valve.
 - .10 Kitz Corporation.
 - .11 Legend Valve.
 - .12 Milwaukee Valve Company.
 - .13 Mueller Steam Specialty; a division of SPX Corporation.
 - .14 NIBCO INC.
 - .15 Norriseal; a Dover Corporation company.
 - .16 Spence Strainers International; a division of CIRCOR International.
 - .17 Sure Flow Equipment Inc.
 - .18 Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - .2 Description:
 - .1 Standard: MSS SP-67, Type I.
 - .2 CWP Rating: 200 psig (1380 kPa).
 - .3 Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - .4 Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
 - .5 Seat: NBR.
 - .6 Stem: One- or two-piece stainless steel.
 - .7 Disc: Nickel-plated or -coated ductile iron.
- .11 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Stainless-Steel Disc:
 - .1 Manufacturers:
 - .1 ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
 - .2 American Valve, Inc.
 - .3 Conbraco Industries, Inc.; Apollo Valves.
 - .4 Cooper Cameron Valves; a division of Cooper Cameron Corp.
 - .5 Crane Co.; Crane Valve Group; Jenkins Valves.
 - .6 Crane Co.; Crane Valve Group; Stockham Division.
 - .7 DeZurik Water Controls.
 - .8 Flo Fab Inc.
 - .9 Hammond Valve.

- .10 Kitz Corporation.
- .11 Legend Valve.
- .12 Milwaukee Valve Company.
- .13 Mueller Steam Specialty; a division of SPX Corporation.
- .14 NIBCO INC.
- .15 Norriseal; a Dover Corporation company.
- .16 Red-White Valve Corporation.
- .17 Spence Strainers International; a division of CIRCOR International.
- .18 Sure Flow Equipment Inc.
- .19 Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- .2 Description:
 - .1 Standard: MSS SP-67, Type I.
 - .2 CWP Rating: 200 psig (1380 kPa).
 - .3 Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - .4 Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - .5 Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
 - .6 Seat: EPDM.
 - .7 Stem: One- or two-piece stainless steel.
 - .8 Disc: Stainless steel.
- .12 200 CWP, Iron, Single-Flange Butterfly Valves with NBR Seat and Stainless-Steel Disc:
 - .1 Manufacturers:
 - .1 ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
 - .2 American Valve, Inc.
 - .3 Conbraco Industries, Inc.; Apollo Valves.
 - .4 Cooper Cameron Valves; a division of Cooper Cameron Corp.
 - .5 Crane Co.; Crane Valve Group; Jenkins Valves.
 - .6 Crane Co.; Crane Valve Group; Stockham Division.
 - .7 DeZurik Water Controls.
 - .8 Flo Fab Inc.
 - .9 Hammond Valve.
 - .10 Kitz Corporation.
 - .11 Legend Valve.
 - .12 Milwaukee Valve Company.
 - .13 Mueller Steam Specialty; a division of SPX Corporation.
 - .14 NIBCO INC.
 - .15 Norriseal; a Dover Corporation company.
 - .16 Red-White Valve Corporation.
 - .17 Spence Strainers International; a division of CIRCOR International.
 - .18 Sure Flow Equipment Inc.
 - .19 Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - .2 Description:

- .1 Standard: MSS SP-67, Type I.
- .2 CWP Rating: 200 psig (1380 kPa).
- .3 Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
- .4 Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
- .5 Seat: NBR.
- .6 Stem: One- or two-piece stainless steel.
- .7 Disc: Stainless steel.

2.7 IRON, GROOVED-END BUTTERFLY VALVES

- .1 175 CWP, Iron, Grooved-End Butterfly Valves:
 - .1 Manufacturers:
 - .1 Kennedy Valve; a division of McWane, Inc.
 - .2 Shurjoint Piping Products.
 - .3 Tyco Fire Products LP; Grinnell Mechanical Products.
 - .4 Victaulic Company.
 - .2 Description:
 - .1 Standard: MSS SP-67, Type I.
 - .2 CWP Rating: 175 psig (1200 kPa).
 - .3 Body Material: Coated, ductile iron.
 - .4 Stem: Two-piece stainless steel.
 - .5 Disc: Coated, ductile iron.
 - .6 Seal: EPDM.
- .2 300 CWP, Iron, Grooved-End Butterfly Valves:
 - .1 Manufacturers:
 - .1 Anvil International, Inc.
 - .2 Kennedy Valve; a division of McWane, Inc.
 - .3 Mueller Steam Specialty; a division of SPX Corporation.
 - .4 NIBCO INC.
 - .5 Shurjoint Piping Products.
 - .6 Tyco Fire Products LP; Grinnell Mechanical Products.
 - .7 Victaulic Company.
 - .2 Description:
 - .1 Standard: MSS SP-67, Type I.
 - .2 NPS 8 (DN 50) and Smaller CWP Rating: 300 psig (2070 kPa).
 - .3 NPS 10 (DN 250) and Larger CWP Rating: 200 psig (1380 kPa).
 - .4 Body Material: Coated, ductile iron.
 - .5 Stem: Two-piece stainless steel.
 - .6 Disc: Coated, ductile iron.
 - .7 Seal: EPDM.

2.8 HIGH-PERFORMANCE BUTTERFLY VALVES

- .1 Class 150, Single-Flange, High-Performance Butterfly Valves:
 - .1 Manufacturers

- .1 ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
- .2 Bray Controls; a division of Bray International.
- .3 Cooper Cameron Valves; a division of Cooper Cameron Corp.
- .4 Crane Valve Group; Flowseal.
- .5 Crane Valve Group; Stockham Division.
- .6 DeZurik Water Controls.
- .7 Hammond Valve.
- .8 Jamesbury; a subsidiary of Metso Automation.
- .9 Milwaukee Valve Company.
- .10 NIBCO INC.
- .11 Process Development & Control, Inc.
- .12 Tyco Valves & Controls; a unit of Tyco Flow Control.
- .13 Xomox Corporation.
- .2 Description:
 - .1 Standard: MSS SP-68.
 - .2 CWP Rating: 285 psig (1965 kPa) at 100 deg F (38 deg C).
 - .3 Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
 - .4 Body Material: Carbon steel, cast iron, ductile iron, or stainless steel.
 - .5 Seat: Reinforced PTFE or metal.
 - .6 Stem: Stainless steel; offset from seat plane.
 - .7 Disc: Carbon steel.
 - .8 Service: Bidirectional.
- .2 Class 300, Single-Flange, High-Performance Butterfly Valves:
 - .1 Manufacturers
 - .1 ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
 - .2 Bray Controls; a division of Bray International.
 - .3 Cooper Cameron Valves; a division of Cooper Cameron Corp.
 - .4 Crane Valve Group; Flowseal.
 - .5 Crane Valve Group; Stockham Division.
 - .6 DeZurik Water Controls.
 - .7 Hammond Valve.
 - .8 Jamesbury; a subsidiary of Metso Automation.
 - .9 Milwaukee Valve Company.
 - .10 NIBCO INC.
 - .11 Process Development & Control, Inc.
 - .12 Tyco Valves & Controls; a unit of Tyco Flow Control.
 - .13 Xomox Corporation.
 - .2 Description:
 - .1 Standard: MSS SP-68.
 - .2 CWP Rating: 720 psig (4965 kPa) at 100 deg F (38 deg C).
 - .3 Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.

- .4 Body Material: Carbon steel, cast iron, or ductile iron.
- .5 Seat: Reinforced PTFE or metal.
- .6 Stem: Stainless steel; offset from seat plane.
- .7 Disc: Carbon steel.
- .8 Service: Bidirectional.

2.9 BRONZE LIFT CHECK VALVES

- .1 Class 125, Lift Check Valves with Bronze Disc:
 - .1 Manufacturers
 - .1 Crane Co.; Crane Valve Group; Crane Valves.
 - .2 Crane Co.; Crane Valve Group; Jenkins Valves.
 - .3 Crane Co.; Crane Valve Group; Stockham Division.
 - .2 Description:
 - .1 Standard: MSS SP-80, Type 1.
 - .2 CWP Rating: 200 psig (1380 kPa).
 - .3 Body Design: Vertical flow.
 - .4 Body Material: ASTM B61 or ASTM B62, bronze.
 - .5 Ends: Threaded.
 - .6 Disc: Bronze.
- .2 Class 125, Lift Check Valves with Nonmetallic Disc:
 - .1 Manufacturers
 - .1 Flo Fab Inc.
 - .2 Hammond Valve.
 - .3 Kitz Corporation.
 - .4 Milwaukee Valve Company.
 - .5 Mueller Steam Specialty; a division of SPX Corporation.
 - .6 NIBCO INC.
 - .7 Red-White Valve Corporation.
 - .8 CWP Rating: 200 psig (1380 kPa).
 - .9 Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - .2 Description:
 - .1 Standard: MSS SP-80, Type 2.
 - .2 CWP Rating: 200 psig (1380 kPa).
 - .3 Body Design: Vertical flow.
 - .4 Body Material: ASTM B61 or ASTM B62, bronze.
 - .5 Ends: Threaded.
 - .6 Disc: NBR, PTFE, or TFE.

2.10 BRONZE SWING CHECK VALVES

- .1 Class 125, Bronze Swing Check Valves with Bronze Disc:
 - .1 Manufacturers
 - .1 American Valve, Inc.
 - .2 Crane Co.; Crane Valve Group; Crane Valves.
 - .3 Crane Co.; Crane Valve Group; Jenkins Valves.

- .4 Crane Co.; Crane Valve Group; Stockham Division.
 - .5 Hammond Valve.
 - .6 Kitz Corporation.
 - .7 Milwaukee Valve Company.
 - .8 NIBCO INC.
 - .9 Powell Valves.
 - .10 Red-White Valve Corporation.
 - .11 Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - .12 Zy-Tech Global Industries, Inc.
- .2 Description:
 - .1 Standard: MSS SP-80, Type 3.
 - .2 CWP Rating: 200 psig (1380 kPa).
 - .3 Body Design: Horizontal flow.
 - .4 Body Material: ASTM B62, bronze.
 - .5 Ends: Threaded.
 - .6 Disc: Bronze.
- .2 Class 125, Bronze Swing Check Valves with Nonmetallic Disc:
 - .1 Manufacturers
 - .1 Crane Co.; Crane Valve Group; Crane Valves.
 - .2 Crane Co.; Crane Valve Group; Jenkins Valves.
 - .3 Crane Co.; Crane Valve Group; Stockham Division.
 - .4 Hammond Valve.
 - .5 Kitz Corporation.
 - .6 Milwaukee Valve Company.
 - .7 NIBCO INC.
 - .8 Red-White Valve Corporation.
 - .9 Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - .2 Description:
 - .1 Standard: MSS SP-80, Type 4.
 - .2 CWP Rating: 200 psig (1380 kPa).
 - .3 Body Design: Horizontal flow.
 - .4 Body Material: ASTM B62, bronze.
 - .5 Ends: Threaded.
 - .6 Disc: PTFE or TFE.
- .3 Class 150, Bronze Swing Check Valves with Bronze Disc:
 - .1 Manufacturers
 - .1 American Valve, Inc.
 - .2 Crane Co.; Crane Valve Group; Crane Valves.
 - .3 Crane Co.; Crane Valve Group; Jenkins Valves.
 - .4 Crane Co.; Crane Valve Group; Stockham Division.
 - .5 Kitz Corporation.
 - .6 Milwaukee Valve Company.
 - .7 NIBCO INC.

- .8 Red-White Valve Corporation.
- .9 Zy-Tech Global Industries, Inc.
- .2 Description:
 - .1 Standard: MSS SP-80, Type 3.
 - .2 CWP Rating: 300 psig (2070 kPa).
 - .3 Body Design: Horizontal flow.
 - .4 Body Material: ASTM B62, bronze.
 - .5 Ends: Threaded.
 - .6 Disc: Bronze.
- .4 Class 150, Bronze Swing Check Valves with Nonmetallic Disc:
 - .1 Manufacturers
 - .1 Crane Co.; Crane Valve Group; Crane Valves.
 - .2 Crane Co.; Crane Valve Group; Jenkins Valves.
 - .3 Hammond Valve.
 - .4 Milwaukee Valve Company.
 - .5 NIBCO INC.
 - .6 Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - .2 Description:
 - .1 Standard: MSS SP-80, Type 4.
 - .2 CWP Rating: 300 psig (2070 kPa).
 - .3 Body Design: Horizontal flow.
 - .4 Body Material: ASTM B62, bronze.
 - .5 Ends: Threaded.
 - .6 Disc: PTFE or TFE.

2.11 IRON SWING CHECK VALVES

- .1 Class 125, Iron Swing Check Valves with Metal Seats:
 - .1 Manufacturers
 - .1 Crane Valve Group; Crane Valves.
 - .2 Crane Valve Group; Jenkins Valves.
 - .3 Crane Valve Group; Stockham Division.
 - .4 Hammond Valve.
 - .5 Kitz Corporation.
 - .6 Legend Valve.
 - .7 Milwaukee Valve Company.
 - .8 Nibco.
 - .9 Powell Valves.
 - .10 Red-White Valve Corporation.
 - .11 Sure Flow Equipment.
 - .12 Watts Regulator Co.; a division of Watts Water Technologies.
 - .13 Zy-Tech Global Industries.
 - .2 Description:
 - .1 Standard: MSS SP-71, Type I.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).

- .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
- .4 Body Design: Clear or full waterway.
- .5 Body Material: ASTM A126, gray iron with bolted bonnet.
- .6 Ends: Flanged.
- .7 Trim: Bronze.
- .8 Gasket: Asbestos free.
- .2 Class 125, Iron Swing Check Valves with Nonmetallic-to-Metal Seats:
 - .1 Manufacturers
 - .1 Crane Co.; Crane Valve Group; Crane Valves.
 - .2 Crane Co.; Crane Valve Group; Stockham Division.
 - .2 Description:
 - .1 Standard: MSS SP-71, Type I.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
 - .4 Body Design: Clear or full waterway.
 - .5 Body Material: ASTM A126, gray iron with bolted bonnet.
 - .6 Ends: Flanged.
 - .7 Ends: Flanged.
 - .8 Trim: Composition.
 - .9 Seat Ring: Bronze.
 - .10 Disc Holder: Bronze.
 - .11 Disc: PTFE or TFE.
 - .12 Gasket: Asbestos free.
- .3 Class 250, Iron Swing Check Valves with Metal Seats:
 - .1 Manufacturers:
 - .1 Crane Valve Group; Crane Valves.
 - .2 Crane Valve Group; Jenkins Valves.
 - .3 Crane Valve Group; Stockham Division.
 - .4 Hammond Valve.
 - .5 Milwaukee Valve Company.
 - .6 NIBCO INC.
 - .7 Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - .2 Description:
 - .1 Standard: MSS SP-71, Type I.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 500 psig (3450 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 300 psig (2070 kPa).
 - .4 Body Design: Clear or full waterway.
 - .5 Body Material: ASTM A126, gray iron with bolted bonnet.
 - .6 Ends: Flanged.
 - .7 Trim: Bronze.
 - .8 Gasket: Asbestos free.

2.12 IRON SWING CHECK VALVES WITH CLOSURE CONTROL

- .1 Class 125, Iron Swing Check Valves with Lever- and Spring-Closure Control:

- .1 Manufacturers
 - .1 NIBCO INC.
- .2 Description:
 - .1 Standard: MSS SP-71, Type I.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
 - .4 Body Design: Clear or full waterway.
 - .5 Body Material: ASTM A126, gray iron with bolted bonnet.
 - .6 Ends: Flanged.
 - .7 Trim: Bronze.
 - .8 Gasket: Asbestos free.
 - .9 Closure Control: Factory-installed, exterior lever and spring.
- .2 Class 125, Iron Swing Check Valves with Lever- and Weight-Closure Control:
 - .1 Manufacturers
 - .1 Crane Co.; Crane Valve Group; Crane Valves.Crane Co.; Crane Valve Group; Jenkins Valves.
 - .2 Crane Co.; Crane Valve Group; Stockham Division.
 - .3 Hammond Valve.
 - .4 Milwaukee Valve Company.
 - .5 NIBCO INC.
 - .6 Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - .2 Description:
 - .1 Standard: MSS SP-71, Type I.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
 - .4 Body Design: Clear or full waterway.
 - .5 Body Material: ASTM A126, gray iron with bolted bonnet.
 - .6 Ends: Flanged.
 - .7 Trim: Bronze.
 - .8 Gasket: Asbestos free.
 - .9 Closure Control: Factory-installed, exterior lever and weight.

2.13 IRON, GROOVED-END SWING CHECK VALVES

- .1 300 CWP, Iron, Grooved-End Swing Check Valves:
 - .1 Manufacturers
 - .1 Anvil International, Inc.
 - .2 Val-Matic Valve & Manufacturing Corp.
 - .3 Shurjoint Piping Products.
 - .4 Tyco Fire Products LP; Grinnell Mechanical Products.
 - .5 Victaulic Company.
 - .2 Description:
 - .1 CWP Rating: 300 psig (2070 kPa).
 - .2 Body Material: ASTM A536, ductile iron.
 - .3 Seal: EPDM.

- .4 Disc: Spring operated ductile iron or stainless steel.

2.14 IRON, CENTER-GUIDED CHECK VALVES

- .1 Class 125, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat:
 - .1 Manufacturers
 - .1 Anvil International, Inc.
 - .2 APCO Willamette Valve and Primer Corporation.
 - .3 Crispin Valve.
 - .4 DFT Inc.
 - .5 Flo Fab Inc.
 - .6 GA Industries, Inc.
 - .7 Hammond Valve.
 - .8 Metraflex, Inc.
 - .9 Milwaukee Valve Company.
 - .10 Mueller Steam Specialty; a division of SPX Corporation.
 - .11 NIBCO INC.
 - .12 Spence Strainers International; a division of CIRCOR International.
 - .13 Sure Flow Equipment Inc.
 - .14 Val-Matic Valve & Manufacturing Corp.
 - .2 Description:
 - .1 Standard: MSS SP-125.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
 - .4 Body Material: ASTM A126, gray iron.
 - .5 Style: Compact wafer.
 - .6 Seat: Bronze.
- .2 Class 125, Iron, Globe, Center-Guided Check Valves with Metal Seat:
 - .1 Manufacturers
 - .1 APCO Willamette Valve and Primer Corporation.
 - .2 Crispin Valve.
 - .3 DFT Inc.
 - .4 Flomatic Corporation.
 - .5 Hammond Valve.
 - .6 Metraflex, Inc.
 - .7 Milwaukee Valve Company.
 - .8 Mueller Steam Specialty; a division of SPX Corporation.
 - .9 NIBCO INC.
 - .10 Spence Strainers International; a division of CIRCOR International.
 - .11 Sure Flow Equipment Inc.
 - .12 Val-Matic Valve & Manufacturing Corp.
 - .13 Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - .2 Description:
 - .1 Standard: MSS SP-125.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).

- .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
- .4 Body Material: ASTM A126, gray iron.
- .5 Style: Globe, spring loaded.
- .6 Ends: Flanged.
- .7 Seat: Bronze.
- .3 Class 150, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat:
 - .1 Manufacturers
 - .1 APCO Willamette Valve and Primer Corporation.
 - .2 Crispin Valve.
 - .3 Val-Matic Valve & Manufacturing Corp.
 - .2 Description:
 - .1 Standard: MSS SP-125.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 300 psig (2070 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 250 psig (1725 kPa).
 - .4 Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
 - .5 Style: Compact wafer.
- .4 Class 150, Iron, Globe, Center-Guided Check Valves with Metal Seat:
 - .1 Manufacturers
 - .1 APCO Willamette Valve and Primer Corporation.
 - .2 Crispin Valve.
 - .3 Val-Matic Valve & Manufacturing Corp.
 - .2 Description:
 - .1 Standard: MSS SP-125.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 300 psig (2070 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 250 psig (1725 kPa).
 - .4 Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
 - .5 Style: Globe, spring loaded.
 - .6 Ends: Flanged.
 - .7 Seat: Bronze.
- .5 Class 250, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat:
 - .1 Manufacturers
 - .1 APCO Willamette Valve and Primer Corporation.
 - .2 Crispin Valve.
 - .3 DFT Inc.
 - .4 Flo Fab Inc.
 - .5 Hammond Valve.
 - .6 Metraflex, Inc.
 - .7 Milwaukee Valve Company.
 - .8 NIBCO INC.
 - .9 Sure Flow Equipment Inc.
 - .10 Val-Matic Valve & Manufacturing Corp.
 - .2 Description:
 - .1 Standard: MSS SP-125.

- .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 400 psig (2760 kPa).
- .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 300 psig (2070 kPa).
- .4 Body Material: ASTM A126, gray iron.
- .5 Style: Compact wafer, spring loaded.
- .6 Seat: Bronze.
- .6 Class 250, Iron, Globe, Center-Guided Check Valves with Metal Seat:
 - .1 Manufacturers
 - .1 APCO Willamette Valve and Primer Corporation.
 - .2 Crispin Valve.
 - .3 DFT Inc.
 - .4 Flomatic Corporation.
 - .5 Hammond Valve.
 - .6 Metraflex, Inc.
 - .7 Milwaukee Valve Company.
 - .8 Mueller Steam Specialty; a division of SPX Corporation.
 - .9 NIBCO INC.
 - .10 Val-Matic Valve & Manufacturing Corp.
 - .2 Description:
 - .1 Standard: MSS SP-125.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 400 psig (2760 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 300 psig (2070 kPa).
 - .4 Body Material: ASTM A126, gray iron.
 - .5 Style: Globe, spring loaded.
 - .6 Ends: Flanged.
 - .7 Seat: Bronze.
- .7 Class 300, Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat:
 - .1 Manufacturers
 - .1 APCO Willamette Valve and Primer Corporation.
 - .2 Val-Matic Valve & Manufacturing Corp.
 - .2 Description:
 - .1 Standard: MSS SP-125.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 500 psig (3450 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 400 psig (2760 kPa).
 - .4 Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
 - .5 Style: Compact wafer, spring loaded.
 - .6 Seat: Bronze.
- .8 Class 300, Iron, Globe, Center-Guided Check Valves with Metal Seat:
 - .1 Manufacturers
 - .1 APCO Willamette Valve and Primer Corporation.
 - .2 Crispin Valve.
 - .3 Val-Matic Valve & Manufacturing Corp.
 - .2 Description:
 - .1 Standard: MSS SP-125.

- .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 500 psig (3450 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 400 psig (2760 kPa).
 - .4 Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
 - .5 Style: Globe, spring loaded.
 - .6 Ends: Flanged.
 - .7 Seat: Bronze.
- .9 Class 125, Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat:
- .1 Manufacturers
 - .1 APCO Willamette Valve and Primer Corporation.
 - .2 Crispin Valve.
 - .3 DFT Inc.
 - .4 Flo Fab Inc.
 - .5 Hammond Valve.
 - .6 Milwaukee Valve Company.
 - .7 NIBCO INC.
 - .8 Spence Strainers International; a division of CIRCOR International.
 - .9 Sure Flow Equipment Inc.
 - .10 Val-Matic Valve & Manufacturing Corp.
 - .2 Description:
 - .1 Standard: MSS SP-125.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
 - .4 Body Material: ASTM A126, gray iron.
 - .5 Style: Compact wafer.
 - .6 Seat: EPDM or NBR.
- .10 Class 125, Iron, Globe, Center-Guided Check Valves with Resilient Seat:
- .1 Manufacturers
 - .1 Anvil International, Inc.
 - .2 APCO Willamette Valve and Primer Corporation.
 - .3 Crispin Valve.
 - .4 DFT Inc.
 - .5 GA Industries, Inc.
 - .6 Hammond Valve.
 - .7 Milwaukee Valve Company.
 - .8 NIBCO INC.
 - .9 Sure Flow Equipment Inc.
 - .10 Val-Matic Valve & Manufacturing Corp.
 - .2 Description:
 - .1 Standard: MSS SP-125.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
 - .4 Body Material: ASTM A126, gray iron.
 - .5 Style: Globe, spring loaded.

- .6 Ends: Flanged.
- .7 Seat: EPDM or NBR.
- .11 Class 150, Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat:
 - .1 Manufacturers
 - .1 APCO Willamette Valve and Primer Corporation.
 - .2 Crispin Valve.
 - .3 Val-Matic Valve & Manufacturing Corp.
 - .2 Description:
 - .1 Standard: MSS SP-125.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 300 psig (2070 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 250 psig (1725 kPa).
 - .4 Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
 - .5 Style: Compact wafer.
 - .6 Seat: EPDM or NBR.
- .12 Class 150, Iron, Globe, Center-Guided Check Valves with Resilient Seat:
 - .1 Manufacturers
 - .1 APCO Willamette Valve and Primer Corporation.
 - .2 Crispin Valve.
 - .3 DFT Inc.
 - .4 Val-Matic Valve & Manufacturing Corp.
 - .2 Description:
 - .1 Standard: MSS SP-125.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 300 psig (2070 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 250 psig (1725 kPa).
 - .4 Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
 - .5 Style: Globe, spring loaded.
 - .6 Ends: Flanged.
 - .7 Seat: EPDM or NBR.
- .13 Class 250, Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat:
 - .1 Manufacturers
 - .1 APCO Willamette Valve and Primer Corporation.
 - .2 Crispin Valve.
 - .3 DFT Inc.
 - .4 Flo Fab Inc.
 - .5 Hammond Valve.
 - .6 Milwaukee Valve Company.
 - .7 NIBCO INC.
 - .8 Sure Flow Equipment Inc.
 - .9 Val-Matic Valve & Manufacturing Corp.
 - .2 Description:
 - .1 Standard: MSS SP-125.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 400 psig (2760 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 300 psig (2070 kPa).

- .4 Body Material: ASTM A126, gray iron.
 - .5 Style: Compact wafer, spring loaded.
 - .6 Seat: EPDM or NBR.
- .14 Class 250, Iron, Globe, Center-Guided Check Valves with Resilient Seat:
 - .1 Manufacturers
 - .1 APCO Willamette Valve and Primer Corporation.
 - .2 Crispin Valve.
 - .3 DFT Inc.
 - .4 Hammond Valve.
 - .5 Milwaukee Valve Company.
 - .6 NIBCO INC.
 - .7 Val-Matic Valve & Manufacturing Corp.
 - .2 Description:
 - .1 Standard: MSS SP-125.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 400 psig (2760 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 300 psig (2070 kPa).
 - .4 Body Material: ASTM A126, gray iron.
 - .5 Style: Globe, spring loaded.
 - .6 Ends: Flanged.
 - .7 Seat: EPDM or NBR.
- .15 Class 300, Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat:
 - .1 Manufacturers
 - .1 APCO Willamette Valve and Primer Corporation.
 - .2 Crispin Valve.
 - .3 Val-Matic Valve & Manufacturing Corp.
 - .2 Description:
 - .1 Standard: MSS SP-125.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 500 psig (3450 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 400 psig (2760 kPa).
 - .4 Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
 - .5 Style: Compact wafer, spring loaded.
 - .6 Seat: EPDM or NBR.
- .16 Class 300, Iron, Globe, Center-Guided Check Valves with Resilient Seat:
 - .1 Manufacturers
 - .1 APCO Willamette Valve and Primer Corporation.
 - .2 Crispin Valve.
 - .3 Val-Matic Valve & Manufacturing Corp.
 - .2 Description:
 - .1 Standard: MSS SP-125.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 500 psig (3450 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 400 psig (2760 kPa).
 - .4 Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
 - .5 Style: Globe, spring loaded.

- .6 Ends: Flanged.
- .7 Seat: EPDM or NBR.

2.15 IRON, PLATE-TYPE CHECK VALVES

- .1 Class 125, Iron, Dual-Plate Check Valves with Metal Seat:
 - .1 Manufacturers
 - .1 APCO Willamette Valve and Primer Corporation.
 - .2 Crane Co.; Crane Valve Group; Crane Valves.
 - .3 Flomatic Corporation.
 - .4 Mueller Steam Specialty; a division of SPX Corporation.
 - .2 Description:
 - .1 Standard: API STD 594.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
 - .4 Body Design: Wafer, spring-loaded plates.
 - .5 Body Material: ASTM A126, gray iron.
 - .6 Seat: Bronze.
- .2 Class 150, Iron, Dual-Plate Check Valves with Metal Seat:
 - .1 Manufacturers
 - .1 APCO Willamette Valve and Primer Corporation.
 - .2 Crane Co.; Crane Valve Group; Crane Valves.
 - .3 Mueller Steam Specialty; a division of SPX Corporation.
 - .4 Val-Matic Valve & Manufacturing Corp.
 - .2 Description:
 - .1 Standard: API STD 594.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 300 psig (2070 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 250 psig (1725 kPa).
 - .4 Body Design: Wafer, spring-loaded plates.
 - .5 Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
 - .6 Seat: Bronze.
- .3 Class 250, Iron, Dual-Plate Check Valves with Metal Seat:
 - .1 Manufacturers
 - .1 APCO Willamette Valve and Primer Corporation.
 - .2 Crane Co.; Crane Valve Group; Crane Valves.
 - .2 Description:
 - .1 Standard: API STD 594.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 400 psig (2760 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 300 psig (2070 kPa).
 - .4 Body Design: Wafer, spring-loaded plates.
 - .5 Body Material: ASTM A126, gray iron.
 - .6 Seat: Bronze.
- .4 Class 300, Iron, Dual-Plate Check Valves with Metal Seat:
 - .1 Manufacturers
 - .1 APCO Willamette Valve and Primer Corporation.

- .2 Crane Co.; Crane Valve Group; Crane Valves.
- .3 Mueller Steam Specialty; a division of SPX Corporation.
- .4 Val-Matic Valve & Manufacturing Corp.
- .2 Description:
 - .1 Standard: API STD 594.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 500 psig (3450 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 400 psig (2760 kPa).
 - .4 Body Design: Wafer, spring-loaded plates.
 - .5 Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
 - .6 Seat: Bronze.
- .5 Class 125, Iron, Single-Plate Check Valves with Resilient Seat:
 - .1 Manufacturers
 - .1 Flo Fab Inc.
 - .2 Sure Flow Equipment Inc.
 - .2 Description:
 - .1 Standard: API STD 594.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
 - .4 Body Design: Wafer, spring-loaded plate.
 - .5 Body Material: ASTM A126, gray iron.
 - .6 Seat: EPDM or NBR.
- .6 Class 125, Iron, Dual-Plate Check Valves with Resilient Seat:
 - .1 Manufacturers:
 - .1 APCO Willamette Valve and Primer Corporation.
 - .2 Cooper Cameron Valves TVB Techno.
 - .3 Crane Co.; Crane Valve Group; Crane Valves.
 - .4 Crane Co.; Crane Valve Group; Stockham Division.
 - .5 NIBCO INC.
 - .6 Spence Strainers International; a division of CIRCOR International.
 - .7 Sure Flow Equipment Inc.
 - .8 Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - .2 Description:
 - .1 Standard: API STD 594.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
 - .4 Body Design: Wafer, spring-loaded plates.
 - .5 Body Material: ASTM A126, gray iron.
 - .6 Seat: EPDM or NBR.
- .7 Class 150, Iron, Dual-Plate Check Valves with Resilient Seat:
 - .1 Manufacturers
 - .1 APCO Willamette Valve and Primer Corporation.
 - .2 Crane Co.; Crane Valve Group; Crane Valves.
 - .3 Crane Co.; Crane Valve Group; Jenkins Valves.

- .4 Val-Matic Valve & Manufacturing Corp.
- .2 Description:
 - .1 Standard: API STD 594.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 300 psig (2070 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 250 psig (1725 kPa).
 - .4 Body Design: Wafer, spring-loaded plates.
 - .5 Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
 - .6 Seat: EPDM or NBR.
- .8 Class 250, Iron, Wafer, Single-Plate Check Valves with Resilient Seat:
 - .1 Manufacturers
 - .1 Sure Flow Equipment Inc.
 - .2 Description:
 - .1 Standard: API STD 594.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 400 psig (2760 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 300 psig (2070 kPa).
 - .4 Body Design: Wafer, spring-loaded plate.
 - .5 Body Material: ASTM A126, gray iron.
 - .6 Seat: EPDM or NBR.
- .9 Class 250, Iron, Dual-Plate Check Valves with Resilient Seat:
 - .1 Manufacturers
 - .1 APCO Willamette Valve and Primer Corporation.
 - .2 Crane Co.; Crane Valve Group; Crane Valves.
 - .3 Sure Flow Equipment Inc.
 - .2 Description:
 - .1 Standard: API STD 594.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 400 psig (2760 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 300 psig (2070 kPa).
 - .4 Body Design: Wafer, spring-loaded plates.
 - .5 Body Material: ASTM A126, gray iron.
 - .6 Seat: EPDM or NBR.
- .10 Class 300, Iron, Dual-Plate Check Valves with Resilient Seat:
 - .1 Manufacturers:
 - .1 APCO Willamette Valve and Primer Corporation.
 - .2 Val-Matic Valve & Manufacturing Corp.
 - .2 Description:
 - .1 Standard: API STD 594.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 500 psig (3450 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 400 psig (2760 kPa).
 - .4 Body Design: Wafer, spring-loaded plates.
 - .5 Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
 - .6 Seat: EPDM or NBR.

2.16 BRONZE GATE VALVES

- .1 Class 125, NRS Bronze Gate Valves:

- .1 Manufacturers
 - .1 American Valve.
 - .2 Crane Valve Group; Crane Valves.
 - .3 Crane Valve Group; Jenkins Valves.
 - .4 Crane Valve Group; Stockham Division.
 - .5 Hammond Valve.
 - .6 Kitz Corporation.
 - .7 Milwaukee Valve Company.
 - .8 Nibco.
 - .9 Powell Valves.
 - .10 Red-White Valve Corporation.
 - .11 Watts Regulator Co.; a division of Watts Water Technologies.
 - .12 Zy-Tech Global Industries.
- .2 Description:
 - .1 Standard: MSS SP-80, Type 1.
 - .2 CWP Rating: 200 psig (1380 kPa).
 - .3 Body Material: ASTM B62, bronze with integral seat and screw-in bonnet.
 - .4 Ends: Threaded or solder joint.
 - .5 Stem: Bronze.
 - .6 Disc: Solid wedge; bronze.
 - .7 Packing: Asbestos free.
 - .8 Handwheel: Malleable iron, bronze or aluminum.
- .2 Class 125, RS Bronze Gate Valves:
 - .1 Manufacturers
 - .1 American Valve, Inc.
 - .2 Crane Co.; Crane Valve Group; Crane Valves.
 - .3 Crane Co.; Crane Valve Group; Jenkins Valves.
 - .4 Crane Co.; Crane Valve Group; Stockham Division.
 - .5 Hammond Valve.
 - .6 Kitz Corporation.
 - .7 Milwaukee Valve Company.
 - .8 NIBCO INC.
 - .9 Powell Valves.
 - .10 Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - .11 Zy-Tech Global Industries, Inc.
 - .2 Description:
 - .1 Standard: MSS SP-80, Type 2.
 - .2 CWP Rating: 200 psig (1380 kPa)
 - .3 Body Material: ASTM B62, bronze with integral seat and screw-in bonnet.
 - .4 Ends: Threaded or solder joint.
 - .5 Stem: Bronze.
 - .6 Disc: Solid wedge; bronze.
 - .7 Packing: Asbestos free.

- .8 Handwheel: Malleable iron, bronze or aluminum.
- .3 Class 150, NRS Bronze Gate Valves:
 - .1 Manufacturers
 - .1 Hammond Valve.
 - .2 Kitz Corporation.
 - .3 Milwaukee Valve Company.
 - .4 NIBCO INC.
 - .5 Powell Valves.
 - .6 Red-White Valve Corporation.
 - .7 Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - .2 Description:
 - .1 Standard: MSS SP-80, Type 1.
 - .2 CWP Rating: 300 psig (2070 kPa).
 - .3 Body Material: ASTM B62, bronze with integral seat and union-ring bonnet.
 - .4 Ends: Threaded.
 - .5 Stem: Bronze.
 - .6 Disc: Solid wedge; bronze.
 - .7 Packing: Asbestos free.
 - .8 Handwheel: Malleable iron, bronze or aluminum.
- .4 Class 150, RS Bronze Gate Valves:
 - .1 Manufacturers
 - .1 Crane Co.; Crane Valve Group; Crane Valves.
 - .2 Crane Co.; Crane Valve Group; Stockham Division.
 - .3 Hammond Valve.
 - .4 Kitz Corporation.
 - .5 Milwaukee Valve Company.
 - .6 NIBCO INC.
 - .7 Powell Valves.
 - .8 Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - .9 Zy-Tech Global Industries, Inc.
 - .2 Description:
 - .1 Standard: MSS SP-80, Type 2.
 - .2 CWP Rating: 300 psig (2070 kPa).
 - .3 Body Material: ASTM B62, bronze with integral seat and union-ring bonnet.
 - .4 Ends: Threaded.
 - .5 Stem: Bronze.
 - .6 Disc: Solid wedge; bronze.
 - .7 Packing: Asbestos free.
 - .8 Handwheel: Malleable iron, bronze or aluminum.

2.17 IRON GATE VALVES

- .1 Class 125, NRS, Iron Gate Valves:
 - .1 Manufacturers
 - .1 Crane Co.; Crane Valve Group; Crane Valves.

- .2 Crane Co.; Crane Valve Group; Jenkins Valves.
- .3 Crane Co.; Crane Valve Group; Stockham Division.
- .4 Flo Fab Inc.
- .5 Hammond Valve.
- .6 Kitz Corporation.
- .7 Legend Valve.
- .8 Milwaukee Valve Company.
- .9 NIBCO INC.
- .10 Powell Valves.
- .11 Red-White Valve Corporation.
- .12 Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- .13 Zy-Tech Global Industries, Inc.
- .2 Description:
 - .1 Standard: MSS SP-70, Type I.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
 - .4 Body Material: ASTM A126, gray iron with bolted bonnet.
 - .5 Ends: Flanged.
 - .6 Trim: Bronze.
 - .7 Disc: Solid wedge.
 - .8 Packing and Gasket: Asbestos free.
- .2 Class 125, OS&Y, Iron Gate Valves:
 - .1 Manufacturers
 - .1 Crane Co.; Crane Valve Group; Crane Valves.
 - .2 Crane Co.; Crane Valve Group; Jenkins Valves.
 - .3 Crane Co.; Crane Valve Group; Stockham Division.
 - .4 Flo Fab Inc.
 - .5 Hammond Valve.
 - .6 Kitz Corporation.
 - .7 Legend Valve.
 - .8 Milwaukee Valve Company.
 - .9 NIBCO INC.
 - .10 Powell Valves.
 - .11 Red-White Valve Corporation.
 - .12 Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - .13 Zy-Tech Global Industries, Inc.
 - .2 Description:
 - .1 Standard: MSS SP-70, Type I.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
 - .4 Body Material: ASTM A126, gray iron with bolted bonnet.
 - .5 Ends: Flanged.
 - .6 Trim: Bronze.

- .7 Disc: Solid wedge.
 - .8 Packing and Gasket: Asbestos free.
 - .3 Class 250, NRS, Iron Gate Valves:
 - .1 Manufacturers
 - .1 Crane Co.; Crane Valve Group; Crane Valves.
 - .2 Crane Co.; Crane Valve Group; Stockham Division.
 - .3 NIBCO INC.
 - .2 Description:
 - .1 Standard: MSS SP-70, Type I.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 500 psig (3450 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 300 psig (2070 kPa).
 - .4 Body Material: ASTM A126, gray iron with bolted bonnet.
 - .5 Ends: Flanged.
 - .6 Trim: Bronze.
 - .7 Disc: Solid wedge.
 - .8 Packing and Gasket: Asbestos free.
- .4 Class 250, OS&Y, Iron Gate Valves:
 - .1 Manufacturers
 - .1 Crane Co.; Crane Valve Group; Crane Valves.
 - .2 Crane Co.; Crane Valve Group; Stockham Division.
 - .3 Hammond Valve.
 - .4 Milwaukee Valve Company.
 - .5 NIBCO INC.
 - .6 Powell Valves.
 - .7 Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - .2 Description:
 - .1 Standard: MSS SP-70, Type I.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 500 psig (3450 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 300 psig (2070 kPa).
 - .4 Body Material: ASTM A126, gray iron with bolted bonnet.
 - .5 Ends: Flanged.
 - .6 Trim: Bronze.
 - .7 Disc: Solid wedge.
 - .8 Packing and Gasket: Asbestos free.

2.18 BRONZE GLOBE VALVES

- .1 Class 125, Bronze Globe Valves with Bronze Disc:
 - .1 Manufacturers
 - .1 Crane Co.; Crane Valve Group; Crane Valves.
 - .2 Crane Co.; Crane Valve Group; Stockham Division.
 - .3 Hammond Valve.
 - .4 Kitz Corporation.
 - .5 Milwaukee Valve Company.
 - .6 NIBCO INC.

- .7 Powell Valves.
 - .8 Red-White Valve Corporation.
 - .9 Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - .10 Zy-Tech Global Industries, Inc.
- .2 Description:
 - .1 Standard: MSS SP-80, Type 1.
 - .2 CWP Rating: 200 psig (1380 kPa).
 - .3 Body Material: ASTM B62, bronze with integral seat and screw-in bonnet.
 - .4 Ends: Threaded or solder joint.
 - .5 Stem and Disc: Bronze.
 - .6 Packing: Asbestos free.
 - .7 Handwheel: Malleable iron, bronze or aluminum.
- .2 Class 125, Bronze Globe Valves with Nonmetallic Disc:
 - .1 Manufacturers
 - .1 Crane Co.; Crane Valve Group; Crane Valves.
 - .2 Crane Co.; Crane Valve Group; Stockham Division.
 - .3 NIBCO INC.
 - .4 Red-White Valve Corporation.
 - .2 Description:
 - .1 Standard: MSS SP-80, Type 2.
 - .2 CWP Rating: 200 psig (1380 kPa).
 - .3 Body Material: ASTM B62 , bronze with integral seat and screw-in bonnet.
 - .4 Ends: Threaded or solder joint.
 - .5 Stem: Bronze.
 - .6 Disc: PTFE or TFE.
 - .7 Packing: Asbestos free.
 - .8 Handwheel: Malleable iron, bronze or aluminum.
- .3 Class 150, Bronze Globe Valves with Nonmetallic Disc:
 - .1 Manufacturers
 - .1 Crane Valve Group; Crane Valves.
 - .2 Hammond Valve.
 - .3 Kitz Corporation.
 - .4 Milwaukee Valve Company.
 - .5 Nibco.
 - .6 Powell Valves.
 - .7 Red-White Valve Corporation.
 - .8 Watts Regulator Co.; a division of Watts Water Technologies.
 - .9 Zy-Tech Global Industries.
 - .2 Description:
 - .1 Standard: MSS SP-80, Type 2.
 - .2 CWP Rating: 300 psig (2070 kPa).
 - .3 Body Material: ASTM B62, bronze with integral seat and union-ring bonnet.
 - .4 Ends: Threaded.

- .5 Stem: Bronze.
- .6 Disc: PTFE or TFE.
- .7 Packing: Asbestos free.
- .8 Handwheel: Malleable iron, bronze or aluminum.

2.19 IRON GLOBE VALVES

- .1 Class 125, Iron Globe Valves:
 - .1 Manufacturers
 - .1 Crane Co.; Crane Valve Group; Crane Valves.
 - .2 Crane Co.; Crane Valve Group; Jenkins Valves.
 - .3 Crane Co.; Crane Valve Group; Stockham Division.
 - .4 Hammond Valve.
 - .5 Kitz Corporation.
 - .6 Milwaukee Valve Company.
 - .7 NIBCO INC.
 - .8 Powell Valves.
 - .9 Red-White Valve Corporation.
 - .10 Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - .11 Zy-Tech Global Industries, Inc.
 - .2 Description:
 - .1 Standard: MSS SP-85, Type I.
 - .2 CWP Rating: 200 psig (1380 kPa).
 - .3 Body Material: ASTM A126 , gray iron with bolted bonnet.
 - .4 Ends: Flanged.
 - .5 Trim: Bronze.
 - .6 Packing and Gasket: Asbestos free.
- .2 Class 250, Iron Globe Valves:
 - .1 Manufacturers
 - .1 Crane Co.; Crane Valve Group; Crane Valves.
 - .2 Crane Co.; Crane Valve Group; Jenkins Valves.
 - .3 Crane Co.; Crane Valve Group; Stockham Division.
 - .4 Hammond Valve.
 - .5 Milwaukee Valve Company.
 - .6 NIBCO INC.
 - .7 Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - .2 Description:
 - .1 Standard: MSS SP-85, Type I.
 - .2 CWP Rating: 500 psig (3450 kPa).
 - .3 Body Material: ASTM A126, gray iron with bolted bonnet.
 - .4 Ends: Flanged.
 - .5 Trim: Bronze.
 - .6 Packing and Gasket: Asbestos free.

2.20 LUBRICATED PLUG VALVES

- .1 Class 125, Regular-Gland, Lubricated Plug Valves with Threaded Ends:
 - .1 Manufacturers:
 - .1 Nordstrom Valves, Inc.
 - .2 Description:
 - .1 Standard: MSS SP-78, Type II.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
 - .4 Body Material: ASTM A48/A48M or ASTM A126, cast iron with lubrication-sealing system.
 - .5 Pattern: Regular or short.
 - .6 Plug: Cast iron or bronze with sealant groove.
- .2 Class 125, Regular-Gland, Lubricated Plug Valves with Flanged Ends:
 - .1 Description:
 - .1 Standard: MSS SP-78, Type II.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
 - .4 Body Material: ASTM A48/A48M or ASTM A126, cast iron with lubrication-sealing system.
 - .5 Pattern: Regular or short.
 - .6 Plug: Cast iron or bronze with sealant groove.
- .3 Class 125, Cylindrical, Lubricated Plug Valves with Threaded Ends:
 - .1 Manufacturers:
 - .1 Homestead Valve; a division of Olson Technologies, Inc.
 - .2 Milliken Valve Company.
 - .3 R & M Energy Systems; a unit of Robbins & Myers, Inc.
 - .2 Description:
 - .1 Standard: MSS SP-78, Type IV.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
 - .4 Body Material: ASTM A48/A48M or ASTM A126, cast iron with lubrication-sealing system.
 - .5 Pattern: Regular or short.
 - .6 Plug: Cast iron or bronze with sealant groove.
- .4 Class 125, Cylindrical, Lubricated Plug Valves with Flanged Ends:
 - .1 Manufacturers:
 - .1 Homestead Valve; a division of Olson Technologies, Inc.
 - .2 Milliken Valve Company.
 - .3 R & M Energy Systems; a unit of Robbins & Myers, Inc.
 - .2 Description:
 - .1 Standard: MSS SP-78, Type IV.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 150 psig (1035 kPa).
 - .4 Body Material: ASTM A48/A48M or ASTM A126, cast iron with lubrication-sealing system.

- .5 Pattern: Regular or short.
 - .6 Plug: Cast iron or bronze with sealant groove.
- .5 Class 250, Regular-Gland, Lubricated Plug Valves with Threaded Ends:
 - .1 Manufacturers:
 - .1 Nordstrom Valves, Inc.
 - .2 Description:
 - .1 Standard: MSS SP-78, Type II.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 400 psig (2760 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 300 psig (2070 kPa).
 - .4 Body Material: ASTM A48/A48M or ASTM A126, cast iron with lubrication-sealing system.
 - .5 Pattern: Regular or short.
 - .6 Plug: Cast iron or bronze with sealant groove.
- .6 Class 250, Regular-Gland, Lubricated Plug Valves with Flanged Ends:
 - .1 Manufacturers:
 - .1 Nordstrom Valves, Inc.
 - .2 Description:
 - .1 Standard: MSS SP-78, Type II.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 400 psig (2760 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 300 psig (2070 kPa).
 - .4 Body Material: ASTM A48/A48M or ASTM A126, cast iron with lubrication-sealing system.
 - .5 Pattern: Regular or short.
 - .6 Plug: Cast iron or bronze with sealant groove.
- .7 Class 250, Cylindrical, Lubricated Plug Valves with Threaded Ends:
 - .1 Manufacturers:
 - .1 Homestead Valve; a division of Olson Technologies, Inc.
 - .2 Milliken Valve Company.
 - .3 R & M Energy Systems; a unit of Robbins & Myers, Inc.
 - .2 Description:
 - .1 Standard: MSS SP-78, Type IV.
 - .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 400 psig (2760 kPa).
 - .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 300 psig (2070 kPa).
 - .4 Body Material: ASTM A48/A48M or ASTM A126, cast iron with lubrication-sealing system.
 - .5 Pattern: Regular or short.
 - .6 Plug: Cast iron or bronze with sealant groove.
- .8 Class 250, Cylindrical, Lubricated Plug Valves with Flanged Ends:
 - .1 Manufacturers:
 - .1 Homestead Valve; a division of Olson Technologies, Inc.
 - .2 Milliken Valve Company.
 - .3 R & M Energy Systems; a unit of Robbins & Myers, Inc.
 - .2 Description:
 - .1 Standard: MSS SP-78, Type IV.

- .2 NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 400 psig (2760 kPa).
- .3 NPS 14 to NPS 24 (DN 350 to DN 600), CWP Rating: 300 psig (2070 kPa).
- .4 Body Material: ASTM A48/A48M or ASTM A126, Grade 40 cast iron with lubrication-sealing system.
- .5 Pattern: Regular or short.
- .6 Plug: Cast iron or bronze with sealant groove.

2.21 ECCENTRIC PLUG VALVES

- .1 175 CWP, Eccentric Plug Valves with Resilient Seating:
 - .1 Manufacturers
 - .1 Clow Valve Co.; a division of McWane, Inc.
 - .2 DeZurik Water Controls.
 - .3 Homestead Valve; a division of Olson Technologies, Inc.
 - .4 M&H Valve Company; a division of McWane, Inc.
 - .5 Milliken Valve Company.
 - .6 Henry Pratt Company.
 - .7 Val-Matic Valve & Manufacturing Corp.
 - .2 Description:
 - .1 Standard: MSS SP-108.
 - .2 CWP Rating: 175 psig (1200 kPa) minimum.
 - .3 Body and Plug: ASTM A48/A48M, gray iron; ASTM A126, gray iron; or ASTM A536, ductile iron.
 - .4 Bearings: Oil-impregnated bronze or stainless steel.
 - .5 Ends: Flanged.
 - .6 Stem-Seal Packing: Asbestos free.
 - .7 Plug, Resilient-Seating Material: Suitable for potable-water service unless otherwise indicated.

2.22 DRAIN VALVES

- .1 Ball-Valve-Type, Hose-End Drain Valves:
 - .1 Bronze ball valve as specified in this Section.
 - .2 Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.23 CHAINWHEELS

- .1 Manufacturers
 - .1 Babbitt Steam Specialty Co.
 - .2 Roto Hammer Industries.
 - .3 Trumbull Industries.
- .2 Description: Valve actuation assembly with sprocket rim, brackets, and chain.
 - .1 Brackets: Type, number, size, and fasteners required to mount actuator on valve.
 - .2 Attachment: For connection to ball butterfly, gate, globe and plug valve stems.
 - .3 Sprocket Rim with Chain Guides: Ductile iron Ductile or cast iron, of type and size required for valve. Include zinc coating.
 - .4 Chain: Hot-dip, galvanized steel Brass, of size required to fit sprocket rim.

PART 3 EXECUTION

3.1 APPLICATION

- .1 If valve applications are not indicated, use the following:
 - .1 Shutoff Service: Ball, butterfly, gate, or plug valves.
 - .2 Butterfly Valve Dead-End Service: Single-flange (lug) type.
 - .3 Throttling Service, Steam: Globe or angle valves.
 - .4 Pump-Discharge Check Valves:
 - .1 NPS 2 (DN 50) and Smaller: Bronze swing check valves with bronze or nonmetallic disc.
 - .2 NPS 2-1/2 (DN 65) and Larger for Hydronic: Iron swing check valves with lever and weight or with spring or iron, center-guided, bronze or resilient-seat check valves.
- .2 Select valves, except wafer types, with the following end connections:
 - .1 For Copper Tubing, NPS 2 (DN 50) and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
 - .2 For Copper Tubing, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.
 - .3 For Copper Tubing, NPS 5 (DN 125) and Larger: Flanged ends.
 - .4 For Steel Piping, NPS 2 (DN 50) and Smaller: Threaded ends.
 - .5 For Steel Piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.
 - .6 For Steel Piping, NPS 5 (DN 125) and Larger: Flanged ends.
 - .7 For Grooved-End Copper Tubing and Steel Piping except Steam and Steam Condensate Piping: Valve ends may be grooved.

3.2 EXAMINATION

- .1 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.
- .2 Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- .3 Examine threads on valve and mating pipe for form and cleanliness.
- .4 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.
- .5 Do not attempt to repair defective valves; replace with new valves.

3.3 INSTALLATION

- .1 Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- .2 Locate valves for easy access and provide separate support where necessary.
- .3 Install valves in horizontal piping with stem at or above center of pipe.
- .4 Install valves in position to allow full stem movement.
- .5 Install chainwheels on operators for ball butterfly, gate, globe and plug valves NPS 4 (DN 100) and larger and more than 96 inches (2400 mm) above floor. Extend chains to 60 inches (1520 mm) above finished floor.

- .6 Install check valves for proper direction of flow and as follows:
 - .1 Swing Check Valves: In horizontal position with hinge pin level.
 - .2 Center-Guided and Plate-Type Check Valves: In horizontal or vertical position, between flanges.
 - .3 Lift Check Valves: With stem upright and plumb.

3.4 ADJUSTING

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

END OF SECTION

PART 1 GENERAL

1.1 GENERAL REFERENCES

- .1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.
- .2 Division 20, including all Common Mechanical Requirements in Section 20 00 00, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.

1.2 RELATED REQUIREMENTS

1.3 SUBMITTALS

- .1 Action Submittals
 - .1 Installer Qualifications: Submit name of adjusting and balancing agency and TAB supervisor for approval within 30 days after award of Contract.
 - .2 TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.
 - .1 Submit to Architect.
 - .2 Submit to the Commissioning Authority.
 - .3 Submit six weeks prior to starting the testing, adjusting, and balancing work.
 - .4 Include certification that the plan developer has reviewed Contract Documents, the equipment and systems, and the control system with the Architect and other installers to sufficiently understand the design intent for each system.
 - .5 Include at least the following in the plan:
 - .1 Preface: An explanation of the intended use of the control system.
 - .2 List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
 - .3 Copy of field checkout sheets and logs to be used, listing each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.
 - .4 Identification and types of measurement instruments to be used and their most recent calibration date.
 - .5 Discussion of what notations and markings will be made on the duct and piping drawings during the process.
 - .6 Final test report forms to be used.
 - .7 Detailed step-by-step procedures for TAB work for each system and issue, including:
 - .1 Terminal flow calibration (for each terminal type).
 - .2 Diffuser proportioning.
 - .3 Branch/submain proportioning.
 - .4 Total flow calculations.
 - .5 Rechecking.
 - .6 Diversity issues.
 - .8 Expected problems and solutions, etc.

- .9 Criteria for using air flow straighteners or relocating flow stations and sensors; analogous explanations for the water side.
- .10 Details of how TOTAL flow will be determined; for example:
 - .1 Air: Sum of terminal flows via control system calibrated readings or via hood readings of all terminals, supply (SA) and return air (RA) pitot traverse, SA or RA flow stations.
 - .2 Water: Pump curves, circuit setter, flow station, ultrasonic, etc.
- .11 Specific procedures that will ensure that both air and water side are operating at the lowest possible pressures and methods to verify this.
- .12 Confirmation of understanding of the outside air ventilation criteria under all conditions.
- .13 Method of verifying and setting minimum outside air flow rate will be verified and set and for what level (total building, zone, etc.).
- .14 Method of checking building static and exhaust fan and/or relief damper capacity.
- .15 Proposed selection points for sound measurements and sound measurement methods.
- .16 Methods for making coil or other system plant capacity measurements, if specified.
- .17 Time schedule for TAB work to be done in phases (by floor, etc.).
- .18 Description of TAB work for areas to be built out later, if any.
- .19 Time schedule for deferred or seasonal TAB work, if specified.
- .20 False loading of systems to complete TAB work, if specified.
- .21 Exhaust fan balancing and capacity verifications, including any required room pressure differentials.
- .22 Interstitial cavity differential pressure measurements and calculations, if specified.
- .23 Procedures for field technician logs of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests (scope and frequency).
- .24 Procedures for formal progress reports, including scope and frequency.
- .25 Procedures for formal deficiency reports, including scope, frequency and distribution.
- .3 Field Logs: Submit at least twice a week to the Commissioning Authority.
- .4 Control System Coordination Reports: Communicate in writing to the controls installer all setpoint and parameter changes made or problems and discrepancies identified during TAB that affect, or could affect, the control system setup and operation.
- .5 Progress Reports.
- .6 Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
 - .1 Submit under provisions of Section 01 40 00.
 - .2 Submit to the the Commissioning Authority within two weeks after completion of testing, adjusting, and balancing.
 - .3 Revise TAB plan to reflect actual procedures and submit as part of final report.
 - .4 Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect and for inclusion in operating and maintenance manuals.

- .5 Provide reports in soft cover, letter size, 3-ring binder manuals, complete with index page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.
- .6 Include actual instrument list, with manufacturer name, serial number, and date of calibration.
- .7 Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.
- .8 Units of Measure: Report data in both I-P (inch-pound) and SI (metric) units.
- .9 Include the following on the title page of each report:
 - .1 Name of Testing, Adjusting, and Balancing Agency.
 - .2 Address of Testing, Adjusting, and Balancing Agency.
 - .3 Telephone number of Testing, Adjusting, and Balancing Agency.
 - .4 Project name.
 - .5 Project location.
 - .6 Project Architect.
 - .7 Project Engineer.
 - .8 Project Contractor.
 - .9 Project altitude.
 - .10 Report date.
- .2 Record Documents
 - .1 Record actual locations of flow measuring stations and balancing valves and rough setting.
- 1.4 TESTING, ADJUSTMENT, AND BALANCING OF AIR SYSTEMS.**
- 1.5 TESTING, ADJUSTMENT, AND BALANCING OF HYDRONIC, STEAM, AND REFRIGERATING SYSTEMS.**
- 1.6 MEASUREMENT OF FINAL OPERATING CONDITION OF HVAC SYSTEMS.**
- 1.7 SOUND MEASUREMENT OF EQUIPMENT OPERATING CONDITIONS.**
- 1.8 VIBRATION MEASUREMENT OF EQUIPMENT OPERATING CONDITIONS.**
- 1.9 COMMISSIONING ACTIVITIES.**

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.1 EXAMINATION

- .1 Verify that systems are complete and operable before commencing work. Ensure the following conditions:
 - .1 Systems are started and operating in a safe and normal condition.
 - .2 Temperature control systems are installed complete and operable.
 - .3 Proper thermal overload protection is in place for electrical equipment.
 - .4 Final filters are clean and in place. If required, install temporary media in addition to final filters.
 - .5 Duct systems are clean of debris.

- .6 Fans are rotating correctly.
- .7 Fire and volume dampers are in place and open.
- .8 Air coil fins are cleaned and combed.
- .9 Access doors are closed and duct end caps are in place.
- .10 Air outlets are installed and connected.
- .11 Duct system leakage is minimized.
- .12 Hydronic systems are flushed, filled, and vented.
- .13 Pumps are rotating correctly.
- .14 Proper strainer baskets are clean and in place.
- .15 Service and balance valves are open.
- .2 Submit field reports. Report defects and deficiencies that will or could prevent proper system balance.
- .3 Beginning of work means acceptance of existing conditions.

3.2 PREPARATION

- .1 Hold a pre-balancing meeting at least one week prior to starting TAB work.
 - .1 Require attendance by all installers whose work will be tested, adjusted, or balanced.
- .2 Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Architect to facilitate spot checks during testing.
- .3 Provide additional balancing devices as required.

3.3 ADJUSTING

- .1 Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 10 percent of design for return and exhaust systems.
- .2 Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.
- .3 Hydronic Systems: Adjust to within plus or minus 10 percent of design.
- .4 Field Logs: Maintain written logs including:
 - .1 Running log of events and issues.
 - .2 Discrepancies, deficient or uncompleted work by others.
 - .3 Contract interpretation requests.
 - .4 Lists of completed tests.
- .5 Ensure recorded data represents actual measured or observed conditions.
- .6 Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- .7 Mark on drawings the locations where traverse and other critical measurements were taken and cross reference the location in the final report.
- .8 After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
- .9 Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
- .10 At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Owner.
- .11 Check and adjust systems approximately six months after final acceptance and submit report.

3.4 GENERAL REQUIREMENTS

- .1 Perform total system balance in accordance with one of the following:
 - .1 AABC (NSTSB), AABC National Standards for Total System Balance.
 - .2 ASHRAE Std 111, Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems.
 - .3 SMACNA (TAB).
 - .4 Maintain at least one copy of the standard to be used at project site at all times.
- .2 Begin work after completion of systems to be tested, adjusted, or balanced and complete work prior to Substantial Completion of the project.
- .3 Where HVAC systems and/or components interface with life safety systems, including fire and smoke detection, alarm, and control, coordinate scheduling and testing and inspection procedures with the authorities having jurisdiction.
- .4 TAB Agency Qualifications:
 - .1 Company specializing in the testing, adjusting, and balancing of systems specified in this section.
 - .2 Having minimum of three years documented experience.
 - .3 Certified by one of the following:
 - .1 AABC, Associated Air Balance Council: www.aabc.com/#sle; upon completion submit AABC National Performance Guaranty.
 - .2 NEBB, National Environmental Balancing Bureau: www.nebb.org/#sle.
 - .3 TABB, The Testing, Adjusting, and Balancing Bureau of National Energy Management Institute: www.tabbcertified.org/#sle.
- .5 TAB Supervisor and Technician Qualifications: Certified by same organization as TAB agency.
- .6 TAB Supervisor Qualifications: Professional Engineer licensed in the State in which the Project is located.

3.5 AIR SYSTEM PROCEDURE

- .1 Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude.
- .2 Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.
- .3 Measure air quantities at air inlets and outlets.
- .4 Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.
- .5 Use volume control devices to regulate air quantities only to extend that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.
- .6 Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.
- .7 Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
- .8 Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.
- .9 Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
- .10 Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

- .11 Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.
- .12 Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 0.05 inches (12.5 Pa) positive static pressure near the building entries.
- .13 Check multi-zone units for motorized damper leakage. Adjust air quantities with mixing dampers set first for cooling, then heating, then modulating.
- .14 For variable air volume system powered units set volume controller to air flow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable air volume temperature control.
- .15 On fan powered VAV boxes, adjust air flow switches for proper operation.

3.6 COMMISSIONING

- .1 See Sections 01 91 13 - General Commissioning Requirements and 23 08 00 for additional requirements.
- .2 Perform prerequisites prior to starting commissioning activities.
- .3 Fill out Prefunctional Checklists for:
 - .1 Air side systems.
 - .2 Water side systems.
- .4 Furnish to the Commissioning Authority, upon request, any data gathered but not shown in the final TAB report.
- .5 In the presence of the Commissioning Authority, verify that:
 - .1 Final settings of all valves, splitters, dampers and other adjustment devices have been permanently marked.
 - .2 The air system is being controlled to the lowest possible static pressure while still meeting design loads, less diversity; this shall include a review of TAB methods, established control setpoints, and physical verification of at least one leg from fan to diffuser having all balancing dampers wide open and that during full cooling of all terminal units taking off downstream of the static pressure sensor, the terminal unit on the critical leg has its damper 90 percent or more open.
 - .3 The water system is being controlled to the lowest possible pressure while still meeting design loads, less diversity; this shall include a review of TAB methods, established control setpoints, and physical verification of at least one leg from the pump to the coil having all balancing valves wide open and that during full cooling the cooling coil valve of that leg is 90 percent or more open.
- .6 No seasonal tests are required.
- .7 No further monitoring is required.
- .8 No deferred testing is required.

3.7 SCOPE

- .1 Test, adjust, and balance the following:
 - .1 HVAC Pumps.
 - .2 Air Coils.
 - .3 Terminal Heat Transfer Units.
 - .4 Air Handling Units.
 - .5 Fans.
 - .6 Air Filters.

- .7 Air Terminal Units.
- .8 Air Inlets and Outlets.

3.8 MINIMUM DATA TO BE REPORTED

- .1 Electric Motors:
 - .1 Manufacturer.
 - .2 Model/Frame.
 - .3 HP/BHP.
 - .4 Phase, voltage, amperage; nameplate, actual, no load.
 - .5 RPM.
 - .6 Service factor.
 - .7 Starter size, rating, heater elements.
 - .8 Sheave Make/Size/Bore.
- .2 Cooling Coils:
 - .1 Identification/number.
 - .2 Location.
 - .3 Service.
 - .4 Manufacturer.
 - .5 Air flow, design and actual.
 - .6 Entering air DB temperature, design and actual.
 - .7 Entering air WB temperature, design and actual.
 - .8 Leaving air DB temperature, design and actual.
 - .9 Leaving air WB temperature, design and actual.
 - .10 Water flow, design and actual.
 - .11 Water pressure drop, design and actual.
 - .12 Entering water temperature, design and actual.
 - .13 Leaving water temperature, design and actual.
 - .14 Saturated suction temperature, design and actual.
 - .15 Air pressure drop, design and actual.
- .3 Heating Coils:
 - .1 Identification/number.
 - .2 Location.
 - .3 Service.
 - .4 Manufacturer.
 - .5 Air flow, design and actual.
 - .6 Water flow, design and actual.
 - .7 Water pressure drop, design and actual.
 - .8 Entering water temperature, design and actual.
 - .9 Leaving water temperature, design and actual.
 - .10 Entering air temperature, design and actual.
 - .11 Leaving air temperature, design and actual.
 - .12 Air pressure drop, design and actual.
- .4 Electric Duct Heaters:
 - .1 Manufacturer.

- .2 Identification/number.
- .3 Location.
- .4 Model number.
- .5 Design kW.
- .6 Number of stages.
- .7 Phase, voltage, amperage.
- .8 Test voltage (each phase).
- .9 Test amperage (each phase).
- .10 Air flow, specified and actual.
- .11 Temperature rise, specified and actual.
- .5 Air Moving Equipment:
 - .1 Location.
 - .2 Manufacturer.
 - .3 Model number.
 - .4 Serial number.
 - .5 Arrangement/Class/Discharge.
 - .6 Air flow, specified and actual.
 - .7 Return air flow, specified and actual.
 - .8 Outside air flow, specified and actual.
 - .9 Total static pressure (total external), specified and actual.
 - .10 Inlet pressure.
 - .11 Discharge pressure.
 - .12 Sheave Make/Size/Bore.
 - .13 Number of Belts/Make/Size.
 - .14 Fan RPM.
- .6 Return Air/Outside Air:
 - .1 Identification/location.
 - .2 Design air flow.
 - .3 Actual air flow.
 - .4 Design return air flow.
 - .5 Actual return air flow.
 - .6 Design outside air flow.
 - .7 Actual outside air flow.
 - .8 Return air temperature.
 - .9 Outside air temperature.
 - .10 Required mixed air temperature.
 - .11 Actual mixed air temperature.
 - .12 Design outside/return air ratio.
 - .13 Actual outside/return air ratio.
- .7 Exhaust Fans:
 - .1 Location.
 - .2 Manufacturer.
 - .3 Model number.

- .4 Serial number.
- .5 Air flow, specified and actual.
- .6 Total static pressure (total external), specified and actual.
- .7 Inlet pressure.
- .8 Discharge pressure.
- .9 Sheave Make/Size/Bore.
- .10 Number of Belts/Make/Size.
- .11 Fan RPM.
- .8 Duct Traverses:
 - .1 System zone/branch.
 - .2 Duct size.
 - .3 Area.
 - .4 Design velocity.
 - .5 Design air flow.
 - .6 Test velocity.
 - .7 Test air flow.
 - .8 Duct static pressure.
 - .9 Air temperature.
 - .10 Air correction factor.
- .9 Duct Leak Tests:
 - .1 Description of ductwork under test.
 - .2 Duct design operating pressure.
 - .3 Duct design test static pressure.
 - .4 Duct capacity, air flow.
 - .5 Maximum allowable leakage duct capacity times leak factor.
 - .6 Test apparatus:
 - .1 Blower.
 - .2 Orifice, tube size.
 - .3 Orifice size.
 - .4 Calibrated.
 - .7 Test static pressure.
 - .8 Test orifice differential pressure.
 - .9 Leakage.
- .10 Air Monitoring Stations:
 - .1 Identification/location.
 - .2 System.
 - .3 Size.
 - .4 Area.
 - .5 Design velocity.
 - .6 Design air flow.
 - .7 Test velocity.
 - .8 Test air flow.
- .11 Flow Measuring Stations:

- .1 Identification/number.
- .2 Location.
- .3 Size.
- .4 Manufacturer.
- .5 Model number.
- .6 Serial number.
- .7 Design Flow rate.
- .8 Design pressure drop.
- .9 Actual/final pressure drop.
- .10 Actual/final flow rate.
- .11 Station calibrated setting.
- .12 Terminal Unit Data:
 - .1 Manufacturer.
 - .2 Type, constant, variable, single, dual duct.
 - .3 Identification/number.
 - .4 Location.
 - .5 Model number.
 - .6 Size.
 - .7 Minimum static pressure.
 - .8 Minimum design air flow.
 - .9 Maximum design air flow.
 - .10 Maximum actual air flow.
 - .11 Inlet static pressure.
- .13 Air Distribution Tests:
 - .1 Air terminal number.
 - .2 Room number/location.
 - .3 Terminal type.
 - .4 Terminal size.
 - .5 Area factor.
 - .6 Design velocity.
 - .7 Design air flow.
 - .8 Test (final) velocity.
 - .9 Test (final) air flow.
 - .10 Percent of design air flow.
- .14 Sound Level Reports:
 - .1 Location.
 - .2 Octave bands - equipment off.
 - .3 Octave bands - equipment on.
- .15 Vibration Tests:
 - .1 Location of points:
 - .1 Fan bearing, drive end.
 - .2 Fan bearing, opposite end.
 - .3 Motor bearing, center (if applicable).

- .4 Motor bearing, drive end.
- .5 Motor bearing, opposite end.
- .6 Casing (bottom or top).
- .7 Casing (side).
- .8 Duct after flexible connection (discharge).
- .9 Duct after flexible connection (suction).
- .2 Test readings:
 - .1 Horizontal, velocity and displacement.
 - .2 Vertical, velocity and displacement.
 - .3 Axial, velocity and displacement.
- .3 Normally acceptable readings, velocity and acceleration.
- .4 Unusual conditions at time of test.
- .5 Vibration source (if non-complying).

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- .1 Cellular Melamine.
- .2 Glass Fiber, Flexible.
- .3 Glass Fiber, Rigid.
- .4 Flexible Removable and Reusable Blanket Insulation.
- .5 Cellular Glass.
- .6 Expanded Polystyrene.
- .7 Expanded Perlite.
- .8 Hydrous Calcium Silicate.
- .9 Polyisocyanurate Cellular Plastic.
- .10 Polyethylene.
- .11 Flexible Elastomeric Cellular Insulation.
- .12 Rigid, Cellular Phenolic.
- .13 Extruded Polystyrene (XPS) Board Insulation.
- .14 Weather Barrier Coatings.
- .15 Jacketing and Accessories.
- .16 Engineered Wall Outlet Seals and Refrigerant Piping Insulation Protection.
- .17 Accessories.

1.2 GENERAL REFERENCES

- .1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.
- .2 Division 20, including all Common Mechanical Requirements in Section 200000, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.

1.3 RELATED REQUIREMENTS

1.4 SUBMITTALS

- .1 Action Submittals
- .2 Informational Submittals
- .3 Closeout Submittals
- .4 LEED Submittals
- .5 Operation and Maintenance Materials
- .6 Record Documents

1.5 QUALITY ASSURANCE

- .1 Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years of documented experience.
- .2 Applicator Qualifications: Company specializing in performing the type of work specified in this section with minimum _____ years of experience.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

1.7 SUMMARY DESCRIPTION

- .1 Piping insulation.
- .2 Flexible removable and reusable blanket insulation.
- .3 Weather barrier coatings.
- .4 Jacketing and accessories.
- .5 Engineered wall outlet seals and refrigerant piping insulation protection.

1.8 FIELD CONDITIONS

- .1 Maintain ambient conditions required by manufacturers of each product.
- .2 Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 PRODUCTS

2.1 REGULATORY REQUIREMENTS

- .1 Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.2 CELLULAR MELAMINE

2.3 GLASS FIBER, FLEXIBLE

2.4 GLASS FIBER, RIGID

2.5 FLEXIBLE REMOVABLE AND REUSABLE BLANKET INSULATION

2.6 CELLULAR GLASS

2.7 EXPANDED POLYSTYRENE

2.8 EXPANDED PERLITE

2.9 HYDROUS CALCIUM SILICATE

2.10 POLYISOCYANURATE CELLULAR PLASTIC

2.11 POLYETHYLENE

2.12 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

2.13 RIGID, CELLULAR PHENOLIC

2.14 EXTRUDED POLYSTYRENE (XPS) BOARD INSULATION

2.15 WEATHER BARRIER COATINGS

2.16 JACKETING AND ACCESSORIES

2.17 ENGINEERED WALL OUTLET SEALS AND REFRIGERANT PIPING INSULATION PROTECTION

2.18 ACCESSORIES

PART 3 EXECUTION

3.1 EXAMINATION

3.2 SCHEDULE

- .1 Heating Systems:
 - .1 Heating Water Supply and Return:
- .2 Cooling Systems:
 - .1 Chilled Water:
 - .2 Cold Condensate Drains:
 - .3 Condensate Drains from Cooling Coils:
 - .4 External Sprayed Coil Piping:

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- .1 Control System.
- .2 BAS Equipment.
- .3 Local Control Units.
- .4 Unitary Controllers.
- .5 Alarm Panels.
- .6 Analog Controllers.
- .7 Time Clocks.
- .8 Electronic Sensors.
- .9 Pneumatic Sensors and Devices.
- .10 Status Sensors and Devices – Electric.
- .11 Gas Detection Equipment.
- .12 Occupancy, Daylighting, And Photo-Electric Sensors.
- .13 Airflow Measuring Stations.
- .14 Duct-Mounted Airflow Station.
- .15 Flow Meters.
- .16 DDC BTU Metering.
- .17 Thermostats.
- .18 Humidistats.
- .19 Actuators.
- .20 Control Valves.
- .21 Dampers.
- .22 Air Supply.
- .23 Control Cable.

1.2 GENERAL REFERENCES

- .1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.
- .2 Division 20, including all Common Mechanical Requirements in Section 20 00 00, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.

1.3 RELATED REQUIREMENTS

1.4 DEFINITIONS

- .1 LonWorks: A control network technology platform for designing and implementing interoperable control devices and networks licensed by Echelon Corp.
- .2 BACnet: A communications protocol for implementing interoperable controllers established by ASHRAE

1.5 PERFORMANCE REQUIREMENTS

- .1 Comply with the following performance requirements:
 - .1 Graphic Display: Display graphic with minimum 30 dynamic points with current data within 5 seconds.

- .2 Graphic Refresh: Update graphic with minimum 30 dynamic points with current data within 2 seconds.
- .3 Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.
- .4 Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.
- .5 Alarm Response Time: Annunciate alarm at workstation within 15 seconds. Multiple workstations must receive alarms within five seconds of each other.
- .6 Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.
- .7 Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.
- .8 Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:
 - .1 Water Temperature: Plus or minus 1 degree F (0.56 degrees C).
 - .2 Water Flow: Plus or minus 5 percent of full scale.
 - .3 Water Pressure: Plus or minus 2 percent of full scale.
 - .4 Space Temperature: Plus or minus 1 degree F (0.56 degrees C).
 - .5 Ducted Air Temperature: Plus or minus 1 degree F (0.56 degrees C).
 - .6 Outside Air Temperature: Plus or minus 2 degrees F (1.1 degrees C).
 - .7 Averaging Air Temperature: Plus or minus 2 degrees F (1.1 degrees C).
 - .8 Dew Point Temperature: Plus or minus 2.7 degrees F (1.5 degrees C).
 - .9 Temperature Differential: Plus or minus 0.27 degrees F (0.15 degrees C).
 - .10 Relative Humidity: Plus or minus 5-percent relative humidity (% RH).
 - .11 Airflow (Pressurized Spaces): Plus or minus 2-percent of full scale (% FS).
 - .12 Airflow (Measuring Stations): Plus or minus 3-% FS.
 - .13 Airflow (Terminal): Plus or minus 5-% FS.
 - .14 Air Pressure (Space): Plus or minus 0.0005 inches wg (0.125 Pa).
 - .15 Air Pressure (Ducts): Plus or minus 0.02 inches wg (5 Pa).
 - .16 Carbon Monoxide: Plus or minus 1-part per million (ppm) CO.
 - .17 Carbon Dioxide: Plus or minus 50-ppm CO₂.
 - .18 Electrical: Plus or minus 2-percent of reading (volts/amps/watts).

1.6 SUBMITTALS

- .1 Action Submittals
 - .1 Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
 - .1 Building Automation System: Include technical data for operator workstation, operating system software, color graphics; editors for graphics, point database, and programming; software licensing, software updates during construction, and other third-party applications.
 - .2 DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for remote operator's terminal, operator display menus, interface equipment to BAS, DDC Controllers, Unitary Controllers, Application Specific Controllers (e.g. Air

- Terminal Controller), transducers/transmitters, sensors, control dampers, damper actuators, control valves, valve actuators, relays/switches, auxiliary control panels.
- .3 Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.
 - .2 Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - .1 Bill of materials of equipment indicating quantity, manufacturer, and model number.
 - .2 Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
 - .3 Wiring Diagrams: Power, signal, and control wiring.
 - .1 Details of control panel faces, including controls, instruments, and labeling.
 - .2 Written description of sequence of operation.
 - .3 Schedule of dampers including size, leakage, and flow characteristics.
 - .1 Coordinate damper sizes with sheet metal and/or mechanical contractor before submitting.
 - .4 Schedule of valves including flow characteristics.
 - .5 Schedule of Terminal Equipment Controllers; e.g. air terminals, unit ventilators, etc.
 - .6 DDC System Hardware:
 - .1 Wiring diagrams for control units with termination numbers.
 - .2 Schematic diagrams and floor plans for field sensors and control hardware.
 - .3 Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.
 - .7 Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.
 - .8 Controlled Systems:
 - .1 Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
 - .2 Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
 - .3 Written description of sequence of operation including schematic diagram.
 - .4 Points list.
 - .4 Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with ASHRAE Std 135.
 - .5 Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with LonWorks.
 - .6 Software and Firmware Operational Documentation: Include the following:
 - .1 Software operating and upgrade manuals
 - .2 Program Software Backup: On a DVD (CD-ROM) complete with data files

- .3 Device address list
- .4 Printout of software application and graphic screens
- .5 Software licenses required by and installed for DDC workstations and control systems
- .7 Software Upgrade Kit: For Owner to use in modifying software to suit future systems revisions or monitoring and control revisions.
- .8 Qualification Data:
 - .1 Manufacturer's product line being submitted shall be in full production for at least two years.
 - .2 Installer shall be factory trained and authorized in the installation, startup, check-out and commissioning of the manufacturer's product line being submitted. Installer's field personnel shall have at least three years' experience in the installation of DDC-style temperature control systems.
- .9 Field quality control test reports
- .10 Installing contractor's commissioning reports
 - .1 Calibration records and list of set points.
- .2 Operation and Maintenance Materials
 - .1 The control system Contractor shall provide and maintain on site working spare parts for the control system during the warranty period including DDC Controllers, power supplies, modules, sensors, floor level (subnet) devices, transformers, etc. The owner will be custodian of these spare parts and shall be authorized to utilize them in performing first level maintenance. The control contractor Contractor shall refurbish/replace spare parts in exchange for failed items.
 - .2 Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - .1 Maintenance instructions and list of spare parts for each type of control device and the compressed air station.
 - .2 Interconnection wiring diagrams with identified and numbered system components and devices.
 - .3 Keyboard illustrations and step-by-step procedures indexed for each operator function.
 - .4 Inspection period, cleaning methods, recommended cleaning materials, and calibration tolerances.
 - .5 Calibration records and list of set points.

1.7 WARRANTIES

- .1 The control system shall be guaranteed for a period of two years after final approval by the Owner. The guarantee shall be provided for a completely installed system, including all components, parts, and assemblies of the control system. The guarantee shall cover parts, materials, and labor to locate and correct any defects in materials or workmanship.
- .2 The Contractor shall initiate the warranty period by formally transmitting to the Owner commencement notification of the period for the system and devices accepted. The warranty period begins when these devices are formally accepted by the Owner (refer to ACCEPTANCE PROCEDURE below).
- .3 Contact information shall be provided for quick service engineering assistance concerning hardware and software problems. There shall be provisions made for getting manufacturer certified diagnostic and repair personnel on the scene quickly should the need arise. There shall also be a software expert familiar with the software of this machine who can be easily

contacted.

- .4 This system shall be inspected by the control system Contractor for a four-hour period once each quarter during the warranty period to run diagnostic tests and also provide maintenance instructions to the operating personnel.
- .5 The control system Contractor shall give the Owner 24 hours prior notification of each maintenance trip during the contract guarantee period. In addition, the Contractor shall furnish the Owner and Engineer a written record of each maintenance trip, number of employees present, time involved and work accomplished.
- .6 Owner shall be able to make changes to database, when prior database is stored on disk in case of error in change, without affecting or voiding warranty.

1.8 QUALITY ASSURANCE

- .1 Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project.
 - .1 All contractor controls personnel working on the project must have documented knowledge and a minimum of 2 years of DDC experience specifically with the control systems being installed in the project.
 - .2 The on-site installer must have demonstrated ability to control all project HVAC equipment using contractor installed, BACnet-compliant components in compliance with the project requirements.
 - .3 The contractor shall provide qualified on-site support for front-end graphics installation and commissioning.
- .2 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.
- .3 Comply with ASHRAE Std 135 for DDC system components.

1.9 MOCK-UPS AND SAMPLES

- .1 Samples for Initial Selection: For each color required, of each type of thermostat or sensor cover with factory-applied color finishes.
- .2 Samples for Verification: For each color required, of each type of thermostat or sensor cover.

1.10 COORDINATION

- .1 Coordinate location of thermostats, humidistats, DDC control sensors, and other exposed control sensors with plans and room details before installation.
- .2 Coordinate equipment with Division 28 Section "Intrusion Detection" to achieve compatibility with equipment that interfaces with that system.
- .3 Coordinate equipment with Division 28 Section "Access Control" to achieve compatibility with equipment that interfaces with that system.
- .4 Coordinate equipment with Division 27 Section "Clock Systems" to achieve compatibility with equipment that interfaces with that system.
- .5 Coordinate equipment with Division 28 Section "PLC Electronic Detention Monitoring and Control Systems" to achieve compatibility with equipment that interfaces with that system.
- .6 Coordinate equipment with Division 26 Section "Network Lighting Controls" to achieve compatibility with equipment that interfaces with that system.
- .7 Coordinate equipment with Division 28 Section "Fire Detection and Alarm" to achieve compatibility with equipment that interfaces with that system.
- .8 Coordinate supply of conditioned electrical branch circuits for control units and operator workstation.

- .9 Coordinate equipment with Division 26 Section "Electrical Power Monitoring and Control" to achieve compatibility of communication interfaces.
- .10 Coordinate equipment with Division 26 Section "Panelboards" to achieve compatibility with starter coils and annunciation devices.
- .11 Coordinate equipment with Division 26 Section "Motor-Control Centers" to achieve compatibility with motor starters and annunciation devices.
- .12 Coordinate installation of control dampers, smoke dampers, HVAC equipment isolation dampers, and pipe-mounted sensors and instruments with the mechanical and/or plumbing contractor.
- .13 Coordinate installation of duct, space, outdoor, or building static pressure sensors with the finished surfaces, installing contractor and the Architect prior to installation.
- .14 Coordinate installation of any exterior wall or roof-mounted sensors, instruments, photocells, or controllers required for the temperature control system with the General Contractor and the Architect prior to installation.
- .15 Coordinate the color selection process of any sensor or device intended to be mounted on finished surfaces with the Architect prior to installation.

1.11 DELIVERY, STORAGE AND HANDLING

- .1 Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.
- .2 System Software: Update to latest version of software at Project completion.

1.12 SUMMARY DESCRIPTION

- .1 This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.
 - .1 Provide Building Automation System (BAS) as shown in the contract documents and described herein.
 - .2 Provide interface to BAS via BACnet or LonTalk or Proprietary as shown in the contract documents and described herein.
 - .3 Provide DDC System as shown in the contract documents and described herein.
 - .4 Sequences modified as a result of start-up, checkout, fine tuning, and/or commissioning shall be resubmitted to the Architect for record.
 - .5 The installing contractor is responsible for and shall provide the integration of the DDC with the existing EMS, including (but not limited to):
 - .1 Insuring that the new DDC Controllers shall interface to the existing EMS network. There are three levels of system architecture: a campus-wide Management Level Network (MLN) that is Ethernet based IP protocol, a high performance peer-to-peer Building Level Network (BLN), and an Application Specific Controller Floor Level Network (FLN). Access to all levels from the EMS appears transparent to the user when accessing data graphically or developing control programs.
 - .2 The design of the new installation shall allow the existing controllers to co-exist with the newly installed controllers without the use of gateways or protocol convertors.
 - .3 New DDC Controllers shall be fully and readily accessible from existing graphical user workstations.
 - .4 Providing communication wiring (cable) from the newly installed DDC controllers to the nearest existing controller or networked to the Owner's IT

- network drop.
- .5 If required for networking, a network interface controller including hardware and panel, software (or firmware), and coordinating electrical power (and UPS back-up if required by Owner) per the contract documents.
 - .6 Providing expansion of and/or upgrading of any network panel software/firmware and/or memory size to accommodate the additional point database and communication traffic (bandwidth) caused by accessing information across the network from the Owner's EMS for graphical display purposes. Inclusive with this is necessary memory or bandwidth for trend data collection.
 - .7 Coordination with the Owner's IT group in terms of their providing for the additional bandwidth requirements as a result of the installation.
 - .8 If not currently at the latest software release version, providing the latest EMS software upgrade to bring the system to the most current released version.

PART 2 PRODUCTS

2.1 CONTROL SYSTEM

- .1 BAS and DDC
 - .1 Manufacturers:
 - .1 Alerton.
 - .2 American Auto-Matrix.
 - .3 Automated Logic Corporation.
 - .4 Delta Controls.
 - .5 Honeywell International.
 - .6 Johnson Controls.
 - .7 KMC Controls.
 - .8 Schneider Electric USA (includes Tour Anderson, Invensys, Andover Controls)
 - .9 Siemens Building Technologies.
 - .10 Staefa Control Systems Inc.
 - .11 Trane.
 - .2 Pneumatic Temperature Controls Systems
 - .1 Manufacturers:
 - .1 Honeywell International.
 - .2 Johnson Controls.
 - .3 Siemens Building Technologies.
 - .3 Stand-alone or Supplemental Controls
 - .1 Manufacturers:
 - .1 Daikin. (McQuay International)
 - .2 Functional Devices.
 - .3 Heat-Timer Corporation.
 - .4 KMC Controls.
 - .5 Pneuline Controls.
 - .6 Sauter Controls Corporation.
 - .7 Solidyne Corp.
 - .8 TCS/BASYS Controls.

- .9 Tekmar Control Systems.
- .10 Teletrol Systems Incorporated.
- .11 Temco Controls Ltd. USA.
- .12 Triangle MicroSystems Inc.
- .4 Control system shall consist of sensors, indicators, dampers, damper actuators, valves, valve actuators, final control elements, interface equipment, other apparatuses and accessories to control mechanical systems.
- .5 Control system shall consist of sensors, indicators, dampers, damper actuators, valves, valve actuators, final control elements, interface equipment, other apparatuses and accessories, and software connected to distributed controllers operating in multiuser, multitasking environment on token-passing network and programmed to control mechanical systems. An operator workstation permits interface with the network via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics.
- .6 Control system shall include the following:
 - .1 Building intrusion detection system specified in Division 28 Section "Intrusion Detection"
 - .2 Building clock control system specified in Division 27 Section "Clock Systems"
 - .3 Building lighting control system specified in Division 26 Section "Network Lighting Controls"
 - .4 Fire alarm system specified in Division 28 Section "Fire Detection and Alarm"
 - .5 Interface to manufacturer-provided equipment controllers, specified in other Division 23 Sections.
 - .6 Direct interface means to third-party controllers via DDC sub-LAN specified herein and/or LonTalk or BACnet interface; as required by the installing contractor for a complete and operational system.
 - .7 Proprietary "gateway products" as shown on control drawings to provide fully functional sub-system control/point monitoring.

2.2 BAS EQUIPMENT

- .1 Operator Workstation: One PC-based microcomputer(s) workstation-class (not residential-class) with Operating System software with minimum configuration as follows:
- .2 Coordinate closely with Owner's IT staff especially if workstation will reside on the Owner's network.
 - .1 Motherboard: With 4 integrated USB 2.0 ports, integrated Intel Pro 10/100 (Ethernet), integrated audio, BIOS, and hardware monitoring.
 - .2 Processor: Intel Core i7; MHz.
 - .3 Random Access Memory: 8 GB minimum GB.
 - .4 Graphics: Video adapter 1280 x 1024 pixels, 32-bit color, 64-MB video memory, with TV out.
 - .5 Monitor: 22 inches (430 mm), 1280 x 1024 pixels, LCD color.
 - .6 Keyboard: QWERTY, 105 keys, (in ergonomic shape – customer preference).
 - .7 Hard-Disk Drive: 256 GB.
 - .8 DVD/RW Read/Write Drive: 16x8x16.
 - .9 Mouse: Two-button, center wheel, Three button optical.
 - .10 Retain UPS requirement based on customer needs.
 - .11 Uninterruptible Power Supply: 2 kVa.

- .12 Revise next sentence, if not an IT integration project, then "provide firewall and virus protection software.
- .13 Operating System: Microsoft Windows 7 Professional with high-speed Internet access. Coordinate firewall and virus protection software requirements with the Owner's IT staff for integration projects. If system is not integrated over the Owner's IT network or is using a proprietary network, provide stand-alone firewall and virus protection software.
 - .1 ASHRAE Std 135 Compliance: Workstation shall use ASHRAE Std 135 protocol and communicate using ISO 8802-3 (Ethernet) data-link/physical layer protocol.
 - .2 LonWorks Compliance: Control units shall use LonTalk protocol and communicate using EIA2/CEA-709.1 data-link/physical layer protocol.
- .14 Printer: Black-and-white dot-matrix or inkjet as follows:
 - .1 Print Head: 1200 x 1200 dpi maximum resolution
 - .2 Paper Handling: Tractor feed for dot-matrix or a minimum of 250 sheet trays
 - .3 Print Speed: Minimum of 15 pages per minute
- .15 Printer: Color inkjet type as follows:
 - .1 Print Head: 4800 x 1200 dpi maximum resolution; optimized color resolution
 - .2 Paper Handling: Minimum of 100 sheets
 - .3 Print Speed: Minimum of 10 pages per minute in black/white and 5 pages per minute in color
- .16 BAS Application Software:
 - .1 I/O capability from operator station
 - .2 System security for each operator via software password and access levels
 - .3 Automatic system diagnostics; monitor system and report failures
 - .4 Field DDC database creation (editing) and support
 - .5 Automatic and manual database save and restore.
 - .6 Automatic and manual database transfer to field panels
 - .7 Dynamic color graphic displays
 - .8 Up to 10 screen displays at once.
 - .9 Custom graphics generation (editing) and graphics library of HVAC equipment and symbols.
 - .10 Ability to print color graphic on a color printer
 - .11 DDC program creation (editing) and support.
 - .12 Automatic and manual database save and restore.
 - .13 Automatic and manual database transfer to field panels
 - .14 Time of Day Program (Scheduling)
 - .15 Includes override scheduling and holiday scheduling
 - .16 Automatic and manual database save and restore.
 - .17 Automatic and manual database transfer to field panels
 - .18 Alarm processing, messages, and reactions.
 - .19 Trend logs retrievable in spreadsheets and database programs.
 - .20 Alarm and event processing.
 - .21 Alarms shall "break-through" and provide audible annunciation (may be turned off)

- .22 Object and property status and control.
- .23 Automatic restart of field equipment on restoration of power.
- .24 Data collection, reports, and logs. Include standard reports for the following:
 - .25 Current values of all objects.
 - .26 Current alarm summary.
 - .27 Disabled objects.
 - .28 Alarm lockout objects.
 - .29 Logs.
 - .30 Custom report development.
 - .31 Utility and weather reports.
 - .32 Workstation application editors for controllers and schedules.
 - .33 Maintenance Management is very expensive. Check with Owner first.
 - .34 Maintenance Management.
- .17 Custom Application Software:
 - .1 English language oriented.
 - .2 Full-screen character editor/programming environment.
 - .3 Allow development of independently executing program modules with debugging/simulation capability.
 - .4 Support conditional statements.
 - .5 Support floating-point arithmetic with mathematic functions.
 - .6 Contains predefined time variables.
- .18 Configure the workstation to restart automatically after a power failure when a UPS is not provided or present.
- .3 Diagnostic Terminal Unit: Portable notebook-style, PC-based, microcomputer capable of accessing system data by connecting to system network with minimum configuration as follows:
 - .1 System: With one integrated USB 2.0 port, integrated Intel Pro 10/100 (Ethernet), integrated audio, bios, and hardware monitoring.
 - .2 Processor: Intel Core i3 , MHz.
 - .3 Random-Access Memory: 8 GB MB.
 - .4 Graphics: Video adapter, minimum 800 x 600 pixels, 64 MB video memory.
 - .5 Monitor: 17 inches (430 mm) LCD color.
 - .6 Keyboard: QWERTY 105 keys, (in ergonomic shape – customer preference).
 - .7 Hard-Disk Drive: 128 GB .
 - .8 CD-ROM Read/Write Drive: 48x24x48 .
 - .9 Pointing Device: Touch pad or other internal device; or optical mouse if intended for desktop use.
 - .10 Software:
 - .1 Provide laptop with Windows Operating System (OS) to comply with Owner's IT requirements for current and future support. Coordinate with the Owner representative.
 - .2 Provide all software necessary, including 3rd party, to provide Owner access to HVAC and equipment controllers (DDC controllers, Unitary Controllers, Terminal Equipment Controllers, and Application Specific Controllers).

- .11 Cables: Provide necessary cables (including proprietary) to connect laptop to each controller as required in the project.
- .4 Direct Digital Control (DDC) Units: Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.
 - .1 Units monitor or control each I/O point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator workstation or diagnostic terminal unit.
 - .2 Stand-alone mode control functions operate regardless of network status. Functions include the following:
 - .1 Global communications.
 - .2 Discrete/digital, analog, and pulse I/O.
 - .3 Monitoring, controlling, or addressing data points.
 - .4 Software applications, scheduling, and alarm processing.
 - .5 Testing and developing control algorithms without disrupting field hardware and controlled environment.
 - .3 Standard Application Programs:
 - .1 Electric Control Programs: Demand limiting, duty cycling, automatic time scheduling, start/stop time optimization.
 - .2 HVAC Control Programs: Night setback/setup, on-off control with differential sequencing, staggered start, equipment lead/lag sequencing, anti-short cycling control, PID control, DDC with fine loop tuning, optimal run time, supply air reset, static pressure reset, and dry bulb/enthalpy economizer.
 - .3 Chiller Control Programs: Control function of condenser water reset, chilled water reset, and equipment lead/lag sequencing.
 - .4 Programming Application Features: Include trend point; alarm processing and messaging; weekly, monthly, and annual scheduling; energy calculations; run time totalization; and security access.
 - .5 Remote communications.
 - .6 Maintenance management.
 - .7 Units of Measure: Inch-pound and SI (metric).
 - .4 Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.
 - .5 ASHRAE Std 135 Compliance: Control units shall use ASHRAE Std 135 protocol and communicate using ISO 8802-3 (Ethernet) data-link/physical layer protocol.
 - .6 LonWorks Compliance: Control units shall use LonTalk protocol and communicate using EIA/CEA-709.1 data-link/physical layer protocol.
 - .7 Enclosure:
 - .1 Indoor - Dustproof rated for operation at 32 to 120 degrees F (0 to 50 degrees C).
 - .8 I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.
 - .1 Binary Inputs: Allow monitoring of on-off signals without external power.
 - .2 Pulse Accumulation Inputs: Accept up to 10 pulses per second.
 - .3 Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4- to 20-mA), or resistance signals.

- .4 Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation with three-position (on-off-auto) override switches and status lights.
- .5 Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4- to 20-mA) or resistance (0- to 135-ohms) with status lights, two-position (auto-manual) switch, and manually adjustable potentiometer.
- .6 Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators.
- .7 Universal I/O's: Provide software selectable binary or analog outputs.
- .9 Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:
 - .1 Output ripple of 5.0 mV maximum peak-to-peak.
 - .2 Combined 1 percent line and load regulation with 100-microsecond response time for 50 percent load changes.
 - .3 Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.
- .10 Power Line Filtering: Internal or external transient voltage and surge suppression for workstations or controllers with the following:
 - .1 Minimum dielectric strength of 1000-V.
 - .2 Maximum response time of 10 nanoseconds.
 - .3 Minimum transverse-mode noise attenuation of 65-dB.
 - .4 Minimum common-mode noise attenuation of 150-dB at 40- to 100-Hz.

2.3 LOCAL CONTROL UNITS

- .1 Modular, comprising processor board with electronically programmable, non-volatile, read-only memory; and backup power source.
- .2 Units monitor or control each I/O point, process information, and download from or upload to operator workstation or diagnostic terminal unit.
- .3 All other controller attributes match the DDC controller.
- .4 Stand-alone mode control functions operate regardless of network status. Functions include the following:
 - .1 Global communications.
 - .2 Discrete/digital, analog, and pulse I/O.
 - .3 Monitoring, controlling, or addressing data points.
- .5 Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.
- .6 ASHRAE Std 135 Compliance: Control units shall use ASHRAE Std 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.
- .7 LonWorks Compliance: Control units shall use LonTalk protocol and communicate using EIA/CEA-709.1 datalink/physical layer protocol.
- .8 Enclosure:
 - .1 Indoor - Dustproof rated for operation at 32 to 120 degrees F (0 to 50 degrees C).

2.4 UNITARY CONTROLLERS

- .1 Controllers shall be provided for (but not limited to) Unit Ventilators, Fan Coils Units, Heat Pumps, etc.

- .2 Unitized, capable of stand-alone operation with sufficient memory to support its operating system, database, and programming requirements, and with sufficient I/O capacity for the application.
 - .1 Configuration: Local keypad and display; diagnostic LEDs for power, communication, and processor; wiring termination to terminal strip or card connected with ribbon cable; memory with bios; and 72-hour battery backup.
 - .2 I/O Interface: Hardwired inputs and outputs into system through controller
 - .3 Operating System: Manage I/O communication to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms. Perform scheduling with real-time clock.
 - .4 Perform automatic controller diagnostics; monitor controller and report failures.
 - .5 ASHRAE 136.
 - .6 LonWorks Compliance: Communicate using EIA/CEA-709.1 data-link/physical layer protocol using LonTalk protocol.
 - .7 Enclosure:
 - .1 Indoor - Dustproof rated for operation at 32 to 120 degrees F (0 to 50 degrees C).
 - .2 Outdoor - Weatherproof rated for operation at minus 10 to 150 degrees F (minus 23 to 65 degrees C).
- .3 Air Terminal Unit Equipment Controllers (TEC)
 - .1 Variable Air Volume (VAV) and Constant Air Volume (CAV). CAV are indicated when minimum and maximum design cfm's are scheduled the same.
 - .2 Other equipment controllers that are similar are Series Fan-Powered and Parallel Fan-Powered VAV Terminals, and dual-duct air terminals.
 - .3 Modular construction, comprising processor board with programmable, nonvolatile, random access memory; and integral interface equipment.
 - .4 Units execute commands from DDC control units and download from or upload to diagnostic terminal unit.
 - .5 Controllers shall operate in stand-alone mode and control functions operate regardless of BACnet status. Functions include the following:
 - .1 BACnet communications
 - .2 Discrete digital input/outputs and analog input/out
 - .3 Hardware for sensing air flow from flow measuring device
 - .4 Monitoring and controlling points
 - .5 HVAC software application programs that are application specific (e.g. VAV) and alarm processing
 - .6 Terminal port for program selection, addressing, air balance, and firmware updates.
 - .6 Application Specific Programs:
 - .1 VAV and CAV air terminal control algorithms as needed to perform the sequences on the drawings.
 - .2 Series and Parallel Fan-Powered air terminal control algorithms as needed to perform the sequences on the drawings.
 - .3 Dual-duct air terminal control algorithms as needed to perform the sequences on the drawings.
 - .7 Units of Measure: Inch-Pound
 - .8 Remote communications to DDC Controllers.

- .9 Local terminal plug for field service and air balancer use. Provide air balance subcontractor with software necessary for air balance work.
- .10 In a proprietary system, protocol compliance is based on the DDC manufacturer's choice. Delete next sentence if not applicable.
- .11 Protocol Compliance: Control units shall communicate using existing BACnet protocol.
- .12 I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.
 - .1 Binary Inputs: Allow monitoring of on-off signals without external power.
 - .2 Pulse Accumulation Inputs: Accept up to 10 pulses per second.
 - .3 Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4- to 20-mA), or resistance signals.
 - .4 Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation with three-position (on-off-auto) override switches and status lights.
 - .5 Analog Outputs: Provide modulating signal, low voltage (0- to 10-V dc) or current (4- to 20-mA); with status lights, two-position (auto-manual) switch, and manually adjustable potentiometer or selector switch.
 - .6 Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators.
 - .7 Universal I/O's (optional as needed): Provide software selectable binary or analog outputs.
 - .8 Airflow probed connections for sensing airflow through terminal.
- .13 Power Supply: Class 2 transformers located in DDC Auxiliary Panel shall provide 24 VAC (current-limited) with fuse protection to TEC's.
- .14 Power Line Filtering: Transient voltage and surge suppression for controllers.
- .15 Enclosure:
 - .1 Indoor – Dust-proof rated for operation at 32 to 120 degrees F (0 to 50 degrees C).

2.5 ALARM PANELS

- .1 Unitized cabinet with suitable brackets for wall or floor mounting. Fabricated 0.06 inch (1.5 mm) thick, furniture-quality steel or extruded-aluminum alloy, totally enclosed, with hinged doors and keyed lock and with manufacturer's standard shop-painted finish. Provide common keying for all panels.
- .2 Indicating light for each alarm point, single horn, acknowledge switch, and test switch, mounted on hinged cover.
 - .1 Alarm Condition: Indicating light flashes and horn sounds.
 - .2 Acknowledge Switch: Horn is silent and indicating light is steady.
 - .3 Second Alarm: Horn sounds and indicating light is steady.
 - .4 Alarm Condition Cleared: System is reset and indicating light is extinguished.
 - .5 Contacts in alarm panel allow remote monitoring by independent alarm company.

2.6 ANALOG CONTROLLERS

- .1 Step Controllers: 6- or 10-stage type, with heavy-duty switching rated to handle loads and operated by electric motor.
- .2 Electric, Outdoor-Reset Controllers: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range, adjustable setpoint, scale range minus

- minus 10 to 70 degrees F (minus 23 to 21 degrees C), and single or double pole contacts.
- .3 Electronic Controllers: Wheatstone-bridge-amplifier type, in steel enclosure with provision for remote-resistance readjustment. Identify adjustments on controllers, including proportional band and authority.
 - .1 Single controllers can be integral with control motor if provided with accessible control readjustment potentiometer.
 - .4 Fan Speed Controllers: Solid-state model providing field-adjustable proportional control of motor speed from maximum to minimum of 55 percent and on-off action below minimum fan speed. To bring motor up to minimum speed rapidly, controller shall briefly apply full voltage when starting motor. Equip with filtered circuit to eliminate radio interference.
 - .5 Receiver Controllers: Single- or multiple-input models with control point adjustment, direct or reverse acting with mechanical Setpoint adjustment with locking device, proportional band adjustment, authority adjustment, and proportional control mode.
 - .1 Remote-control-point adjustment shall be plus or minus 20 percent of sensor span, input signal of 3 to 15 psig (21 to 103 kPa).
 - .2 Proportional band shall extend from 2- to 20-percent for 5 psig (34 kPa).
 - .3 Authority shall be 20- to 200-percent.
 - .4 Air supply pressure of 25 psig (172 kPa), input signal of 3 to 15 psig (21 to 103 kPa), and output signal of zero to supply pressure.
 - .5 Gages: 1-1/2 inches (38 mm) in diameter, 2.5 percent full-scale accuracy, marked in psig (kPa), and ranged to match transmitter input or output pressure.

2.7 TIME CLOCKS

- .1 Manufacturers:
 - .1 ATC-Diversified Electronics.
 - .2 Grasslin Controls Corporation.
 - .3 Paragon Electric Co.
 - .4 Precision Multiple Controls.
 - .5 SSAC Inc.
 - .6 TCS/Basys Controls.
 - .7 Theben AG - Lumilite Control Technology.
 - .8 Time Mark Corporation.
- .2 Seven-day, programming-switch timer with synchronous timing motor and seven-day dial; continuously charged, nickel-cadmium-battery-driven, eight-hour, power-failure carryover; multiple-switch trippers; minimum of two and maximum of eight signals per day with two normally open and two normally closed output contacts.
- .3 Solid-state, programmable time control with 4 separate programs each with up to 100 on-off operations; 1-second resolution; lithium battery backup; keyboard interface and manual override; individual on-off-auto switches for each program; 365-day calendar with 20 programmable holidays; choice of fail-safe operation for each program; system fault alarm; and communications package allowing networking of time controls and programming from PC.

2.8 ELECTRONIC SENSORS

- .1 Description
 - .1 Vibration and corrosion resistant, for wall, immersion, or duct mounting as required.
 - .2 All sensors provided with a guard or cover shall submit color samples to the Architect before ordering sensors.

- .3 Room Sensor Cover Construction: Manufacturer's standard locking covers. This applies to all wall mounted sensors.
 - .1 Color: Submit color selection to Architect prior to ordering.
 - .2 Orientation: Vertical.
 - .3 Appearance: Flush.
 - .4 Housing: Metal.
- .4 Room sensor accessories include the following:
 - .1 Insulating Base: For sensors located on exterior walls and cold surfaces.
 - .2 Guard: Locking; heavy-duty transparent plastic; mounted on separate base.
 - .3 Adjusting Device: As required for calibration and cover screws.
- .2 Air Terminal Equipment Room Sensor
 - .1 Manufacturers:
 - .1 Siemens Building Technologies.
 - .2 Johnson Controls.
 - .2 Sensor:
 - .1 See Thermistor and RTD below.
 - .3 Wiring requirement: Twisted, shielded-pair cable or pre-manufactured cables with terminations matched to the controller.
 - .4 Room Sensor Cover Construction: Manufacturer's standard locking covers. Include the following with those listed above.
 - .1 Electronic display: LCD (temperature)
 - .2 Setpoint Adjustment: Concealed.
 - .3 Setpoint Indication: Exposed.
 - .4 Pushbutton for override: Required.
- .3 Thermistors
 - .1 Manufacturers:
 - .1 MINCO.
 - .2 MAMAC Systems.
 - .3 RDF Corporation.
 - .2 Sensor type and accuracy:
 - .1 Negative temperature coefficient (NTC) sensor with 10K-ohms or less resistance.
 - .3 Wiring requirement: Twisted, shielded-pair cable.
 - .4 Accuracy: Plus or minus 0.5 degrees F (0.3 degrees C) at calibration point.
 - .5 Wiring requirement: Twisted, shielded-pair cable.
 - .6 Insertion Elements in Ducts: Single point, 8 inches (200 mm) long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft (0.84 sq. m).
 - .7 Averaging Elements in Ducts: 36 inches (914 mm) long, flexible use where prone to temperature stratification or where ducts are larger than 10 sq. ft (1 sq. m).
 - .8 Insertion Elements for Liquids: Brass well (for copper, brass, or plastic pipe) with minimum insertion length of 2-1/2 inches (64 mm). Stainless steel well for ferrous pipe.
 - .9 Outside Air Sensors: Watertight inlet fitting, shielded from direct sunlight.

- .10 Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.
- .4 RTD and Transmitters
 - .1 Manufacturers:
 - .1 MINCO.
 - .2 MAMAC Systems.
 - .3 RDF Corporation.
 - .2 Sensor element:
 - .1 Platinum.
 - .2 Nickel.
 - .3 Accuracy: Plus or minus 0.5 degrees F (0.3 degrees C) at calibration point.
 - .4 Wiring requirement: Twisted, shielded-pair cable.
 - .5 Insertion Elements in Ducts: Single point, 8 inches (200 mm) long; use where not affected by temperature stratification or where ducts are smaller than 9-sq. ft. (0.84-sq. m)).
 - .6 Averaging Elements in Ducts: 18 inches (460 mm) long, rigid use where prone to temperature stratification or where ducts are larger than 9 sq. ft (0.84 sq. m); length as required.
 - .7 Insertion Elements for Liquids: Brass well (for copper or brass pipe) with minimum insertion length of 2-1/2 inches (64 mm). Stainless steel well for ferrous pipe.
 - .8 Outside Air Sensors: Watertight, electrical inlet fitting; sensors are shielded from direct sunlight.
 - .9 Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.
 - .10 Transmitter output shall be 4- to 20-mA, nominal 24-V dc. Output impedance must meet DDC input requirements.
- .5 Humidity
 - .1 Manufacturers:
 - .1 General Electric. (General Eastern Instruments)
 - .2 MAMAC Systems.
 - .3 ROTRONIC Instrument Corp.
 - .4 TCS/Basys Controls.
 - .5 Vaisala.
 - .2 Sensor: Bulk polymer sensor element
 - .3 Accuracy: 5 % RH with linear output.
 - .4 Wiring requirement: Twisted, shielded-pair cable.
 - .5 Room Sensor Range: 5- to 95-% RH.
 - .6 Room Sensor Cover Construction: Manufacturer's standard locking covers.
 - .1 Setpoint Adjustment: Controlled through DDC controller
 - .2 Display: Concealed, LED.
 - .3 Color: _____.
 - .4 Orientation: Vertical.
 - .7 Duct Sensor Range: 5- to 95-% RH with element guard and mounting plate.
 - .8 Outside Air Sensor Range: 5- to 95-% RH with mounting enclosure/sunshield, suitable for operation at outdoor temperatures of 32 to 120 degrees F (0 to 50

- degrees C).
- .9 Transmitter output shall be 4- to 20-mA, nominal 24-V dc. Output impedance must meet DDC input requirements.
- .6 Pressure Transmitters/Transducers
 - .1 Manufacturers:
 - .1 BEC Controls.
 - .2 General Electric. (General Eastern Instruments)
 - .3 MAMAC Systems.
 - .4 Rotronic Instrument Corp.
 - .5 Setra Systems.
 - .6 TCS/Basys Controls.
 - .7 Vaisala.
 - .2 Sensors: Appropriate sensing chamber for medium being sensed.
 - .3 Wiring requirement: twisted, shielded-pair cable for wiring unless specified otherwise by the manufacturer.
 - .4 Air Static Pressure Transmitter: Non-directional sensor with suitable range for expected input, and temperature compensated.
 - .1 Accuracy: 2-% full scale with repeatability of 0.5 percent.
 - .2 Output: 4- to 20-mA. Output impedance must meet input requirements.
 - .3 Building Static Pressure Range: Minus 0.05 to 0.05 inches wg (Minus 12 to 12 Pa).
 - .4 Duct Static Pressure Range: 0 to 2.5 inches wg (0 to 623 Pa).
 - .5 Hydronic Pressure Transducers: Stainless steel diaphragm construction, suitable for service; minimum 150 psig (1034 kPa) operating pressure; linear output.
 - .1 Accuracy: 2-% FS scale reading with repeatability of 0.5-% FS
 - .2 Output: 4- to 20-mA, nominal 24-V dc. Output impedance must meet input requirements.
 - .3 Range: 0 to 60 psig (0 to 414 kPa).
 - .6 Hydronic Differential Pressure Transducers: Stainless steel diaphragm construction, suitable for service; minimum 150 psig (1034 kPa) operating pressure and tested to 300 psig (2068 kPa); linear output. Provide 3-valve manifold with instrument.
 - .1 Accuracy: 1-% FS overall accuracy: includes sensor accuracy, linearity, hysteresis, and non-repeatability.
 - .2 Output: 4- to 20-mA, nominal 24-V dc, loop- powered. Output impedance must meet DDC input requirements.
 - .3 Range: 0 to 60 psig (0 to 414 kPa).
 - .7 Air Differential Pressure Switch: Snap acting, pilot-duty rated contact, and with suitable scale range and setting adjustment.
 - .1 SPDT or DPDT, dry contact style device
 - .2 Range: Adjustable from 1- to 10- inches wg
 - .3 Differential: Adjustable from 2-psig to 10-psig
 - .8 Air Differential Pressure Switch: Snap acting, pilot-duty rated contact, and with suitable scale range and setting adjustment.
 - .1 SPDT or DPDT, dry contact style device
 - .2 Range: Adjustable from 1 to 10 inches wg (249 to 2490 Pa).
 - .3 Differential: Adjustable from 0.1 to 0.25 inches wg (25 to 62 Pa).

- .9 Process Pressure and Differential Pressure Transmitters: Direct acting for gas or steam service; range suitable for system; linear output.
 - .1 Accuracy: 1-% FS with repeatability of 0.5-% FS.
 - .2 Output: 4- to 20-mA, nominal 24-V dc, loop-powered. Output impedance must meet DDC input requirements.
 - .3 Air Pressure Range: 0 to 100 psig (0 to 68 kPa).
 - .4 Velocity Pressure Range: 0 to 0.5 inches wg (0 to 125 Pa).
 - .5 Add vacuum pressure sensors if required in project.

2.9 PNEUMATIC SENSORS AND DEVICES

- .1 Pneumatic Transmitters
 - .1 Vibration and corrosion resistant
 - .2 Range as required for 3 to 15 psig (21 to 103 kPa) output signal corresponding to the device's sensing range.
- .2 Space Temperature Sensors: Linear-output type, 50 to 100 degrees F (10 to 38 degrees C) range, with blank locking covers matching room thermostats.
- .3 Room Return Air Temperature Sensors: Linear-output type, with bimetal sensing element, and corrosion-proof construction, 50 to 100 degrees F (10 to 38 degrees C) range; designed to be mounted in light troffers.
- .4 Duct-Mounted or Immersion-Type Temperature Sensors:
 - .1 Temperature Transmitters: Rigid-stem type with bimetal sensing elements unless averaging is required, 3 to 15 psig (21 to 103 kPa) output signal.
 - .1 Averaging Element Sensors: Single- or multiple-unit capillary elements.
 - .2 Tamperproof Sensors: Corrosion-resistant construction, suitable for mounting on vibrating surface with exposed capillary protected with temperature-compensated armor or protective tubing.
 - .3 Pipe-Mounted Temperature-Sensing Elements: Rod-and-tube type; with separable wells, filled with heat-conductive compound. Brass well (for copper or brass pipe) with minimum insertion length of 2-1/2 inches (64 mm). Stainless steel well for ferrous pipe.
 - .4 Outdoors: Provide bulb shield with mounting bracket.
 - .2 Space and Duct Humidity Transmitters: One pipe, directly proportional, with minimum sensing span of 20 to 80 percent relative humidity for 3 to 15 psig (21 to 103 kPa) output signal, corrosion resistant and temperature compensated, and with factory-calibrated adjustment.
 - .1 Space Mounting: With cover to match thermostats.
 - .3 Differential Liquid Pressure Transmitters: One pipe, direct acting for gas, liquid, or steam service; pressure sensor and transmitter of linear-output type; with range of 0 to 50 psig (0 to 344 kPa), and 3 to 15 psig (21 to 103 kPa) output signal.
 - .1 Accuracy: 5 percent of full range and 2 percent of full scale at midrange.
 - .2 Output Signal: 3 to 15 psig (21 to 103 kPa).
 - .4 Differential Air Pressure Transmitters: One pipe, direct acting, double bell; unidirectional with suitable range for expected input; and temperature compensated.
 - .1 Accuracy: 5 percent of full range and 2 percent of full scale at midrange.
 - .2 Output Signal: 3 to 15 psig (21 to 103 kPa).
- .5 Digital-to-Pneumatic Transducers: Convert plus or minus 12-V dc pulse-width-modulation outputs, or continuous proportional 4- to 20-mA current or 0- to 10-V dc voltage to 0 to 20 psig (0 to 138 kPa).

- .1 Manufacturers:
 - .1 BEC Controls Corporation.
 - .2 MAMAC Systems.
 - .3 Advanced Controls Technologies.
- .6 Pneumatic Valve/Damper Position Indicator: Potentiometer mounted in enclosure with adjustable crank-arm assembly connected to damper to transmit 0 to 100 percent valve/damper travel.
- .7 Relays: For summing, reversing, amplifying, switching, and highest or lowest pressure selection, and with adjustable I/O ratio.
- .8 Pneumatic Switches: With indicating plates and accessible adjustment; calibrated and marked.
- .9 Pressure-to-Electric (PE) Switches: Adjustable setpoint from 3 to 30 psig (21 to 207 kPa), adjustable differential from 1.5 to 20 psig (10 to 138 kPa), SPST or DPST as required for connection, contacts rated for pilot duty at 125-VA at 277-VAC.
- .10 Electric-to-Pressure Valve (E/P): Electrically operated, two-position, three-way air valve, with coil rated for various voltages as required for connected circuits.

2.10 STATUS SENSORS AND DEVICES - ELECTRIC

- .1 Status Input for Fan: Differential pressure switch with pilot-duty rated contacts and adjustable range of 0 to 5 inch wg (0 to 1245 Pa).
 - .1 Manufacturers:
 - .1 Cleveland Controls.
- .2 Status Input for Pump: Liquid differential pressure switch with pilot-duty rated contacts and adjustable pressure range of 20 to 60 psig (138 to 414 kPa) and differential pressure range of 5 to 30 psig (34 to 207 kPa), SPDT contacts pilot-duty rated or for application, 1/4" female NPT pipe connections.
 - .1 Manufacturers:
 - .1 United Electric Controls.
- .3 Sensing Inputs for Electric Motors:
 - .1 Manufacturers:
 - .1 American Aerospace Controls.
 - .2 Current Transformer/Transmitter: Comply with ISA 50.00.01, current-sensing, fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current and 1 percent full-scale accuracy, for AC or DC applications.
 - .3 Voltage Transformer/Transmitter (100- to 600-V AC): Comply with ISA 50.00.01, single-loop, self-powered transmitter, adjustable, with suitable range and 1 percent full-scale accuracy, for AC or DC applications.
 - .4 Power Monitor: 3-phase type with disconnect/shorting switch assembly, listed voltage and current transformers, with pulse kilowatt hour output and 4- to 20-mA kW output, with maximum 2 percent error at 1.0 power factor and 2.5 percent error at 0.5 power factor, for AC and DC applications.
- .4 Current Switch: Self-powered, current-sensing, split-core, solid-state devices with adjustable trip current and indicating LED, selected to match motor current and DDC input requirements.
 - .1 Manufacturers:
 - .1 Nielsen-Kuljian.
 - .2 Veris Industries.

- .5 Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
 - .1 Manufacturers:
 - .1 DDC equipment manufacturer's recommended product
- .6 Water Flow Switch: Bellows-actuated mercury or snap-acting type with pilot-duty rating, stainless-steel or bronze paddle, with appropriate range and differential adjustment, in NEMA 250, Type 1 enclosure.
 - .1 Manufacturers:
 - .1 Xylem.
 - .2 I.T.M. Instruments.
- .7 Liquid Leak Detectors
 - .1 Liquid detectors shall utilize microchip technology for detection of conductive liquids through one of the following types of sensors: gold-plated probes, self-adhesive sensor tape with copper electrodes and durable cotton cover, or rope type sensor. Detectors shall be selected based on the best use for the application. Power requirement shall be 11-27 VAC or VDC and have a green LED normal operation indicator. Unit shall have a SPDT pilot duty low voltage alarm contact. Unit shall be waterproof and rustproof. A red LED shall indicate the presence of liquid. Unit shall have an adjustable setpoint.
 - .2 Manufacturers:
 - .1 R. E. Technologies.
 - .2 Dorlen Products. (Water Alert)
- .8 Control Relay: Monitors or controls AC or DC motors or other equipment (as required), with cover, with visual indicator when energized, and two SPDT contacts rated 120/250 VAC at 8 Amps.
 - .1 Manufacturers:
 - .1 Dayton.
 - .2 Omron.
 - .3 Functional Devices.
- .9 Damper End Switch (limit switch): Fully encapsulated, mercury-type, damper end switch with two contacts per switch; one for interlock wiring and one for DDC input.
 - .1 Manufacturers:
 - .1 KELE Controls part number TS-470-2.
- .10 Emergency Power-Off (EPO) Push-button: ADA compliant, push-button switch with clear cover to prevent inadvertent closure. Push-to-activate push-button, key-to-reset feature, and providing two SPDT contacts rated 120/250 VAC at 10 Amps.
 - .1 Manufacturers:
 - .1 Safety Technology International – model SS-2212PO.
- .11 Boiler EPO Contactor: Electrically operated, electrically held; provide contactor in NEMA 12 rated enclosure. Six (6) normally closed contacts rated 120/250 VAC at 20 Amps.
 - .1 Manufacturers:
 - .1 Allen-Bradley.
 - .2 Cutler-Hammer.
 - .3 Square-D.

2.11 GAS DETECTION EQUIPMENT

- .1 Carbon Monoxide Sensors:

- .1 Manufacturers:
 - .1 General Eastern. (General Electric)
 - .2 MSA Canada.
 - .3 TSI Incorporated.
 - .4 Vaisala.
- .2 Sensor element:
 - .1 Sensor range shall be 0- to 200-ppm
 - .2 Single point, dual-level detectors using solid-state, plug-in sensors, with a 3-year minimum life
 - .3 Suitable for operating over a temperature range of 32 to 104 degrees F (0 to 40 degrees C).
 - .4 Provide two factory-calibrated, cross-sectional area, rated alarm levels at 50 and 100-ppm; calibrated for 2 percent of full scale accuracy.
- .3 Accuracy: Plus or minus 1-ppm CO at calibration point.
- .4 Wiring requirement: Twisted, shielded-pair cable.
- .5 Insertion Elements in Ducts: Provide template for cutting or drilling ductwork with mounting-hole alignment.
- .6 Room Sensor Cover Construction: Manufacturer's standard locking covers.
 - .1 Setpoint Adjustment: None
 - .2 Display: Concealed.
 - .3 Orientation: Vertical.
- .7 Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.
- .8 Transmitter output:
 - .1 4- to 20-mA, nominal 24-V dc; loop-powered, compatible with DDC system input impedance.
 - .2 Optional output listed below, remove if not needed.
 - .3 Output shall be SPDT relay rated at pilot-duty.
- .2 Carbon Dioxide Sensor:
 - .1 Manufacturers:
 - .1 General Eastern. (General Electric)
 - .2 MSA Canada.
 - .3 Telaire.
 - .4 TSI Incorporated.
 - .5 Vaisala.
 - .6 Valtronics.
 - .2 Sensor element:
 - .1 Sensor range shall be 0- to 2000-ppm.
 - .2 Single detector using solid-state, non-dispersive, infrared (NDIR) sensor.
 - .3 Suitable for operation over a temperature range of 23 to 130 degrees F (minus 5 to 54 degrees C) for outside air; a temperature range of 32 to 104 degrees F (0 to 40 degrees C) for duct- or room-mounted.
 - .4 Calibrated for 4 percent of full scale accuracy, with continuous or averaged reading.

- .3 Accuracy: Plus or minus 50-ppm CO₂ at calibration point. Accuracy includes hysteresis, repeatability, and yearly drift values.
- .4 Wiring requirement: Twisted, shielded-pair cable.
- .5 Insertion Elements in Ducts: Provide template for cutting or drilling ductwork for mounting holes.
- .6 Room Sensor Cover Construction: Manufacturer's standard locking covers.
 - .1 Setpoint Adjustment: None
 - .2 Display: Concealed.
 - .3 Orientation: Vertical.
- .7 Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.
- .8 Transmitter output: 4- to 20-mA, nominal 24-V dc; loop-powered, compatible with DDC system input impedance.

2.12 OCCUPANCY, DAYLIGHTING, AND PHOTO-ELECTRIC SENSORS

- .1 Refer to Division 26 Section "Lighting Control Devices" for equipment that relates to this Section.

2.13 AIRFLOW MEASURING STATIONS

- .1 Manufacturers:
 - .1 Ebtron. Gold Advantage II Model GT
 - .2 Air Monitoring Corporation.
- .2 Provide airflow/temperature measurement devices (ATMD) where indicated on the plans.
 - .1 Fan inlet measurement devices shall not be substituted for duct or plenum measurement devices indicated on the plans.
- .3 Each ATMD shall consist of one or more sensor probes and a single, remotely mounted, microprocessor-based transmitter capable of independently processing up to 16 independently wired sensor assemblies.
 - .1 Each sensor assembly shall contain two individually wired, hermetically sealed, bead-in-glass thermistors.
 - .2 Thermistors shall be mounted in the sensor assembly using a marine-grade, waterproof epoxy. Thermistor leads shall be protected and not exposed to the environment.
 - .3 The airflow rate of each sensor assembly shall be equally weighted and averaged by the transmitter prior to output.
 - .4 The temperature of each sensor assembly shall be velocity weighted and averaged by the transmitter prior to output.
 - .5 Each transmitter shall have a 16-character alpha-numeric display capable of displaying airflow, temperature, system status, configuration settings and diagnostics.
 - .6 Devices using chip-in-glass or diode-case chip thermistors are not acceptable.
 - .7 Devices using less than two thermistors in each sensor assembly are not acceptable.
 - .8 Devices using platinum wire RTDs are not acceptable.
 - .9 Devices having electronic circuitry mounted in or at the sensor probe are not acceptable.
 - .10 Pitot tubes and arrays are not acceptable.
 - .11 Vortex shedding devices are not acceptable.
- .4 All Sensor Probes

- .1 Each sensor assembly shall independently determine the airflow rate and temperature at each measurement point.
- .2 Each sensor assembly shall be calibrated at a minimum of 16 airflow rates and 3 temperatures to standards that are traceable to the National Institute of Standards and Technology (NIST).
- .3 Airflow accuracy shall be +/-2% of Reading over the entire operating airflow range.
 - .1 Devices whose accuracy is the combined accuracy of the transmitter and sensor probes must demonstrate that the total accuracy meets the performance requirements of this specification throughout the measurement range.
- .4 Temperature accuracy shall be +/- 0.15 degrees F (+/- 0.08-degrees C) over the entire operating temperature range of minus 20 to 160 degrees F (minus 29 to 71 degrees C).
- .5 The operating humidity range for each sensor probe shall be 0% RH to 99% RH (non-condensing).
- .6 Each sensor probe shall have an integral, U.L. listed, plenum rated cable and terminal plug for connection to the remotely mounted transmitter. All terminal plug interconnecting pins shall be gold plated.
- .7 Each sensor assembly shall not require matching to the transmitter in the field.
- .8 A single manufacturer shall provide both the airflow/temperature measuring probe(s) and transmitter for each measurement location.
- .5 Duct and Plenum Probes
 - .1 Probe shall be constructed of extruded, gold anodized, 6063 aluminum tube. All wires within the aluminum tube shall be Kynar coated.
 - .2 Probe assembly mounting brackets shall be constructed of 304 stainless steel. Probe assemblies shall be mounted using one of the following options:
 - .1 Insertion mounted through the side or top of the duct.
 - .2 Internally mounted inside the duct or plenum.
 - .3 Standoff mounted inside the plenum.
 - .3 The number of sensor housings provided for each location shall be as follows:
 - .1 Total # of Sensors/Location
 - .2 4
 - .3 6
 - .4 8
 - .5 12
 - .6 16
 - .4 The operating airflow range shall be 0 to 5,000 FPM unless otherwise indicated on the plans.
- .6 Transmitters
 - .1 The transmitter shall have an integral LCD display capable of simultaneously displaying airflow and temperature. The LCD display shall be capable of displaying individual airflow and temperature readings of each independent sensor assembly.
 - .2 The transmitter shall be capable of field configuration and diagnostics using an on-board pushbutton interface and LCD display.
 - .3 The transmitter shall have a power switch and operate on 24 VAC (isolation not required).
 - .1 The transmitter shall use a switching power supply fused and protected from transients and power surges.

- .2 The transmitter shall use "watch-dog" circuitry to assure reset after power disruption, transients and brownouts.
- .4 All interconnecting pins, headers and connections on the main circuit board, option cards and cable receptacles shall be gold plated.
- .5 The operating temperature range for the transmitter shall be minus 20 to 120 degrees F (minus 29 to 49 degrees C). The transmitter shall be installed at a location that is protected from weather and water.
- .6 The transmitter shall be capable of communicating with other devices using one of the following interface options:
 - .1 Linear analog output signals for airflow and temperature: Field selectable, fuse protected and isolated, 0-V dc to 10-V dc / 4-mA to 20-mA (4-wire), output impedance compatible with DDC system input.
- .7 The transmitter shall be capable of accepting an infrared interface card for downloading airflow and temperature data or uploading transmitter configuration data using a handheld PDA (Palm or Microsoft Windows Mobile operating systems).
 - .1 Provide PDA upload/download software.
 - .2 Download software shall be capable of displaying and saving individual sensor airflow rates, the average airflow rates, individual sensor temperatures and the average temperature received from the transmitter.
 - .3 Upload software shall be capable of displaying and saving all setup parameters that can be configured using the on-board pushbutton interface and LCD display.
 - .4 Provide a Microsoft Excel file capable of creating balance reports from PDA data files transferred to a Windows 98 or higher based PC.
 - .5 Provide a Microsoft Excel file to create configuration data files that can be transferred from a Windows 2000, Windows XP or higher based PC to a PDA for upload to one or more transmitters.
- .7 The ATMD shall be UL listed as an entire assembly.
- .8 The manufacturer's authorized representative shall review and approve placement and operating airflow rates for each measurement location indicated on the plans.
- .9 A written report shall be submitted to the consulting mechanical engineer if any measurement locations do not meet the manufacturer's placement requirements.
- .10 Select Ebtron Gold or Silver above or determine whether a lower cost solution like duct-mounted below can be used. Airflow stations are advisable over airflow arrays for accuracy.

2.14 DUCT-MOUNTED AIRFLOW STATION

- .1 Manufacturers:
 - .1 Air Monitor Corporation.
 - .2 Dietrich-Standard.
- .2 Combination of air straightener and multiport, self-averaging, Pitot-tube station and/or airflow measuring arrays.
- .3 Casing: Galvanized-steel frame.
- .4 Flow Straightener: Aluminum honeycomb, 3/4 inch (20 mm) parallel cell, 3 inches (75 mm) deep.
- .5 Sensing Manifold: Copper manifold with bullet-nosed static pressure sensors positioned on equal area basis.

2.15 FLOW METERS

- .1 Steam/Liquid Differential Pressure Transducers: (flow only)

- .1 Manufacturers:
 - .1 ABB.
 - .2 Dietrich – Standard.
 - .3 Honeywell.
 - .4 ITT Barton.
 - .5 Rosemont/Fischer.
 - .6 Siemens.
 - .7 Tobar.
- .2 Each differential pressure transducer shall be selected and calibrated for operations between 0- and 125-% of the normal differential pressure and up to 150 psig (1034 kPa) line pressure. The calibration point shall be rounded upward to the nearest 10 inches wg (2491 Pa) (for spans less than 200 inches wg (49.8 kPa)) or to the nearest 5 psig (34.5 kPa) for larger spans. Calibration date shall be included on an embossed tag attached to each transmitter.
- .3 The accuracy, including linearity, hysteresis and repeatability, of the transducer for measuring differential pressure shall be better than 0.25-% of the span stated above throughout a minimum of a 6:1 turndown. Turndown ratio shall be based on the actual flow span.
- .4 The transducer shall not be damaged by pressures of up to 500 psig (3447 kPa) on either side of the transducer and all wetted parts shall be inert in the presence of up to 50-% concentration of ethylene or propylene glycol in water.
- .5 Provide a drain valve for each side of the pressure chamber. Furnish and install mounting brackets appropriate for the installation location.
- .6 Span and zero shall be individually adjustable.
- .7 Shall be 2-wire and 4- to 20-mA output.
- .2 Steam/Liquid Differential Pressure Transducers: (pressure only)
 - .1 Manufacturers:
 - .1 ABB.
 - .2 Dietrich – Standard.
 - .3 ITT Barton.
 - .4 Siemens.
 - .5 Tobar.
 - .2 Each differential pressure transducer shall be selected and calibrated for operations between 0- and 200-% of the normal differential pressure. The calibration point shall be rounded upward to the nearest 10 inches wg (2491 Pa) (for spans less than 200 inches wg (49.8 kPa)) or to the nearest 5 psig (34.5 kPa) for larger spans. Calibration date shall be included on an embossed tag attached to each transducer.
 - .3 The accuracy, including linearity, hysteresis and repeatability, of the transducer for measuring differential pressure shall be better than 2-% of the span stated above throughout a minimum of a 4:1 turndown. Turndown ratio shall be based on the actual differential span.
 - .4 The transducer shall not be damaged by pressures of up to 500 psig (3447 kPa) on either side of the transducer and all wetted parts shall be inert in the presence of up to 50-% concentration of ethylene or propylene glycol in water.
 - .5 Provide a drain valve for each side of the pressure chamber. Furnish and install mounting brackets appropriate for the installation location.
 - .6 Span and zero shall be individually adjustable.

- .7 Shall be 2-wire and 4- to 20-mA output.
- .3 Indication Gauges for Steam/Liquid Pressure Transducers:
 - .1 Manufacturers:
 - .1 Beckman.
 - .2 Dwyer.
 - .3 Moore.
 - .4 Testoterm.
 - .2 Each transducer shall come with an indicating gauge that reads in GPM for flow measurement or inches water column (in. wg) for pressure sensing. The gauge shall be analog differential pressure type piped in parallel to the transducer.
 - .3 The analog pressure gauge shall be selected and calibrated for the same span as the transducer it serves.
 - .4 The accuracy, including linearity, hysteresis and repeatability, of the gauge for measuring differential pressure shall be better than 3% of the span stated above throughout its span. Calibration data shall be included on an embossed tag attached to each gauge.
 - .5 The gauge shall not be damaged by pressures of up to 500 psig (3447 kPa) on either side of the gauge and all wetted parts shall be inert in the presence of up to 50-% concentration of ethylene or propylene glycol in water.
 - .6 Scale shall be a minimum of 4.5 inches (114 mm) long. Furnish and install two bleed fittings for each gauge and mounting brackets appropriate for the installation location.
 - .7 Gauges shall be field mounted. Provide a phenolic identification tag for each gauge and indicator.
- .4 Steam/Liquid Flow Sensors: (differential pressure type)
 - .1 Manufacturers:
 - .1 Dietrich-Standard (Annubar Diamond II).
 - .2 Gerand.
 - .3 Preso.
 - .2 Unidirectional sensors shall be of the venturi-type or velocity pressure type. They shall be constructed of stainless steel, sized to the system's range of flow, and have an accuracy of 0.5-%.
 - .3 Bi-directional sensors shall be of the velocity pressure type. They shall be constructed of stainless steel, sized to the system's range of flow, and have an accuracy of 0.5-%.
- .5 Three Valve Manifold for Steam/Liquid Pressure Transducers:
 - .1 Manufacturers:
 - .1 D/A Manufacturing.
 - .2 Provide a three-valve manifold for each transducer. Pressures of up to 500 psig (3447 kPa) shall not damage the manifold. All wetted parts shall be inert in the presence of up to a 50% concentration of ethylene or propylene glycol in water.
 - .3 The manifold shall be designed for direct mounting on the transducer it serves and utilizes two quarter-turn valves to provide zeroing, blocking and normal service modes.
- .6 Liquid Flow Meters: (Electro-Magnetic Type)
 - .1 Manufacturers (Water or Glycol/Water):
 - .1 ABB .
 - .2 EMCO.

- .3 Krohne.
- .4 Rosemount.
- .5 Siemens.
- .2 Manufacturers (Steam Condensate)
 - .1 ABB.
 - .2 EMCO.
 - .3 Krohne.
 - .4 Rosemount.
 - .5 Siemens.
- .3 The meter system shall consist of a primary flow sensor and transmitter. The flow sensor shall be equipped with 150-lb. flanges. The meter system shall be installed with all necessary grounding components and gaskets per manufacturer's instructions. The meter shall be capable of bi-directional operation. The meter shall be sized appropriately for the range of flow for the system. The electrodes shall be stainless steel or Hasteloy C. The transmitter shall be provided with a remote mounting bracket, cable, integral LCD display, NEMA 4X housing, and shall indicate flow rate, totalize flow, and shall have an isolated 2-wire 4-20 mA linear output signal and a pulsed output signal for totalization. The transmitter shall be capable of being field calibrated and reprogrammed from the outside housing via magnetic probe or integral keypad menu switching. Unit electronics shall have noise immunity. The primary flow sensor and transmitter shall be mounted in accessible locations. Unit shall have the capability to maintain flow total in non-volatile memory. The flow meter shall be provided with a 1-year warranty and application non-degraded performance guarantee. The flow meter and transmitter as a unit shall have the following minimum characteristics:
 - .1 Flow meter Liner:
 - .2 Heating hot water, domestic hot water, and other water systems operating at or above 110 degrees F (43 degrees C): Teflon
 - .3 Chilled water, domestic cold water, and other water systems operating below 110 degrees F (43 degrees C): Polyurethane
 - .4 Accuracy:
 - .5 At 1- to 33-feet per second (0.3- to 10.1-m/s) velocity: plus or minus 0.5-% of rate.
 - .6 At 0.3-feet per second (0.1-m/s) velocity: $\pm 2\%$ of rate.
 - .7 Each unit shall be factory calibrated for the specified flow and shall be calibrated in both directions if the application is bi-directional. Calibration shall be a minimum of three point. Specific performance test data shall be furnished with the meter.
 - .8 Each meter shall provide two analog 4- to 20-mA signals or a single 4-to 20-mA signal and a digital contact closure on reverse flow.
 - .9 Meters for steam condensate shall be capable of sensing flow with condensate conductivity down to 6 $\mu\text{S/cm}$.
- .4 Provide a phenolic tag for each transmitter to identify service and meter ID number (i.e. SECONDARY CHILLED WATER FLOW, FM-1, etc.).

2.16 DDC BTU METERING

- .1 DDC BTU metering shall be accomplished using the following equipment at each metering point:

- .1 One (1) liquid flow meter unit with current-loop transmitter as specified elsewhere in this section.
 - .1 Flow meter range shall be 125% of the maximum expected flow capacity.
- .2 Two (2) high-precision matched temperature sensor assemblies with current-loop transmitters. Sensors with stainless steel wells shall be installed in each respective supply and return pipe as shown on project drawings for ferrous piping (use copper or brass wells for copper piping).
 - .1 Manufacturers: MINCO and TCS
 - .2 Temperature sensors shall be a matched pair selected for this application.
 - .3 Temperature sensor accuracy shall be plus or minus 0.1-F (0.05-C) at calibration temperature. Calibration temperature for chilled water is 44.0-F (6.7-C) and for heating hot water is 180.0-F (82.2-C)
- .3 These devices shall be wired to a local DDC panel. Calculations for instantaneous and totalized load shall be incorporated into the panel control code, and the necessary virtual points shall be created to allow remote monitoring and trending via the DDC system.
- .2 DDC shall perform BTU computations using linear, square law, or multi-point linearization data interpretation, as needed, based on the flow meter used. Inputs shall include:
 - .1 4- to 20-ma signal from hydronic flow meter
 - .2 4- to 20-ma signal from two, high-accuracy, immersion temperature sensors
- .3 Input devices shall be rated for the environment in which they are installed. DDC shall perform rate of flow calculations as well as monitor the flow and totalize it weekly, monthly, and yearly. These values shall be available at the BAS in graphical format for operator monitoring. Flow rate alarms shall be programmed for low flow and high flow conditions.
- .4 Provide an equipment tag for each transmitter device to identify service and ID number (i.e. CHILLED WATER BTU METER – ANNEX BUILDING, etc.).

2.17 THERMOSTATS

- .1 Manufacturers:
 - .1 Danfoss Inc.
 - .2 Erie Controls.
 - .3 Heat-Timer Corporation.
 - .4 Sauter Controls Corporation.
 - .5 Tekmar Control Systems.
 - .6 Theben AG - Lumilite Control Technology.
- .2 Combination Thermostat and Fan Switches: Line-voltage thermostat with push-button or lever-operated fan switch.
 - .1 Label switches FAN ON-OFF
 - .2 Mount on single electric switch box.
- .3 Electric, solid-state, microcomputer-based room thermostat with remote sensor.
 - .1 Automatic switching from heating to cooling
 - .2 Preferential rate control to minimize overshoot and deviation from setpoint
 - .3 Capable of providing four separate temperatures per day
 - .4 Instant override of setpoint for continuous or timed period from 1 hour to 31 days.
 - .5 Short-cycle protection.
 - .6 Programming based on weekday, Saturday, and Sunday

- .7 Selection features include degree F or degree C display, keyboard disable, remote sensor, and fan on-auto.
- .8 Battery replacement without program loss.
- .9 Thermostat display features include the following:
 - .1 Time of the day
 - .2 Actual room temperature
 - .3 Programmed temperature setpoints
 - .4 Programmed time for occupied/unoccupied
 - .5 Duration of timed override
 - .6 Day of week
 - .7 System mode indications include "heating," "off," "fan auto," and "fan on."
- .4 Low-Voltage, On-Off Thermostats: NEMA DC 3, 24-V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater, concealed setpoint adjustment 55- to 85 F (13- to 30 C) setpoint range, and 2 F (1 C) maximum differential.
- .5 Line-Voltage, On-Off Thermostats: Bimetal-actuated, open contact or bellows-actuated, enclosed, snap-switch or equivalent solid-state type, with heat anticipator; listed for electrical rating; with concealed setpoint adjustment, 55- to 85 F (13- to 30 C) setpoint range, and) 2 F (1 C) maximum differential.
 - .1 Electric Heating Thermostats: Equip with off position on dial wired to break ungrounded conductors.
 - .2 Selector Switch: Integral, manual, On-Off-Auto.
- .6 Remote-Bulb Thermostats: On-off or modulating type, liquid filled to compensate for changes in ambient temperature; with copper capillary and bulb, unless otherwise indicated.
 - .1 Bulbs in water lines with separate wells of same material as bulb.
 - .2 Bulbs in air ducts with flanges and shields.
 - .3 Averaging Elements: Copper tubing with either single- or multiple-unit elements, extended to cover full width of duct or unit; adequately supported.
 - .4 Scale settings and differential settings are clearly visible and adjustable from front of instrument.
 - .5 On-Off Thermostat: With precision snap switches and with electrical ratings required by application.
 - .6 Modulating Thermostats: Construct so complete potentiometer coil and wiper assembly is removable for inspection or replacement without disturbing calibration of instrument.
- .7 Fire-Protection Thermostats: Listed and labeled by an nationally recognized testing laboratory (NRTL) acceptable to authority's having jurisdiction; with fixed or adjustable settings to operate at not less than 75-degrees F (24-degrees C) above normal maximum operating temperature, and the following:
 - .1 Reset: Manual only
 - .2 Reset: Automatic, with control circuit arranged to require manual reset at central control panel; with pilot light and reset switch on panel labeled to indicate operation.
- .8 Pneumatic Room Thermostats: one pipe(s), fully proportional with adjustable throttling range and tamperproof locking settings, direct or reverse acting as required.
 - .1 Factory Calibration: .2.5 F (31.0- C)
 - .2 Range: 45- to 85 F (7- to 29 C)
 - .3 Sensitivity Adjustment Range: 1- to 4 F (12.4- to 49.6-kPa C)

- .4 Dual-Temperature Thermostats: Automatic changeover from normal setting to lower setting for unoccupied cycles, with manual-reset lever to permit return to normal temperatures during unoccupied cycles, with automatic reset to normal during next cycle of operation.
- .5 Limits: Field adjustable, to limit setting cooling setpoint above 74-F (23-C) and heating setpoint below 72-F (22-C)
- .6 Room Thermostat Cover Construction: Manufacturer's standard locking covers.
 - .1 Setpoint Adjustment:
 - .2 Setpoint Indication: Concealed
 - .3 Thermometer: Concealed
 - .4 Orientation: Vertical
- .7 Room thermostat accessories include the following:
 - .1 Insulated Base: For thermostats located on exterior walls.
 - .2 Thermostat Guards: Locking; heavy-duty, transparent plastic; mounted on separate base
 - .3 Adjusting Key: As required for calibration and cover screws.
 - .4 Aspirating Boxes: For flush-mounted aspirating thermostats.
 - .5 Setpoint Adjustment: 1/2 inch (13 mm) diameter, adjustment knob.
- .9 Immersion Thermostat: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range and adjustable setpoint.
- .10 Airstream Thermostats: Two-pipe, fully proportional, single-temperature type; with adjustable setpoint in middle of range, adjustable throttling range, plug-in test fitting or permanent pressure gage, remote bulb, bimetal rod and tube, or averaging element.
- .11 Electric, Low-Limit, Duct Thermostat (Freezestat): Snap-acting, single-pole, single-throw, manual-reset-only switch, that trips when the air temperature sensed across any 12 inches (300 mm) of capillary length is equal to or below setpoint, concealed setpoint adjustment for low and high setting, and provides 15- to 55-degrees F (minus 9- to 13-degrees C) setpoint range and fixed differential.
 - .1 Bulb Length: Minimum 20 feet (6 m).
 - .2 Quantity: One thermostat for every 20-sq. ft. (2-sq. m.) of coil surface.
- .12 Electric, High-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- or automatic- reset switch that trips if temperature sensed across any 12-inches (300-mm) of bulb length is equal to or above setpoint.
 - .1 Bulb Length: Minimum 20 feet (6 m).
 - .2 Quantity: One thermostat for every 20 sq. ft (2 sq. m) of coil surface.
- .13 Heating/Cooling Valve-Top Thermostats: Proportional acting for proportional flow, with molded-rubber diaphragm, remote-bulb liquid-filled element, direct and reverse acting at minimum shutoff pressure of 25 psig (172 kPa), and cast housing with position indicator and adjusting knob.

2.18 HUMIDISTATS

- .1 Manufacturers:
 - .1 MAMAC Systems.
 - .2 Rotronic Instrument Corp.
- .2 Pneumatic:
 - .1 Room Humidistats: Wall-mounting, proportioning type with adjustable throttling range, 20 to 90 percent relative humidity (RH) operating range, and cover matching room thermostat cover. Calibrated for +/- 5% RH accuracy.

- .2 Duct-Mounted Humidistats: Proportioning type with adjustable throttling range, 20 to 90 percent RH operating range, in galvanized-steel duct box.
- .3 Cover Construction: Manufacturer's standard locking covers. Calibrated for +/- 5% RH accuracy.
 - .1 Setpoint Adjustment: Concealed.
 - .2 Setpoint Indication: Concealed.
 - .3 Display: Concealed.
 - .4 Orientation: Vertical.
 - .5 Output range: Linearly scaled from 3 psig to 15 psig (21 kPa to 103 kPa).
- .3 Electric:
 - .1 Room or Duct-Mounted Humidistats: Electric insertion, 2-position type, with adjustable 2 percent RH throttling range, 20 to 90 percent RH operating range, and single- or double-pole contacts. Calibrated for +/- 5% RH accuracy.
 - .2 Cover Construction: Manufacturer's standard locking covers.
 - .1 Setpoint Adjustment: Concealed.
 - .2 Setpoint Indication: Concealed.
 - .3 Display: Concealed.
 - .4 Orientation: Room sensor vertical.

2.19 ACTUATORS

- .1 Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
 - .1 Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
 - .2 Motor characteristics such as NEMA designation, temperature rating, service factor, enclosure type, and efficiency are specified in Division 23 Section "Common Motor Requirements for HVAC Equipment." If different characteristics are required, insert additional subparagraphs below to suit Project.
 - .3 Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
 - .4 Non-spring Return motors for valves larger than NPS 2-1/2 (DN 65): Size for running torque of 150 in x lbf (16.9 N x m) and breakaway torque of 300 in x lbf (33.9 N x m).
 - .5 Spring-Return motors for valves larger than NPS 2-1/2 (DN 65): Size for running and breakaway torque of 150 in x lbf (16.9 N x m).
 - .6 Non-spring Return motors for dampers larger than 25 sq. ft (2.3 sq. m): Size for running torque of 150 in x lbf (16.9 N x m) and breakaway torque of 300 in x lbf (33.9 N x m).
 - .7 Spring-Return motors for dampers larger than 25 sq. ft (2.3 sq. m): Size for running and breakaway torque of 150 in x lbf (16.9 N x m).
- .2 Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
 - .1 Manufacturers:
 - .1 Belimo Aircontrols (USA).
 - .2 Valves: Size for torque required for valve close off at maximum pump differential pressure.
 - .3 Dampers: Size for running torque calculated as follows:

- .1 Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft (87.0 kg-cm/sq. m) of damper cross-sectional area.
- .2 Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft (62.0 kg-cm/sq. m) of damper cross-sectional area.
- .3 Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft (49.7 kg-cm/sq. m) of damper cross-sectional area.
- .4 Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft (37.3 kg-cm/sq. m) of damper cross-sectional area.
- .5 Dampers with 2 to 3 inches wg (498 to 747 Pa) of Pressure Drop or Face Velocities of 1000 to 2500 fpm (5 to 12.7 m/s): Increase running torque by 1.5.
- .6 Dampers with 3 to 4 inches wg (747 to 996 Pa) of Pressure Drop or Face Velocities of 2500 to 3000 fpm (12.7 to 15.2 m/s): Increase running torque by 2.0.
- .4 Coupling: V-bolt and V-shaped, toothed cradle.
- .5 Overload Protection: Electronic overload or digital rotation-sensing circuitry.
- .6 Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual, gear release on non-spring-return actuators.
- .7 Manual Operation: Provided for all valve actuators.
- .8 Power Requirements (Two-Position Spring Return): 24-V ac.
- .9 Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
- .10 Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
- .11 Temperature Rating: Minus 22 to 122 degrees F (Minus 30 to 50 degrees C).
- .12 Temperature Rating (Smoke Dampers): Minus 22 to 250 degrees F (Minus 30 to 121 degrees C).
- .13 Run Time: 12 seconds open, 5 seconds closed.
- .3 Pneumatic Valve Operators: Rolling-diaphragm, piston-type with spring range as required and positioning relay for start-point adjustment/sequencing and spring-loaded for return, sized to operate with sufficient reserve power to provide smooth modulating action or two-position action. Operator shall provide full valve close-off at maximum pump differential pressure.
 - .1 Manufacturers:
 - .1 Siemens Building Technologies.
 - .2 Johnson Controls.
 - .3 Honeywell International.
 - .2 Positioning relays: With the following characteristics:
 - .1 Start Point: Adjustable from 2 to 12 psig (14 to 83 kPa).
 - .2 Operating Span: Adjustable from 5 to 13 psig (35 to 90 kPa).
 - .3 Linearity: Plus or minus 10 percent of output signal span.
 - .4 Hysteresis: 3 percent of span.
 - .5 Response: 0.1 psig (690 Pa) input change.
 - .6 Maximum Pilot Signal Pressure: 20 psig (138 kPa).
 - .7 Maximum Control Air Supply Pressure: 60 psig (414 kPa).
- .4 Pneumatic Damper Operators: Rolling-diaphragm, piston-type with adjustable stops and spring-loaded for return, sized to operate with sufficient reserve power to provide smooth modulating action or two-position action, and positioning relay for start-point adjustment/sequencing.

- .1 Positioning relays: With the following characteristics:
 - .1 Start Point: Adjustable from 2 to 12 psig (14 to 83 kPa).
 - .2 Operating Span: Adjustable from 5 to 13 psig (35 to 90 kPa).
 - .3 Linearity: Plus or minus 10 percent of output signal span.
 - .4 Hysteresis: 3 percent of span.
 - .5 Response: 0.1 psig (690 Pa) input change.
 - .6 Maximum Pilot Signal Pressure: 20 psig (138 kPa).
 - .7 Maximum Control Air Supply Pressure: 60 psig (414 kPa).
- .2 Actuator Housing: Molded or die-cast zinc, aluminum, or high-impact plastic rated for operation at 50 to 140 degrees F (10 to 60 degrees C) unless located in outside air plenums.
 - .1 Plastic actuator housings located in return air plenums or any ductwork shall be UL 910 tested and approved for use by the NFPA 90A standard (Standard for the Installation of Air Conditioning and Ventilation Systems).
- .3 Inlet Vane Operators: High pressure, with pilot positioners, rated to exceed the torque or thrust requirements in order to provide smooth modulating action.

2.20 CONTROL VALVES

- .1 Manufacturers:
 - .1 Erie Controls.
 - .2 Magnatrol Valve Corporation.
 - .3 Neles-Jamesbury.
 - .4 TAC Inc. (Schneider Electric).
- .2 Control Valves - General:
 - .1 Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.
- .3 Control Valve Piping –General:
 - .1 Brass- and bronze-body valves shall be piped with copper/brass/bronze pipe using copper/brass/bronze piping fittings. When piping connects to ferrous piping connections, dielectrics must be used.
 - .2 Steel- and iron-body control valves shall be piped with ferrous piping using ferrous pipe fittings. When piping connects to non-ferrous piping connections, dielectrics must be used.
- .4 Standard valves are also available for Class 250, 250 psig (1724 kPa) and up to 350 degrees F (177 degrees C) operating conditions. Coordinate with mechanical system engineer.
- .5 Hydronic Globe Control Valves shall have the following characteristics:
 - .1 NPS 2 (DN 50) and Smaller: Class 125 bronze body, bronze trim, rising stem, renewable composition disc, screwed ends, with back-seating capacity, and repackable under pressure.
 - .2 NPS 2-1/2 (DN 65) and Larger: Class 125 iron body, bronze trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc.
 - .3 Internal Construction: Replaceable plugs and stainless steel or brass seats.
 - .1 Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom.
 - .2 Double-Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom.

- .4 Sizing: 3 psig (21 kPa) maximum pressure drop at design flow rate or the following:
 - .1 Two-Position: Line size or one size smaller.
 - .2 Two-Way Modulating: Either the value specified above or twice the load pressure drop, whichever is more.
 - .3 Three-Way Modulating: Twice the load pressure drop, but not more than value specified above.
- .5 Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.
- .6 Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of total system (pump) head for two-way valves and 100 percent of pressure differential across valve or 100 percent of total system (pump) head.
- .6 Butterfly Control Valves shall have the following characteristics:
 - .1 Manufacturers:
 - .1 Centerline (Crane).
 - .2 DeZurik.
 - .3 Keystone.
 - .2 Rating: 150-psig (1034-kPa) maximum pressure differential, ASTM A126 cast-iron or ASTM A536 ductile-iron body and bonnet, extended neck, stainless-steel stem, field-replaceable EPDM or Buna N sleeve and stem seals.
 - .3 Butterfly valves are acceptable for piping or equipment isolation use. For modulating service, do not allow the valve to go over 60% open under control to the load.
 - .4 Body Style: Wafer
 - .5 Disc Type: Nickel-plated ductile iron
 - .6 Sizing: 3-psig (21-kPa) maximum pressure drop at design flow rate or the following:
 - .1 Two-Position (isolation): 1-psi (7kPa) or less at design flow rate.
 - .2 Two-Way Modulating: Either the value specified above or twice the load water pressure drop, whichever is more.
 - .3 Three-Way Modulating: Twice the load water pressure drop, but not more than value specified above.
- .7 Terminal Unit Control Valves shall have the following characteristics:
 - .1 Rating: NPS 2 (DN 50) and smaller, bronze body, bronze trim, rising stem, two or three ports as indicated, renewable composition disc, sweat and threaded ends, with back-seating capacity, and repackable under pressure.
 - .2 Class 125 for service at 125-psig (860-kPa) and 250-F (121-C) operating conditions.
 - .3 Sizing: 3-psig (21-kPa) maximum pressure drop at design flow rate for hydronic valves and able to close against pump shutoff head.
 - .4 Flow Characteristics:
 - .1 Hydronic Valves: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.
 - .2 Steam Valves: Two-way valves shall have linear characteristics.
- .8 Self-Contained Control Valves shall have the following characteristics:
 - .1 Type: Bronze body, bronze trim, two or three ports as indicated, replaceable plugs and seats, and available in union and threaded ends.
 - .2 Rating: Class 125 for service at 125-psig (860-kPa) and 250-F (121-C) operating conditions.
 - .3 Thermostatic Operator: Wax-filled integral sensor with integral adjustable dial.

- .4 Coordinate the following two sections with above requirements and Owner preference/acceptance.
- .9 Pressure-Independent Characterized Control Valves (PICCV) shall have the following characteristics:
 - .1 Manufacturers:
 - .1 Belimo.
 - .2 NPS 1-1/4 (DN 32) and Smaller: Pressure rated at 400-psig (2758-kPa) body; 200-psig (1379-kPa) close-off pressure.
 - .3 Internal Construction: Internal construction: chrome plated brass ball and stem (stainless steel stem also acceptable), characterizing disc shall be brass or Tefzel and replaceable, diaphragm for small valves shall be Nomex or silicone, for larger valves polyester-reinforced silicone. End fittings shall be threaded (female NPT).
 - .4 Service: Chilled or heating hot water and glycol (up to 60% solution).
 - .5 Rating: Class 125 for service at 125-psig (860-kPa) and 250-F (121-C) operating conditions.
 - .6 Sizing: 3-psig (21-kPa) maximum pressure drop at design flow rate, to close against pump shutoff head.
 - .7 Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.
 - .8 Provide spring-return actuators where noted on drawings or in schedules.
- .10 Characterized Ball Valves shall have the following characteristics:
 - .1 Manufacturers:
 - .1 Honeywell International.
 - .2 Johnson Controls.
 - .3 Siemens Building Technologies.
 - .2 Service: Chilled water or heating hot water and glycol solutions (up to 60%). Full port ball valves shall be used only for pipe isolation service. Modulating service valves shall be characterized port valves.
 - .3 Internal construction: chrome or stainless steel-plated brass ball with stainless steel stem and trim, characterizing disc shall be plastic and replaceable.
 - .4 Rating: Class 125 for service at 125-psig (860-kPa) and 250-F (121-C) operating conditions.
 - .5 Sizing: 3-psig (21-kPa) maximum pressure drop at design flow rate; close off pressure no less than 130 psig (896-kPa)
 - .6 Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.
 - .7 Provide spring-return actuators where noted on drawings or in schedules.

2.21 DAMPERS

- .1 Manufacturers:
 - .1 American Warming and Ventilating.
 - .2 Mestek.
 - .3 TAMCO.
 - .4 United Enertech Corp.
- .2 Dampers: AMCA-rated, parallel blade per the design requirements; 0.108-inch (2.7-mm) minimum thickness, galvanized-steel or 0.125-inch (3.2-mm) minimum thick, extruded-aluminum frames with holes for duct mounting; damper blades shall not be less than 0.064-

inch (1.6-mm) thick galvanized steel with maximum blade width of 8-inch (200-mm) and length of 48-inches (1220-mm)

- .1 Secure blades to 1/2-inch (13-mm) diameter, zinc-plated axles using zinc-plated hardware, with oil-impregnated, sintered bronze blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
- .2 Operating Temperature Range: From minus 40- to 200-F (- 40- to 93-C)
- .3 Edge Seals, Standard Pressure Applications: Closed-cell neoprene or silicone.
- .4 Edge Seals, Low-Leakage Applications: Use inflatable blade edging or replaceable rubber blade seals.
- .5 Jamb Seals: spring-loaded, stainless steel, only.
- .6 Leakage ratings or dampers shall be less than 0 cfm per sq. ft. (4.6 L/s per sq. m) of damper area, at differential pressure of 4-inches wg (1000-Pa) when damper is held by torque of 50 in. x lbf (5.6 N x m) when tested according to AMCA 500D.

2.22 AIR SUPPLY

2.23 CONTROL CABLE

- .1 Electronic and fiber-optic cables for control wiring are specified in Division 27 Section "Communications Horizontal Cabling."

PART 3 EXECUTION

3.1 EXAMINATION

- .1 Verify that a commercial power supply is available to control units and operator workstation.
- .2 Verify that emergency power supply is available to control units and operator workstation if required for project.
- .3 Verify that the UPS is rated for the controller power needs and has been provided.
- .4 Verify that pneumatic piping and duct-, pipe-, and equipment-mounted devices are installed properly before proceeding with wiring installation.

3.2 INSTALLATION

- .1 General
 - .1 Install software and/or custom programming in DDC control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.
 - .2 Connect and configure equipment and software to achieve sequence of operation specified.
 - .3 Install DDC controller panels in locations noted on plans or coordinate with Architect. Coordinate with Electrical Contractor for power.
 - .4 Install DDC temperature control instruments and devices on all controlled equipment per control plans and provide supply air and control branch air piping as required for a complete installation.
 - .5 DDC control system wiring in conduit, J-hooks, or installed in bridle rings (when allowed) shall:
 - .1 Run conduit runs along building and steel sight-lines (not diagonal or where support is improper).
 - .2 Support all conduit with independent hangers, not from ductwork/piping or from ductwork/piping hangers/trays/supports/Unistrut; and independent of other trade's work.

- .3 Anchor J-hooks to walls or suspend J-hooks using 1/4-inch minimum diameter threaded rod hangers. Do not support J-hooks from ceiling or equipment hangers. J-hooks shall not impede removal of accessible ceiling tiles.
- .6 Control wiring and pneumatic tubing in conduit or installed exposed (when allowed) shall:
 - .1 Run conduit runs along building and steel sight lines (not diagonal or where support is not proper).
 - .2 Support all conduit with independent hangars, not from ductwork/piping or from ductwork/piping hangars/trays/supports and independent of other trade's work.
 - .3 Anchor J-hooks to walls or suspend J-hooks using 1/4-inch minimum diameter threaded rod hangers. Do not support J-hooks from ceiling or equipment hangers. J-hooks shall not impede removal of accessible ceiling tiles.
 - .4 Pneumatic tubing in mechanical equipment rooms shall always be installed in conduit or installed as copper tubing.
 - .5 Pneumatic tubing installed in plenum air spaces (exposed or concealed) and in duct/piping shafts shall be plenum-rated by Underwriters' Laboratories Inc.
- .7 Mount compressor and tank unit on elastomeric mounts. Vibration isolators are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment." Isolate air supply with wire-braid-reinforced rubber hose. Secure and anchor according to manufacturer's written instructions and seismic-control requirements.
 - .1 Pipe manual and automatic drains to nearest floor drain.
 - .2 Supply instrument air from compressor units through dryer, filter, pressure reducing valve, and pressure relief valve, with pressure gages at inlet and outlet connections, and shutoff and bypass valves at the air dryer and filter/PRV combination.
- .8 Install temperature control panels in locations noted on plans or coordinate with Architect. Coordinate with Electrical Contractor for power.
- .9 Install temperature control instruments and devices on all controlled equipment per control plans and provide supply air and control branch air piping as required for a complete installation.
- .10 Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Installation height of devices.
 - .1 Install averaging elements in ducts and plenums in crossing or zigzag pattern.
- .11 Install guards on thermostats in the following locations:
 - .1 Building Entrances
 - .2 Public areas and restrooms
 - .3 Where indicated on drawings
- .12 Furnish automatic dampers according to Division 23 Section "Air Duct Accessories" to installing contractor for installation.
- .13 Install damper motors on outside of ductwork in warm areas, not in locations exposed to outdoor temperatures.
- .14 Install labels and nameplates to identify control components according to Division 23 Section "Identification for HVAC Piping and Equipment."
- .15 Furnish hydronic instrument wells, valves, and other accessories according to Division 23 Section "Hydronic Piping" to installing contractor for installation.
- .16 Furnish steam and condensate instrument wells, valves, and other accessories according to Division 23 Section "Steam and Condensate Heating Piping" to installing

- contractor for installation.
- .17 Install hydronic, gas, compressed air, and/or steam flow meters and accessories according to this specification and per locations shown on the plans.
- .18 Install refrigerant instrument wells, valves, and other accessories according to Division 23 Section "Refrigerant Piping."
- .19 Install electronic and fiber-optic cables according to Division 27 Section "Communications Horizontal Cabling."
- .2 Pneumatic Piping
 - .1 Install piping in mechanical equipment rooms inside mechanical equipment enclosures, in pipe chases, or suspended ceilings with easy access.
 - .1 Install copper tubing with maximum unsupported length of 36-inches (914-mm) for tubing exposed to view.
 - .2 Install polyethylene tubing in metallic raceways or electrical metallic tubing. Electrical metallic tubing materials and installation requirements are specified in Division 26 Section "Raceway and Boxes for Electrical Systems."
 - .2 Install terminal single-line connections, less than 18-inches (457-mm) in length, with copper or polyethylene tubing run inside flexible steel protection.
 - .3 Route conduit for poly and poly-lines along building and steel lines (not diagonal) and do not hang conduit from ductwork and piping or their support means
 - .4 In concealed locations such as pipe chases and suspended ceilings with easy access, install copper tubing. Electrical metallic tubing materials and installation requirements are specified in Division 26 Section "Raceway and Boxes for Electrical Systems."
 - .5 In concrete slabs, furred walls, or ceilings with no access, install copper or polyethylene tubing in electrical metallic tubing or vinyl-jacketed polyethylene tubing.
 - .1 Protect embedded-copper and vinyl-jacketed polyethylene tubing with electrical metallic tubing extending 6-inches (150-mm) above finished slab and 6-inches (150-mm) into slab. Pressure test tubing before and after pour for leak and pinch.
 - .2 Install polyethylene tubing in electrical metallic tubing extending 6-inches (150-mm) above floor line; pull tubing into electrical metallic tubing after pour.
 - .6 Install tubing with sufficient slack and flexible connections to allow for vibration of piping and equipment.
 - .7 Terminate polyethylene tubing at devices/sensors mounted on heating hot water and/or steam piping/equipment with the final 18-inches (460-mm) in copper tubing.
 - .8 Purge tubing with dry, oil-free, compressed air before connecting control instruments. (Nitrogen may also be used).
 - .1 Bridge cabinets and doors with flexible connections fastened along hinge side; protect against abrasion. Tie and support tubing.
 - .9 Number-code or color-code control air piping for future identification and service of control system, except local individual room control tubing.
 - .10 Pressure Gages or Test Plugs: Install on branch lines at each receiver controller, at valve and damper actuators, and on signal lines at each transmitter, except individual rooms. In temperature control panels, provide a gage and isolation valve for service at the entering supply air piping and at any branch connection that is adjustable.
- .3 Electrical Wiring and Connection
 - .1 Install raceways, boxes, and cabinets according to Division 26 Section "Raceway and Boxes for Electrical Systems."
 - .2 Install building wire and cable according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

- .3 Route conduit and plenum cables along building and steel lines (not diagonal) and do not hang conduit or bridle rings from ductwork and piping or their support means
- .4 Install signal and communication cable according to Division 27 Section "Communications Horizontal Cabling."
 - .1 Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
 - .2 Install exposed cable in raceway.
 - .3 Install concealed cable in raceway.
 - .4 Bundle and harness multi-conductor instrument cable in place of single cables where several cables follow a common path.
 - .5 Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
 - .6 Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
 - .7 Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.
- .5 Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.
- .6 Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

3.3 FIELD QUALITY CONTROL

- .1 Manufacturer's Field Service: Engage a factory-authorized service representative to inspect test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- .2 Perform the following field tests and inspections and prepare test reports:
 - .1 Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
 - .2 Test and adjust controls and safeties.
 - .3 Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - .4 Pressure test control air piping at 30-psig (207-kPa) or 1.5 times the operating pressure for 24 hours, with maximum 5-psig (35-kPa) loss.
 - .5 Pressure test high-pressure control air piping at 150-psig (1034-kPa) and low-pressure control air piping at 30-psig (207-kPa) for 2 hours, with maximum 1-psig (7-kPa) loss.
 - .6 Test calibration of pneumatic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
 - .7 Test each point through its full operating range to verify that safety and operating control setpoints are as required.
 - .8 Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
 - .9 Test each system for compliance with sequence of operation.
 - .10 Test software and hardware interlocks.
- .3 DDC Verification:
 - .1 Verify that instruments are installed before calibration, testing, and loop or leak checks.

- .2 Check instruments for proper location and accessibility.
- .3 Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
- .4 Check that insertion instruments are located in the correct section of piping.
- .5 Check instrument piping for proper fittings, slope, material, and support.
- .6 Check instrument tubing for proper fittings, material, and support.
- .7 Check installation of air supply for each instrument.
- .8 Check water flow instruments. Inspect tag number and line and bore size, verify that upstream/downstream dimensions are per manufacturer's requirements, and that instruments are installed correctly.
- .9 Check airflow instruments. Inspect tag number and ductwork size, verify that upstream/downstream dimensions are per manufacturer's requirements, and that instruments are installed correctly.
- .10 Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
- .11 Check temperature instruments, material, and length of sensing elements.
- .12 Check control dampers/valves. Verify that proper blade alignment, either parallel or opposed, has been provided. Verify that valves are installed in the correct direction.
- .13 Delete subparagraph below is all electric DDC controls.
- .14 Check air-operated dampers/valves. Verify that pressure gages are provided and that proper blade alignment, either parallel or opposed, has been provided. Verify that valves are installed in the correct direction. Verify that pilot positioners, end switches, and/or feedback devices if provided, are installed and calibrated properly.
- .15 Check electric-operated dampers/valves and hydraulic-operated valves. Verify that proper blade alignment, either parallel or opposed, has been provided. Verify that valves are installed in the correct direction. Verify end switches and/or feedback devices are installed properly.
- .16 Check DDC system as follows:
 - .1 Verify that DDC controller power supply is from emergency power supply, if applicable.
 - .2 Verify that wires at control panels are tagged with their service designation and approved tagging system.
 - .3 Verify that spare I/O capacity has been provided.
 - .4 Verify that DDC controllers are protected from power supply surges.
- .4 Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.4 ADJUSTING

- .1 Calibrating and Adjusting:
 - .1 Calibrate installed devices and instruments, whether electric or pneumatic.
 - .2 Make three-point calibration test for both linearity and accuracy for each analog instrument.
 - .3 Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
 - .4 Control System Inputs and Outputs:
 - .1 Check analog inputs at 0, 50, and 100 percent of span.
 - .2 Check analog outputs using milli-ampere meter at 0, 50, and 100 percent output.

- .3 Check digital inputs using jumper wire.
- .4 Check digital outputs using ohmmeter to test for contact making or breaking.
- .5 Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.
- .5 Flow:
 - .1 Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
 - .2 Manually operate flow switches to verify that they make or break contact.
- .6 Pressure:
 - .1 Calibrate pressure transmitters at 0, 50, and 100 percent of span.
 - .2 Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.
- .7 Temperature:
 - .1 Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
 - .2 Calibrate temperature switches to make or break contacts.
- .8 Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.
- .9 Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
- .10 Provide diagnostic and test instruments for calibration and adjustment of system.
- .11 Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.
- .2 Adjust initial temperature, CO, CO2, static pressure, humidity, etc., set points.
- .3 Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other than normal occupancy hours for this purpose.

3.5 DEMONSTRATION AND TRAINING

- .1 Engage a factory-authorized service representative of the manufacturer (or manufacturers authorized and trained installation representative) to demonstrate the system's operational status in all modes of control. This shall be arranged for the following:
- .2 Modify this section to include unique arrangements and Owner's needs. This may vary significantly.
 - .1 Every control drawing Mxxx: Demonstrate system in all modes of operation per Sequence of Operation stated.
 - .2 Where there are multiple devices (VAV box, unit heater, cabinet unit heater, fan coil unit, etc.) installed identically, perform demonstration on 25% of the installed quantity, in all modes of operation per Sequence of Operation stated.
- .3 Refer to Division 01 Section "Demonstration and Training."

3.6 GRAPHIC DISPLAY GENERATION

- .1 Provide the following graphic displays as a minimum at the operator workstations, arranged in logical penetration paths:

- .1 Overall campus layout which shows all of the buildings on the Owner's campus.
- .2 Individual building layout or isometric for each building connected to the system.
- .3 Floor plans for each floor within each building, with display of present values of space conditions sensed by connected space sensors, display of the name of the air handler associated with each space sensor, display of the room number in which the sensor is located and color coding to indicate whether the sensed space condition is within the acceptable range, is too high, or is too low. TC Contractor shall confirm Owner desired room names prior to graphics generation which may differ from the room names indicated on construction documents.
- .4 Schematic diagram for each HVAC system. Each system schematic display shall include at least the following:
 - .1 Schematic arrangement of ductwork, fans, dampers, coils, valves, piping, pumps, equipment etc.
 - .2 System name.
 - .3 Area served.
 - .4 Present value or status of all inputs, along with present setpoint.
 - .5 Present percent open for each damper, valve, etc. based on commanded position.
 - .6 Reset schedule parameters for all points, where applicable.
 - .7 Present occupancy mode.
 - .8 Present economizer mode, where applicable.
 - .9 Present outside air temperature.
 - .10 Associated space conditions and setpoints, where applicable.
 - .11 Status of application programs (e.g., warm-up, night cycle, duty cycle, etc.).
 - .12 Color coding to indicate normal and abnormal values, alarms, etc.
- .5 Manual override capability for each on/off or open/closed controlled digital output (for fans, pumps, 2-position dampers and valves, etc.) and each modulating analog output (for dampers, valves, VFD speed modulation type points, etc) shall be provided. Graphic display of output point auto or manual override status shall be provided.
- .6 Sequence of operation in written (text) format for each HVAC system.
- .7 Overall BAS system schematic.
- .8 System management graphic for each network device and/or DDC panel.
- .9 Provide a separate page for critical alarm summary.
- .2 Contractor to provide graphics that are fully operational prior to commissioning.

3.7 SYSTEMS INTEGRATION

- .1 The following items have been provided and are prepared for Demonstration and Owner Training:
 - .1 New DDC Controllers are interfaced to the existing EMS network.
 - .2 New DDC Controllers are fully and readily accessible from existing graphical user workstations.
 - .1 Graphics "links" are provided from top most level graphic to sub-graphic (if existing) and then to the newly installed systems.
 - .2 New systems are readily identifiable with links to the equipment controller graphic or another sub-graphic.
 - .3 Back buttons ("links") take users back one level and provide a link out to the top-most graphic.

- .3 All DDC/EMS communication wiring (cable) is coordinated and provided, and fully tested with the Owner's IT staff.
- .4 EMS software upgrades or updates and networking software upgrades or updates have been provided, when required.
- .5 Networking (building level) controllers requiring upgrades or updates have been provided, when required.

3.8 OWNER TRAINING

- .1 Engage a factory-authorized service representative to train Owner's maintenance personnel on how to operate, maintain, and adjust HVAC instrumentation and controls.
 - .1 Training shall be provided for a period of 40 hours in 4-hour increments; to be scheduled with the Owner's representative at least 2-weeks in advance.
 - .2 Provide all training materials needed for a complete training session including but not limited to Operation and Maintenance Manuals, product catalogs, and "record drawings" of the controls installation.
 - .3 Training shall be a combination of classroom (printed material and electronic presentations) and mechanical room (hands-on) instruction.
- .2 Refer to Division 01 Section "Demonstration and Training."

3.9 ACCEPTANCE PROCEDURE

- .1 SUBMITTALS data relevant to point index, functions limits, sequences, interlocks, power fail/restarts, logs, software routines and associated parameters, and other pertinent information for the operating system and database shall be forwarded from the control system contractor to the Owner.
- .2 Approved database will be entered into the central computer, debugged, and down line loaded to Controllers. Prior to on-line operation, a complete demonstration and readout of the computer command shall be performed in the presence of the Owner. In addition, a printout of the database generated for all points, shall be reviewed with the Owner by the control system contractor. Modification to the database shall be made by the control system contractor as directed by the Owner.
- .3 All points shall be verified prior to "punch-out" for correct and accurate correspondence between the CRT data display and actual field location and equipment operation.
- .4 Upon successful completion of system generation the Owner shall be requested in writing to inspect and approve the satisfactory operation of the control system, sub-systems, and accessories.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- .1 Manufacturer/Installer.
- .2 Multi-Sensor Monitor.
- .3 Sensors/Probes.
- .4 Multi-Sensor Specifications.
- .5 Network Server.
- .6 Air-Sampling Tubing.
- .7 System Software Overview.

1.2 GENERAL REFERENCES

- .1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.
- .2 Division 20, including all Common Mechanical Requirements in Section 20 00 00, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.

1.3 RELATED REQUIREMENTS

1.4 ABBREVIATIONS AND ACRONYMS

- .1 BAS: Hardware, software, and equipment necessary for the Building Automation System.
- .2 FMS: Hardware, software, and equipment necessary for the Facility Environment Monitoring System.
- .3 FMC: Refers to the Facility Environment Monitoring System Contractor. The FMC is the Contractor responsible for the installation of the FMS as specified in this Section.
- .4 DDC: Direct digital control.
- .5 I/O: Input/output.
- .6 MS/TP: Master slave/token passing.
- .7 PC: Personal computer.

1.5 DEFINITIONS

- .1 BACnet: A data communication protocol for designing, integrating, and implementing otherwise proprietary systems into a common Building Automation System for ease of use and display.

1.6 SUBMITTALS

- .1 Action Submittals
 - .1 Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
 - .2 Electronic Submittal: Provide submittal data electronically through the tier of contractors.
 - .3 Shop drawings shall include:
 - .1 Complete package of drawings for the system to include:
 - .1 Index sheet

- .2 Legend of symbols and acronyms used
- .3 Communications Riser
- .4 Standard Wiring Diagrams
- .5 Standard Wiring Types and Sources
- .6 Device addressing scheme
- .7 Equipment numbers
- .8 Systems Summary
- .9 System Schematic
- .10 Point-to-point wiring diagrams
- .11 Bill of Materials
- .2 Detailed equipment assemblies to indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection. Wiring diagrams shall include power, signal, and control wiring.
- .3 FMS Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator workstation equipment, interface equipment, control units, sensors, control panels, and operator interface equipment.
- .4 FMS Software: Include technical data for operating system software, operator interface, color graphics, and other third-party applications.
- .5 Integrated Systems: Include written description of sequence of operation including schematic diagram of interface to DDC.
- .4 Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with BACnet.
- .5 Software and Firmware Operational Documentation (for O&M and Close-out): Include the following:
 - .1 Software operating and upgrade manuals.
 - .2 Program Software Backup: On a CD media, complete with data files.
 - .3 Device address list.
 - .4 Printout of software application and graphic screens.
 - .5 Software license required by and installed for DDC workstations and control systems.
- .6 Field Quality Control Test Reports
 - .1 Revise Shop Drawings to reflect actual installation and operating sequences.
 - .2 Record actual locations of control components, including control units, Sensor Suites, and sensors.
 - .3 Submit the electronic files for all as-built shop drawings on CD media in pdf format.
- .2 Operation and Maintenance Materials
 - .1 For instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
 - .1 Maintenance instructions and lists of spare parts for each type of control device and any other ancillary equipment that is part of instrumentation and control system.
 - .2 Interconnection wiring diagrams with identified and numbered system components and devices.

- .3 Keyboard illustrations and step-by-step procedures indexed for each operator function.
- .4 Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
- .5 Calibration records and list of set points.
- .6 Revise Shop Drawings to reflect actual installation and operating sequences.
- .7 Record actual locations of control components, including control units, Sensor Suites, and sensors.
- .8 Submit the electronic files for all as-built shop drawings on CD media in pdf format.
- .2 Operating and Maintenance Manuals that are project specific and provide:
 - .1 System Overview
 - .2 Network Architecture
 - .3 Hardware cut sheets and product descriptions
 - .4 Wiring diagrams
- .3 Record Documents
 - .1 Include the following:
 - .1 Revise Shop Drawings to reflect actual installation and operating sequences.
 - .2 Record actual locations of control components, including control units, Sensor Suites, and sensors.
 - .3 Submit the electronic files for all as-built shop drawings on CD media in pdf format.

1.7 QUALITY ASSURANCE

- .1 Installer Qualifications: The FMC shall have support services and comply with the service requirements of a 24-hour response time. Any technician working on the FMS shall be certified by the FMS manufacturer for such work. Support services is defined as having access to complete parts inventory, having all required test and diagnostic equipment, and having factory certified technicians on the systems specified herein. Support services shall reside within a one-hour driving radius of the project site.
- .2 Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.8 MOCK-UPS AND SAMPLES

- .1 Samples for Initial Selection: For each color required, of each type of interior or exterior sensor cover with factory-applied color finishes.
- .2 Samples for Verification: For each color required, of each type of interior or exterior sensor cover.

1.9 COORDINATION

- .1 Coordinate location of room, duct, and other exposed control sensors with plans and room details before installation.

1.10 DELIVERY, STORAGE AND HANDLING

- .1 Products, equipment, and sensors shipped to the construction site shall be stored in conditioned spaces meeting the manufacturer's requirements for storage.
- .2 Products, equipment, and sensors installed on the construction site shall be wrapped and sealed in plastic in order to protect them from construction dust, debris, etc., until a proper

operating environment can be maintained.

1.11 SUMMARY DESCRIPTION

- .1 The FMS shall monitor and analyze airborne parameters such as particulates, volatile organic compounds (VOCs), moisture content, gases such as carbon monoxide and carbon dioxide (CO, CO₂), and others as indicated in the specification.
- .2 The FMS shall provide continuous monitoring of environmental conditions and ventilation performance as prescribed in the Sensor Suite section, and provide protected information access via a web-based user interface to analytical summaries, system generated reports, in onscreen graphical form, system distributed reports, and analysis based notifications. Utilities are to be included to export FMS data as a comma separated values (.csv) file format.
- .3 The FMS system architecture shall utilize room, duct, and outdoor air probes networked to distributed Air Data Routers and Sensor Suites communicating over a data and air-sampling network. The air-sampling network shall consist of an air packet transportation network that shall transport air samples from the environment being monitored to Sensor Suites located throughout the facility. The air-sampling network shall consist of intelligent air packet routers, an electrically conductive MicroDuct® network, and structured cable. Gathering of air samples shall occur via room, duct, and outdoor air-sampling probes located as indicated in the documents.
 - .1 All material and equipment shall be standard components, regularly manufactured and available by the manufacturer and not custom designed especially for this project.
 - .2 Software and system architecture shall be factory tested with the exception of site-specific software, which shall be tested on-site and specified under PART 3 - EXECUTION. System architecture shall be fully modular permitting expansion of application software, databases, graphics, peripherals, and field hardware.
 - .3 Sensors shall be readily available as over-the-counter parts and may be purchased as OEM parts through 3rd party providers.
 - .4 Do not use this installation as a product "beta" test site unless explicitly approved in writing by Owner or Owner's representative.
 - .5 Upon completion of installation of all software and hardware, the system shall perform all operational functions described herein and per contract document Sequence of Operations.
- .4 FMS System Hardware shall provide all Air Data Routers, Sensor Suite Sensors; Room, Duct, and Outdoor Air Probes; Information Management Servers, Vacuum Pumps, Structured Cable, power transformers, and wiring for a complete system.
- .5 FMS System Software shall provide all software identified in this specification for the implementation of a complete system providing point databases, point descriptors, point database editor, graphical displays, graphics editor, report generator, point summaries, and test sequences. The latest software shall be provided and updated (if available) at system turnover.
- .6 FMS System shall provide a BACnet Integration Server in order to integrate into the Owner's IT Network for distributed information purposes (e.g. BAS). The FMC shall provide integration coordination with the Owner's IT staff.
 - .1 BACnet communication shall be compatible with CAT-5e or CAT-6 cabling.
- .7 Annual Services Agreement
 - .1 At the time the sensors are shipped from the factory as described later in this specification, the FMC shall transmit an agreement for annual services to the owner marked "PAID IN FULL" that shall provide services for the system for a period of five years. Under this agreement, the FMC shall provide sensor element replacement, calibration services, diagnostics, software upgrades, materials and equipment

necessary for ongoing system operation. At a minimum, twice a year, provide calibration with NIST traceable calibration gases and test instrumentation, functional testing, sensor element evaluation to determine useful life and element replacement as required, and evaluation services to insure the ongoing performance of all sensors as installed system per this specification. This service shall include, but not be limited to the following:

- .1 Provide a factory certified depot to remove all sensors within the sensor suite on a periodic basis (as a minimum, twice per year), and replace with pre-packaged, certified, industry traceable, factory calibrated sensors. Removed sensors shall be returned to the manufacturer for factory recalibration, internal cleaning, upgrades, sensor element replacement, and component and board repairs. Written records shall be provided to the owner for every visit indicating the performance of such calibrations along with all pertinent data.
- .2 All costs for the repair and replacement of any defective sensor and for any consumable element or part on the sensor shall be included.
- .3 Software upgrades to correct bugs, fixes, and patches for the sensors shall be included.

.8 FMS Interface to DDC

- .1 The FMS shall monitor and analyze airborne parameters such as particulates, volatile organic compounds (VOCs), moisture content, gases such as carbon monoxide and carbon dioxide (CO and CO₂ respectively), and others as indicated in the FMS specification. As a result of this analysis, the FMS shall output values to the DDC with changes in operational parameters; most significantly airflow rates. The system shall also provide analysis of how the indoor environment responds as a result of the mechanical system modes of operation, and provide performance reports and other data to building management.
- .2 DDC Contractor's Responsibility: The DDC contractor shall be required to implement an interface between the DDC and the FMS which shall communicate with the BAS via BACnet. The BAS contractor shall be responsible for:
 - .1 Mapping the necessary FMS data points in the DDC BACnet database. These data points shall be read from the FMS and serve as data values to be used as input points in the building control systems for values such as minimum outdoor air levels, overall ventilation rates, humidity levels, and others as indicated in the specification or on the drawings.
 - .2 Creating/coordinating point values to the FMS that are indicators of the ventilation system and other components in the building.
 - .3 Implementing the necessary control sequences to respond to the directions from the FMS. These directions shall be integrated from a priority standpoint so that other control actions such as smoke control are not impeded.
 - .4 Provide qualified on-site staff during startup of the FMS to insure that communication is functional, that data values are received from the FMS, that control DDC sequences as a result of this data are implemented properly and effectively, and that necessary data is transmitted to the FMS.
 - .5 In a Lab, Vivarium or other Critical Environment the BAS shall at a minimum provide the flow feedback of the supply flows and room's general exhaust that are being commanded as a result of the FMS information. This flow feedback shall be delivered via BACnet unless otherwise stated.
 - .6 The BAS shall provide additional points as prescribed by the engineer. These points shall be delivered via BACnet unless otherwise stated.
 - .7 The following DDC points are required to perform analytic functions:
 - .1 To calculate Air Change Rates:

- .1 Total space supply air flow feedback
 - .2 Total space exhaust air flow feedback
 - .3 A means of determining effective occupancy state of the space, either a BACnet variable to reflect occupied state, or a schedule that reflects the typical occupancy schedule
 - .2 To perform fume hood analytics:
 - .1 Fume hood flow feedback
 - .2 Fume hood sash opening percentage
 - .3 Fume hood occupancy state
 - .3 To perform ventilation demand analytics:
 - .1 Values representing thermal overrides for heating and cooling
 - .2 Value that represents the total fume hood flow per zone
- .9 Add this only if interfacing to a BAS (existing or new) – FMS Integration to BAS
 - .1 The FMC shall provide a BACnet compatible integration server and software to interface with the facility's BAS. Communication shall be via BACnet IP.
 - .1 Owner's IT shall be responsible for providing IP drop at the Owner's designated location of the integration server.
 - .2 Communication wiring from the integration server to the FMS shall be provided by the FMC.
 - .2 FMC shall provide dynamic graphic of complete FMS. If large it may be separated into two graphics. Comply with Owner's designated graphic color and point naming conventions.
 - .1 Place a link in the Main Graphic of the building to link into the FMS graphic.
 - .2 Provide a link in the FMS graphic back to the main graphic or Owner's choice of graphic.

PART 2 PRODUCTS

2.1 MANUFACTURER/INSTALLER

- .1 Manufacturer (FMS)
 - .1 Aircuity.
- .2 Installer (FMC)
 - .1 DDC TC Installer or 3rd Party – designate which

2.2 MULTI-SENSOR MONITOR

- .1 The Multi-Sensor Monitor shall be a distributed, network based, multi-point sensing device. The Multi-Sensor Monitor shall be furnished as a complete, self-contained unit, housing all electronics, sensing card cage, sampling manifolds, flow regulators, pressure regulators, firmware, and software.
- .2 The Multi-Sensor Monitor shall support communications with a network of 30 other Multi-Sensor Monitors, and a Network Server.
- .3 The Multi-Sensor Monitor shall provide a continuous-duty vacuum pump, with an automatic standby redundant back-up vacuum pump, for each Multi-Sensor Monitor.
 - .1 Nominal vacuum: Minus 8-psig (Minus 16.32-inches Hg) (Minus 55.2-kPa (Minus 414-mmHg))
 - .2 Flow Rate: 1-SCFM (28.32-liters per minute) 1-SCFM (28.32-liters per minute)
- .4 The Multi-Sensor Monitor base unit shall consist of an enclosure; hinged door with keyed lock; terminations area for both field wiring and Air-sampling Tubing connections; a

- communications/processor board; electronic flow measurement and controller assembly; and sensor bay.
- .5 The Multi-Sensor Monitor shall utilize a card cage to allow for the ease of selection and installation of a diverse array of environmental and specialty sensors. As a minimum, the Multi-Sensor Monitor shall incorporate the following sensors: Carbon Dioxide, Dew Point, and Relative Humidity (%RH).
 - .6 Sampling Rate - The sensors selected for the Multi-Sensor Monitor, shall insure that the FMS sampling rate for any given test area/sampling point be no greater than once per every 20 minutes. The FMC shall provide the appropriate level of sensor performance and the required quantity of Multi-Sensor Monitors to guarantee that each test area/sampling point is sampled continuously and uninterrupted no less than once every 20 minutes.
 - .7 The Multi-Sensor Monitor shall be modular in nature, and allow for the addition and removal of the sensors for application specific sensing requirements, and ease of calibration and service. Additional modular sensor-bay expansion capabilities shall be provided for additional sensors.
 - .8 All point data, algorithms and application software within the Multi-Sensor Monitor shall be programmable from the Network Server. Each Multi-Sensor Monitor shall contain both software and firmware to receive and perform full test area sequencing schemes downloaded from the Network Server.
 - .9 Each Multi-Sensor Monitor shall contain a serial port for interfacing with a portable computer. Multi-Sensor Monitor and network interrogation shall be possible through this port.
 - .10 The Multi-Sensor Monitor shall house an on-board flow regulator, orifice plate, and differential pressure sensor to maintain a continuous, regulated flow rate through the Air-sampling Tubing.
 - .11 On-board diagnostics shall continuously perform system checks to insure the integrity of the Air-sampling Tubing against leaks and occlusions.
 - .12 Multi-Sensor Monitors shall be capable of proper operation in an ambient temperature environment of 32- to 125-F (0- to 51.7-C) 10 to 90% RH.
 - .13 Multi-Sensor Monitors shall have LED indication for visual status of communication and power.
 - .14 Multi-Sensor Monitors shall operate on 24VAC power fed from a common 120/24VAC transformer connected to the Multi-Sensor Monitor.

2.3 SENSORS/PROBES

- .1 Room Temperature Sensors
 - .1 A semi-flush mounted, room temperature sensor and air-sampling port are to be housed within one enclosure; the port within the enclosure shall accept Air-sampling Tubing.
 - .2 Temperature Sensing Element:
 - .1 Platinum RTD: Range of -30- to 130-F (-34- to 54-C)
 - .2 Accuracy: Plus or minus 0.3-degrees F (Plus or minus 0.17-degrees C) 6
 - .3 Internal coarse filter to screen out large particulate from entering the Air-sampling Tubing.
 - .4 Terminations:
 - .1 Sensor: Two-wire (not including shield if required)
 - .2 Power: Three-wire
 - .3 Air-sampling Tubing: Integral hose clamp
 - .5 Option to include only air-sampling; the internal temperature sensor shall not be included.

- .2 Duct Probe and Outdoor Air Mount
 - .1 A duct temperature sensor and a stainless steel air sample probe are to be mounted within one metal general purpose enclosure. Duct sample probe to accept integral Air-sampling Tubing.
 - .2 Temperature Sensing Element:
 - .1 Platinum RTD: Range of- 30- to 130-degrees F (- 34- to 54-degrees C)
 - .2 Accuracy: + or - 0.3-degrees F (+ or - 0.17-degrees C)
 - .3 Internal coarse filter to screen out large particulate from entering the Air-sampling Tubing.
 - .4 Terminations:
 - .1 Sensor: Two-wire (not including shield if required)
 - .2 Power: Two-wire (internal DC power supply)
 - .3 Air-sampling Tubing: Integral speed fitting
 - .5 Option to include only air-sampling, the internal temperature sensor shall not be included.
 - .6 Outdoor Air Locations: Provide a NEMA 4X weatherproof enclosure.

2.4 MULTI-SENSOR SPECIFICATIONS

Model Number	SEN-DPT-2	SEN-C2D-3
Typical Application	Dew Point Temp, Relative Humidity*, Enthalpy*, Monitoring or Control	Dew Point Temp, Relative Humidity*, Enthalpy*, Monitoring or Control - CO2 Based Demand Controlled Ventilation (DCV) or Monitoring
Sensor: Dew Point (DP)		
Element	Capacitive Polymer Sensor	Dual Wavelength, Non-Dispersive Infrared Sensor
Range	0- to ambient °FDP or 70 °FDP (minus 18 to ambient °CDP or 21 °CDP), whichever is less.	Minus 58- to ambient °FDP or 122 °FDP (minus 50 to 50 °CDP), whichever is less.
Accuracy	Dew Point: ± 2 °FDP (± 1 °CDP) RH: Calibrated @ 65 °F (18 °C) and ± 0.5 °F (± 0.28 °C) ± 6% RH @ 10 to 60% RH ± 8% RH @ 61 to 90% RH	Dew Point: ± 0.9 °FDP (± 0.5 °CDP) from 20- to 65-°FDP (minus 7- to 18-°CDP) RH: Calibrated @ 65 °F (18 °C) and ± 0.5 °F (± 0.28 °C) ± 6% RH @ 10 to 60% RH ± 8% RH @ 61 to 90% RH
Response	30 seconds	10 seconds
Sensor: Carbon Dioxide (CO2)		
Element		Dual Wavelength, Non-Dispersive Infrared Sensor

Range	0– to 3000-ppm
Accuracy	± 45-ppm up to 1000 ppm
Resolution	3-ppm
Response	10 seconds

- .1 *Relative Humidity and Enthalpy measurements are computed from dew point and dry bulb temperatures. Therefore, a local dry bulb temperature sensor is additionally required via a room sensor, duct probe or outdoor air probe.

Model Number	SEN-PAR-1
Typical Application	Particulate Monitoring or Control
Sensor: Airborne Particulates - Small Particles PM2.5	
Element	Optical Particle Counter
Range	PM2.5: 0.3 to 2.5µm
Accuracy	± 25% of reading
Concentration Range	100–10,000,000 particles pcf
Response	30 seconds

Model Number	SEN-TVC-1	SEN-TVC-2	SEN-TVC-1&2	SEN-TVC-1&3
Typical Application	Total Volatile Organic Compounds (TVOCs) Monitoring for Non-Critical Ventilation Applications	Total Volatile Organic Compounds (TVOCs) Monitoring for Non-Critical Ventilation Applications	Combines the MOS sensor (SEN-TVC-1) and the PID sensor (SEN-TVC-2) into one assembly, while supporting the individual sensing capabilities of each. This configuration is recommended for Research Labs.	Combines the MOS sensor (SEN-TVC-1) and an enhanced version of our PID into one assembly that is designed to support Vivariums and other environments where there are likely to be higher concentrations of adsorptive compounds, such as ammonia.
Sensor: TVOCs				
Element	Metal Oxide Semiconductor (MOS)	Photo-ionization Detector (PID)- VOCs & other gases with ionization potentials <10.6eV		
Range	Calibrated Range: 0 to 50 ppm (as Isobutylene) Maximum Range: 0 to 100 ppm (as	Calibrated Range: 0 to 5 ppm (as Isobutylene) Maximum Range: 0 to 20 ppm (as		

	Isobutylene)	Isobutylene)		
Accuracy	±0.5 ppm (as Isobutylene) or 25% of reading (whichever is greater)	±0.2 ppm (as Isobutylene) or 2.5% of reading (whichever is greater)		
Resolution	0.2 ppm	0.025 ppm		
Drift Stability	± 15 ppm/6 months @ 50 ppm	± 2 ppm/6 months @ 5 ppm		
Response	30 seconds	30 seconds		
Model Number	SEN-COM-1			
Typical Application	Carbon Monoxide Monitoring or Control			
Sensor: CO				
Element	Electrochemical Sensor			
Range	0–150 ppm CO			
Accuracy	± 3 ppm CO or 5% of reading, whichever is greater			
Resolution	1 ppm CO			
Response	30 seconds			

2.5 NETWORK SERVER

- .1 The Network Server (Server) shall provide network management of Multi-Sensor Monitors, Air-sampling Controllers, Air-sampling Network, and integration to the DDC System or BAS via a BACnet/IP interface, and interface to a web-based portal for viewing of graphs, charts, and data derived from the FMS.
- .2 All point data, algorithms and application software shall reside in the Network Server. Each Multi-Sensor Monitor shall contain both software and firmware to receive and perform full test area sequencing schemes downloaded from the Network Server.
- .3 The hardware platform for the Network Server shall, at a minimum, consist of:
 - .1 PC processor with minimum 64-bit word structure
 - .2 Minimum 2GHz processor speed
 - .3 Minimum 2GB on board RAM
 - .4 Hard drive, minimum 100GB
 - .5 Network Interface Card (NIC)
 - .6 RS-232 Serial Port
 - .7 Operating System shall be Windows XP
- .4 The Owner shall provide CAT5e or CAT6 cabling and installation between the Network Server's Network Interface Card and the Owner's Building Ethernet Connection. Final Building Ethernet Connection shall be coordinated with the Owner's IT Group.
- .5 The Network Server shall be located within 25 feet of the nearest Multi-Sensor Monitor and be connected to the Server through the RS-232 serial port.

2.6 AIR-SAMPLING TUBING

- .1 The FMS shall utilize a pre-engineered system of Air-sampling Tubing to facilitate network wide communications; distribution of low voltage power to Air-sampling Controllers and Multi-Sensor Monitors; and provide a sampling medium for air samples all within a single

- cable.
- .2 The cable shall consist of multiple wires to distribute communications, data, and low voltage power throughout the FMS. As a minimum, Air-sampling Tubing shall consist of:
 - .1 Communications - 22 AWG, twisted, shielded pair, cable; drain wire; stranded conductors
 - .2 Low Voltage Power - 18 AWG, 3-wire, stranded conductors
- .3 An inner pathway shall be furnished as an integral part of the Air-sampling Tubing to facilitate collection of test area air samples. Pathway shall be lined with a smooth, electrically conductive, chemically inert surface to insure air samples remain pure and uncorrupted and do not adhere to the wall lining during transport.
- .4 Air-sampling Tubing shall not require specialized tools for installation. Installation of the cable shall follow local area network practices.
- .5 Air-sampling Tubing shall be suitable for riser and plenum applications, be Underwriters' Laboratories Listed to UL CMP standards, and carry the appropriate markings throughout the cable length.
- .6 Dedicated wiring specifically used for the FMS consisting of a minimum of:
 - .1 Communications - 22 AWG; twisted, shielded pair cable; drain wire; stranded conductors
 - .2 Low Voltage Power - 18 AWG; 3-wire; stranded conductors

2.7 SYSTEM SOFTWARE OVERVIEW

- .1 The FMC shall provide all installation/programming required for operation of the FMS-provided software specified herein. All functionality described herein shall be regarded as a minimum. The FMC shall provide the following as a minimum:
 - .1 Completed database
 - .2 Configuration of all the Air-sampling Network, Air-sampling Controllers, Multi-Sensor Monitor, Network Server and user interface application programs
 - .3 All Configuration tools, and all software licenses, required to configure and operate all products installed on this project
- .2 System Configuration
 - .1 Database creation and Modification: All changes shall be done utilizing standard procedures. The system shall allow changes to be made either at the local site through a portable computer or central workstation.
 - .2 The system shall permit the operator to perform, as a minimum, the following:
 - .1 Add and delete points/objects
 - .2 Modify point parameters
 - .3 Create and modify control sequences and programs
 - .4 Reconfigure application programs
- .3 Web-based User Interface and Data Management System
 - .1 Included with the system shall be a fully integrated web-based user interface and data management system. The data management system shall be password protected and shall be able to store sampled data from all test areas for online viewing and reporting.
 - .2 Unlimited data access, viewing, report generation and remote data storage shall be provided with the FMS for the duration of the project commissioning and for the entire warranty period.
- .4 Test Sequencing

- .1 The system shall allow the operator to designate any test area to be scheduled with an operator command through the Information Management Server.
- .2 The operator shall be able to make all schedule additions, modifications, and deletions to the test schedules. The operator shall have the capability to edit all schedules and then download any or all schedule changes to the FMS.
- .5 Integration with the Building Automation System (BAS)
 - .1 The FMC shall provide all software programming required for the functional integration of the FMS specified herein with the BAS manufacturer/installer.
 - .2 FMS data point-mapping and other functional requirements for BAS support shall be coordinated and provided by the FMC (or TCC if Owner directed).
 - .3 The FMC shall provide qualified on-site staff to facilitate system start-up and commissioning, and verify that all control and monitoring operations as identified in the contract documents are functional.

PART 3 EXECUTION

3.1 EXAMINATION

- .1 Verify that conditioned power supply is available to control units.
- .2 Verify that duct-, room-, and outdoor air devices are installed before proceeding with installation.

3.2 INSTALLATION

- .1 Installation
 - .1 Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.
 - .2 Connect and configure equipment and software to achieve sequence of operation specified.
 - .3 Verify location of sensors and other exposed control sensors with Drawings and room details before installation. Install sensors 48 inches above the floor.
 - .4 Install guards on sensors in the following locations:
 - .1 Entrances
 - .2 Public areas
 - .3 Where indicated on the construction documents
 - .5 Install labels and nameplates to identify control components according to Division 20 Section "Identification for Piping and Equipment."
 - .6 Install duct, room, or outdoor air sensors and other accessories according to Division 23 Section "Instrumentation and HVAC Controls."
 - .7 Install electronic and fiber-optic cables according to Division 27 Section "Communications Horizontal Cabling." Coordinate these requirements with manufacturer's recommendation and requirements.
 - .8 Label all sensors. Tag shall be similar to variable air volume terminal unit tag located at underside of suspended ceiling- refer to division 20, "Mechanical Identification." Review label tag with owner prior to labeling.
- .2 Electrical Wiring and Connection
 - .1 Install raceways, boxes, and cabinets according to Division 26 Section "Raceway and Boxes for Electrical Systems."
 - .2 Install building wire and cable according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

- .1 All wiring in mechanical spaces of areas with exposed ceilings shall be installed in conduit or electrical trays.
- .3 Install signal and communication cable according to Division 27 Section "Communications Horizontal Cabling."
 - .1 Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
 - .2 Install exposed cable in raceway.
 - .3 Install concealed cable in raceway.
 - .4 Bundle and harness multi-conductor instrument cable in place of single cables where several cables follow a common path.
 - .5 Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
 - .6 Number-code or color-code conductors for future identification and service of control system.
 - .7 Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.
- .4 A duplex receptacle must be located within 6 feet of any cord-connected assembly. Coordinate location and available circuit with Architect/Engineer.
- .5 Label all wiring at each end to identify what device and /or contact point is at the other end of the wire.

3.3 FIELD QUALITY CONTROL

- .1 Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- .2 Perform the following field tests and inspections and prepare test reports:
 - .1 Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
 - .2 Test and adjust controls and safeties.
 - .3 Pressure test all Air-Sample Tubing
 - .4 Test each point through its full operating range to verify that safety and operating control set points are as required.
 - .5 Test each control loop to verify stable mode of operation and compliance with sequence of operation. Tune PID loop actions based on design conditions.
 - .6 Test each system for compliance with sequence of operation.
 - .7 Test software and hardware interlocks.
- .3 DDC Verification:
 - .1 Verify that instruments are installed before calibration, testing, and loop or leak checks.
 - .2 Check instruments for proper location and accessibility.
 - .3 Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
 - .4 Check instrument tubing for proper fittings, slope, material, and support.
 - .5 Check installation of air supply for each instrument.
 - .6 Check flow instruments. Inspect tag number and line and bore size, and verify that inlet side is identified and that meters are installed correctly.

- .7 Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
- .8 Check temperature instruments and material and length of sensing elements.
- .9 Check control valves. Verify that they are in correct direction.
- .10 Check air-operated dampers. Verify that pressure gages are provided and that proper blade alignment, either parallel or opposed, has been provided.
- .11 Check DDC system as follows:
 - .1 Verify that DDC controller power supply is from emergency power supply, if applicable.
 - .2 Verify that wires at control panels are tagged with their service designation and approved tagging system.
 - .3 Verify that spare I/O capacity has been provided.
 - .4 Verify that DDC controllers are protected from power supply surges.
- .4 Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.4 ADJUSTING

- .1 Calibrating and Adjusting:
 - .1 Calibrate instruments.
 - .2 Make three-point calibration test for both linearity and accuracy for each analog instrument.
 - .3 Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
 - .4 Control System Inputs and Outputs:
 - .1 Check analog inputs at 0, 50, and 100 percent of span.
 - .2 Check analog outputs using milliampere meter at 0, 50, and 100 percent output.
 - .3 Check digital inputs using jumper wire.
 - .4 Check digital outputs using ohmmeter to test for contact making or breaking.
 - .5 Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.
 - .5 Flow:
 - .1 Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
 - .2 Manually operate flow switches to verify that they make or break contact.
 - .6 Pressure:
 - .1 Calibrate pressure transmitters at 0, 50, and 100 percent of span.
 - .2 Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.
 - .7 Temperature:
 - .1 Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
 - .2 Calibrate temperature switches to make or break contacts.
 - .8 Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.

- .9 Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
- .10 Provide diagnostic and test instruments for calibration and adjustment of system.
- .11 Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.
- .2 Adjust initial temperature and humidity set points.
- .3 Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other than normal occupancy hours for this purpose.

3.5 DEMONSTRATION AND TRAINING

- .1 The controls contractor shall provide 40 hours of factory training. Training periods shall be selected by the Owner or Owner Representative and provided on-site in an Owner's facility conducive to training of personnel.
- .2 FMS on-site training shall be broken down by system and sub-system. The FMC shall cover all aspects of the system for each system type, describing the type and location of each controller, sensor, and covering the entire control program for each system in detail. Training sessions shall not exceed 4 hours in length. If more than 4 hours is required to cover building system or sub-system then multiple training sessions are required.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- .1 Hydronic Piping, Above Grade.
 - .1 Steel Pipe
 - .1 Steel Pipe Sizes 10" and Smaller
 - .2 Steel Pipe Sizes 12" and Larger
 - .2 Copper Tube
 - .3 Pressure-Rated Polypropylene Pipe
 - .4 Cross-Linked Polyethylene (PEX) Pipe
 - .5 Grooved Mechanical Joint Fittings
- .2 Radiant Heating Piping.
 - .1 Copper Tube
 - .2 Cross-Linked Polyethylene (PEX) Pipe
 - .3 Composite Polyethylene Pipe
 - .4 Hose
- .3 Equipment Drains and Overflows.
 - .1 Copper Tube
 - .2 PVC Pipe
 - .3 ABS Pipe
- .4 Pipe Hangers and Supports.
- .5 Unions, Flanges, Mechanical Couplings, and Dielectric Connections.
 - .1 Unions for Pipes 2" and Less
 - .2 Flanges for Pipes 2" and Larger
 - .3 Mechanical Couplings for Grooved and Shouldered Joints
 - .4 Dielectric Connections
- .6 Thrust Blocking and Anchors for Underground Hydronic Piping.

1.2 GENERAL REFERENCES

- .1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.
- .2 Division 20, including all Common Mechanical Requirements in Section 20 00 00, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.

1.3 RELATED REQUIREMENTS

1.4 SUBMITTALS

- .1 Action Submittals
 - .1 Welders Certificate: Include welders certification of compliance with ASME BPVC-IX; AWS D1.1/D1.1M.
 - .2 Product Data:
 - .1 Include data on pipe materials, pipe fittings, and accessories.
 - .2 Provide manufacturer's catalog information.

- .3 Show grooved joint couplings, fittings, valves, and specialties on drawings and product submittals, specifically identified with the manufacturer's style or series designation.
- .3 Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.
- .4 Field Test Reports: Written reports of tests specified in Part 3 of this Section, including:
 - .1 Test procedures.
 - .2 Failed test results and corrective action taken to achieve requirements.
 - .3 Test results that comply with requirements.
- .5 Water Analysis: Submit a copy of the water analysis to illustrate water quality available at project site.
- .2 Operation and Maintenance Materials
 - .1 Include installation instructions, spare parts lists, exploded assembly views.
- .3 Record Documents
 - .1 Buried piping manufacturer to submit plan of the underground piping system including thrust block and anchor plate layout and details including anchorage, pipe expansion, and seismic calculations.

1.5 QUALITY ASSURANCE

- .1 Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section, with minimum three years of experience.
- .2 Installer Qualifications: Company specializing in performing work of the type specified in this section, with a minimum three years of experience.
- .3 Provide all grooved joint couplings, fittings, valves, specialties, and grooving tools from a single manufacturer.
- .4 Date stamp all castings used for coupling housings, fittings, valve bodies, etc. for quality assurance and traceability.
- .5 Coupling Manufacturer:
 - .1 Perform on-site training by factory-trained representative to the Contractor's field personnel in the proper use of grooving tools and installation of grooved joint products.
 - .2 Periodic job site visits by factory-trained representative to ensure best practices in grooved joint installation.
 - .3 A distributor's representative is not considered qualified to perform the training.
- .6 Welder Qualifications: Certify in accordance with ASME BPVC-IX; AWS D1.1/D1.1M.
 - .1 Provide a certificate from authority having jurisdiction indicating approval of welders.
- .7 Refrigerant Piping
 - .1 Refer to 23 23 00 - Refrigerant Piping

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- .2 Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS

2.1 GENERAL

- .1 Hydronic System Requirements
 - .1 Comply with ASME B31.9 and applicable federal, state, and local regulations.
 - .2 Piping: Provide piping, fittings, hangers, and supports as required, as indicated, and as follows:
 - .1 Where more than one piping system material is specified, provide joining fittings that are compatible with piping materials and ensure that the integrity of the system is not jeopardized.
 - .2 Use non-conducting dielectric connections whenever jointing dissimilar metals.
 - .3 Provide pipe hangers and supports in accordance with ASME B31.9; MSS SP-58; unless indicated otherwise.
 - .3 Pipe-to-Valve and Pipe-to-Equipment Connections: Use flanges, unions, grooved couplings (where specified for pipe) to allow disconnection of components for servicing; do not use direct welded, soldered, or threaded connections.
 - .1 Where grooved joints are used in piping, provide grooved valve/equipment connections if available; if not available, provide flanged ends and grooved flange adapters.

2.2 HYDRONIC PIPING, ABOVE GRADE

- .1 Steel Pipe:
 - .1 Steel Pipe Sizes 10 inch and smaller: ASTM A53/A53M, Schedule 40, black, using one of the following joint types:
 - .1 Welded Joints: ASTM A234/A234M, wrought steel welding type fittings; AWS D1.1/D1.1M welded.
 - .2 Threaded Joints: ASME B16.3, malleable iron fittings.
 - .3 Grooved Joints: AWWA C606 grooved pipe, fittings of same material, and mechanical couplings.
 - .2 Steel Pipe Sizes 12 inch (305 mm) and Greater: ASTM A53/A53M, 3/8 inch (9.5 mm) wall, black, using one of the following joint types:
 - .1 Welded Joints: ASTM A234/A234M, wrought steel welding type fittings; AWS D1.1/D1.1M welded.
 - .2 Threaded Joints: ASTM A536 ductile iron fittings.
 - .3 Grooved Joints: AWWA C606 grooved pipe, fittings of same material, and mechanical couplings.
- .2 Copper Tube: ASTM B88 (ASTM B88M), Type K drawn, using one of the following joint types:
 - .1 Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings.
 - .1 Solder: {RS#564} lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver for pipes smaller than 2-1/2 inches.
 - .2 Braze: AWS A5.8M/A5.8 BCuP copper/silver alloy pipes 2-1/2-inches or larger or piping routed above operating rooms, delivery rooms, cesarean rooms, recovery rooms, special procedure rooms, nurseries, intensive care units, food storage and preparation areas, computer rooms, telecommunication rooms, electrical rooms, or IDF/MDF rooms.
- .3 Pressure-Rated Polypropylene Pipe: ASTM D2774 or ASTM F2389, PP-RCT resin pipe with fiber layer, SDR 11.

- .1 Fittings: ASTM F2389, butt heat fusion. Transitions to comply with ASTM F1960 or ASME B16.5.
- .2 Manufacturers:
 - .1 Uponor, Inc: www.uponorpro.com/#sle.
 - .2 Aquatherm.
 - .3 Rovanco.
 - .4 Rehau.
- .4 Cross-Linked Polyethylene (PEX) Pipe: ASTM F876 or ASTM F877.
 - .1 Manufacturers:
 - .1 Uponor, Inc: Wirsbo hePEX; www.uponorpro.com/#sle.
 - .2 Rovanco.
 - .3 Rehau.
 - .2 Oxygen Barrier: Limit oxygen diffusion through the tube to maximum 0.000044 grains per cu ft/day (0.10 mg per cu m/day) at 104 degrees F (40 degrees C) in accordance with DIN 4726.
 - .3 PPI TR-4, Pressure Design Basis:
 - .1 160 psig (1102 kPa) at maximum 73 degrees F (23 degrees C).
 - .2 100 psig (689 kPa) at maximum 180 degrees F (82 degrees C).
 - .3 80 psig (551 kPa) at maximum 200 degrees F (93 degrees C).
 - .4 Fittings: Brass and copper.
 - .5 Fittings: Brass and engineered polymer (EP).
 - .6 Joints: Mechanical compression fittings.
 - .7 Joints: ASTM F1960, cold-expansion fittings.
- .5 Grooved Mechanical Joint Fittings: ASTM A536, Grade 65-45-12 ductile iron; ASTM A47/A47M, Grade 32510 malleable iron; ASTM A53/A53M, Type F, E, or S, Grade B fabricated steel; or, ASTM A106/A106M, Grade B steel fittings with grooves or shoulders designed to accept grooved end couplings. Cut-groove piping is not acceptable.
 - .1 Grooved Mechanical-Joint Couplings: Ductile or malleable iron housing and synthetic rubber gasket of central cavity pressure-responsive design for operating temperature range from -30 degrees F to 230 degrees F. Gasket material as recommended by manufacturer for design conditions.
 - .1 Manufacturers:
 - .1 Anvil International.
 - .2 Shurjoint Piping Products.
 - .3 Victaulic.
 - .4 Grinnell Mechanical Products.

2.3 RADIANT HEATING PIPING

- .1 Copper Tube: ASTM B88 (ASTM B88M), Type K annealed.
 - .1 Fittings: ASME B16.22, wrought copper.
 - .2 Mechanical Press Sealed Fittings: Double pressed type complying with ASME B16.22, utilizing EPDM, non toxic synthetic rubber sealing elements.
 - .1 Manufacturers:
 - .1 FNW; Copper Press: www.fnw.com/#sle.
 - .3 Joints: Solder, lead free, ASTM B32 HB alloy (95-5 tin-antimony), or tin and silver.
- .2 Cross-Linked Polyethylene (PEX) Pipe: ASTM F876 or ASTM F877 .

- .1 Manufacturers:
 - .1 Uponor, Inc: www.uponorpro.com/#sle.
 - .2 Rovanco.
 - .3 Rehau.
- .2 Fittings: Brass and copper.
- .3 Joints: Mechanical compression fittings.
- .4 Oxygen Barrier: Limit oxygen diffusion through the tube to maximum 0.000044 grains per cu ft/day (0.10 mg per cu m/day) at 104 degrees F (40 degrees C) in accordance with DIN 4726.
- .5 PPI TR-4, Pressure Design Basis:
 - .1 160 psig at maximum 73 degrees F.
 - .2 100 psig at maximum 180 degrees F.
 - .3 80 psig at maximum 200 degrees F.
- .6 Fittings: Brass and engineered polymer (EP).
- .7 Joints: Mechanical compression fittings.
- .8 Joints: ASTM F1960, cold-expansion fittings.
- .3 Composite Polyethylene Pipe: Aluminum tube laminated between two layers of high density polyethylene.
 - .1 Operating Pressure:
 - .1 150 psig (1034 kPa) at maximum 140 degrees F (60 degrees C).
 - .2 125 psig (861 kPa) at maximum 180 degrees F (82 degrees C).
 - .3 125 psig (861 kPa) at maximum 140 degrees F (60 degrees C).
 - .2 Fittings: Brass flared compression.
 - .3 Joints: Fittings adapt to copper tubing or copper tube fittings, threaded pipe and fittings, and copper compression fittings.
- .4 Hose: Composite hose with nitrile liner, braided fiber reinforcing, neoprene cover, 150 psig (1034 kPa) operating pressure at 205 degrees F (96 degrees C).
 - .1 Fittings: Copper.
 - .2 Joints: Nipple with stainless steel clamp.

2.4 EQUIPMENT DRAINS AND OVERFLOWS

- .1 Copper Tube: ASTM B88 (ASTM B88M), Type L drawn; using one of the following joint types:
 - .1 Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings; {RS#564} lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
- .2 PVC Pipe: ASTM D1785, Schedule 40, or ASTM D2241, SDR 21 or 26.
 - .1 Fittings: ASTM D2466 or ASTM D2467, PVC.
 - .2 Joints: Solvent welded in accordance with ASTM D2855.
- .3 ABS Pipe: ASTM D2680.
 - .1 Fittings: Compatible with piping material.
 - .2 Joints: Solvent welded with ASTM D2235 cement.

2.5 PIPE HANGERS AND SUPPORTS

- .1 In grooved installations, use rigid couplings with offsetting angle-pattern bolt pads or with wedge-shaped grooves in header piping to permit support and hanging in accordance with

ASME B31.9.

- .2 Rooftop Supports for Low-Slope Roofs: Steel pedestals with bases that rest on top of roofing membrane, not requiring any attachment to the roof structure and not penetrating the roofing assembly, with support fixtures as specified; and as follows:
 - .1 Bases: High-density polypropylene.
 - .2 Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
 - .3 Steel Components: Stainless steel or carbon steel hot-dip galvanized after fabrication in accordance with ASTM A123/A123M.
 - .4 Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports; corrosion-resistant material.
 - .5 Height: Provide minimum clearance of 24 inches (600 mm) under pipe to top of roofing.
 - .6 Manufacturers:
 - .1 PHP Systems/Design: www.phpsd.com/#sle.
 - .2 Dura Blok.
 - .3 Rooftop Blox.

2.6 UNIONS, FLANGES, MECHANICAL COUPLINGS, AND DIELECTRIC UNIONS

- .1 Unions for Pipe of 2 Inches (50 mm, DN) and Less:
 - .1 Ferrous Piping: 150 psi, threaded, ASME B16.39.
 - .2 Copper Pipe: Bronze, soldered joints.
- .2 Flanges for Pipe 2 Inches (50 mm, DN) and Greater:
 - .1 Ferrous Piping: 150 psi forged steel, slip-on.
 - .2 Copper Piping: Bronze.
 - .3 Gaskets: 1/16 inch (1.6 mm) thick, preformed neoprene.
- .3 Mechanical Couplings for Grooved and Shouldered Joints: Two or more curved housing segments with continuous key to engage pipe groove, circular C-profile gasket, and bolts to secure and compress gasket.
 - .1 Dimensions and Testing: In accordance with AWWA C606.
 - .2 Mechanical Couplings: Comply with ASTM F1476.
 - .3 Housing Material: Ductile iron; galvanized; complying with ASTM A536.
 - .4 Gasket Material: EPDM suitable for operating temperature range from minus minus 30 degrees F (minus 34 degrees C) to 230 degrees F (110 degrees C).
 - .5 Gasket Material for Glycol systems operating below 140 degrees F (60 degrees C):
Nitrile rubber suitable for operating temperature range from minus 20 degrees F to 180 F (minus 29 degrees C to 82 degrees C).
 - .6 Bolts and Nuts: Hot dipped galvanized or zinc-electroplated steel.
 - .7 When pipe is field grooved, provide coupling manufacturer's grooving tools.
 - .8 Manufacturers:
 - .1 Anvil International: www.anvilintl.com/#sle.
 - .2 Shurjoint Piping Products, Inc: www.shurjoint.com/#sle.
 - .3 Victaulic Company: www.victaulic.com/#sle.
 - .4 Grinnell Mechanical Products.
- .4 Dielectric Connections: Provide dielectric waterway or dielectric flange fittings.
 - .1 Waterways:

- .1 Water impervious insulation barrier capable of limiting galvanic current to 1 percent of short circuit current in a corresponding bimetallic joint.
- .2 Dry insulation barrier able to withstand 600-volt breakdown test.
- .3 Construct of galvanized steel with threaded end connections to match connecting piping.
- .4 Suitable for the required operating pressures and temperatures.
- .2 Flanges:
 - .1 Dielectric flanges with same pressure ratings as standard flanges.
 - .2 Water impervious insulation barrier capable of limiting galvanic current to 1 percent of short circuit current in a corresponding bimetallic joint.
 - .3 Dry insulation barrier able to withstand 600-volt breakdown test.
 - .4 Construct of galvanized steel with threaded end connections to match connecting piping.
 - .5 Suitable for the required operating pressures and temperatures.

2.7 THRUST BLOCKING AND ANCHORS FOR UNDERGROUND HYDRONIC PIPING

PART 3 EXECUTION

3.1 APPLICATION

- .1 Select system components with pressure rating equal to or greater than system operating pressure.
- .2 Install hydronic piping in accordance with the following:

	Above Grade			Above Grade Inside Shafts			Below Grade Preinsulated			Below Grade Uninsulated	
Service	W/S	GC	Cu	W	Cu	___	W	Cu	___	W	Cu
Chilled Water	X	X	X	X	X		X	X		N/A	N/A
Heating Hot Water	X		X	X	X		X	X		N/A	N/A
Condenser Water	X	X	X	X	X		N/A	N/A		X	N/A

Legend:

W/S: Welded or Screwed, Steel

W: Welded Steel

GC: Grooved Coupling, Steel

Cu: Copper

N/A: Not Acceptable or Not Applicable

- .3 Chilled Water - Use copper up to and including 3-inches, then use welded steel for larger sizes
- .4 Heating Hot Water - Use copper up to and including 3-inches, then use welded steel for larger sizes
- .5 Install other piping as follows:
 - .1 Makeup-water piping installed aboveground: Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
 - .2 Makeup-Water Piping Installed below ground: Type K, annealed-temper copper tubing, wrought-copper fittings, and soldered joints. Use the fewest possible joints.

- .3 Condensate-Drain Piping: Type DWV, drawn-temper copper tubing Type K, wrought-copper fittings, and soldered joints.
- .4 Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.
- .5 Air-vent piping:
 - .1 Inlet: Same material as service where installed, with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.
 - .2 Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.
- .6 Safety Valve Inlet and Outlet Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed, with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.

3.2 PREPARATION

- .1 Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- .2 Prepare pipe for grooved mechanical joints as required by coupling manufacturer.
- .3 Remove scale and dirt on inside and outside before assembly.
- .4 Prepare piping connections to equipment using jointing system specified.
- .5 Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.
- .6 After completion, fill, clean, and treat systems. See Section 23 25 00 - HVAC Water Treatment for additional requirements.
- .7 Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting. See Section 09 91 23 - Interior Painting.

3.3 INSTALLATION

- .1 General
 - .1 Install in accordance with manufacturer's written instructions and requirements.
 - .2 Drawings indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
 - .3 Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
 - .4 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.
 - .5 Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
 - .6 Install piping to permit valve servicing.
 - .7 Install piping at a uniform grade of 0.2 percent upward in direction of flow, unless indicated on drawings.
 - .8 Install piping to allow application of insulation.
 - .9 Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
 - .10 Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.

- .11 Install air vents and pressure-relief valves in accordance with Section 23 21 14 - Hydronic Specialties.
- .12 Install sleeves for piping penetrations of walls, ceilings, and floors.
- .13 Install sleeve seals for piping penetrations of concrete walls and slabs.
- .14 Install escutcheons for piping penetrations of walls, ceilings, and floors.
- .15 Install heating water, glycol, chilled water, and condenser water, to ASME B31.9 requirements.
- .16 Route piping in orderly manner, parallel to building structure, and maintain gradient.
- .17 Install piping to conserve building space and to avoid interference with use of space.
- .18 Group piping whenever practical at common elevations.
- .19 Sleeve pipe passing through partitions, walls, and floors.
- .20 Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 078400 - Firestopping.
- .21 Slope piping and arrange to drain at low points.
- .22 Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. See Section 20 05 16 - Expansion Fittings and Loops for Mechanical Piping.
 - .1 Flexible couplings may be used in header piping to accommodate thermal growth, thermal contraction in lieu of expansion loops.
 - .2 Use flexible couplings in expansion loops.
- .23 Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. See Section 200719 - Mechanical Piping Insulation.
- .24 Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Section 08 31 00 - Access Doors and Panels.
- .25 Use eccentric reducers to maintain top of pipe level.
- .26 Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc-rich primer to welds.
- .2 PVC Pipe: Make solvent-welded joints in accordance with ASTM D2855.
- .3 PP-RCT Pipe: Make heat fusion joint per manufacturers instructions.
- .4 Grooved Joints:
 - .1 Install in accordance with the manufacturer's latest published installation instructions.
 - .2 Gaskets to be suitable for the intended service, molded, and produced by the coupling manufacturer.
- .5 Inserts:
 - .1 Provide inserts for placement in concrete formwork.
 - .2 Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 - .3 Provide hooked rod to concrete reinforcement section for inserts carrying pipe over inches (100 mm).
 - .4 Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 - .5 Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.
- .6 Equipment Drains and Overflows
 - .1 Install drains, consisting of a tee fitting, 3/4 inch (20 mm) ball valve, and short 3/4 inch (20 mm) threaded nipple with cap, at low points in piping system mains and elsewhere

as required for system drainage.

- .7 Unions, Flanges, Mechanical Couplings, and Dielectric Unions
 - .1 Unions
 - .1 Install unions in piping, 3/4 inch (50 mm) and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
 - .2 Flanges
 - .1 Install flanges in piping, 2-1/2 inch (65 mm) and larger, at final connections of equipment and elsewhere as indicated.
 - .3 Dielectric Fittings
 - .1 Install shutoff valve immediately upstream of each dielectric fitting.
 - .2 Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
 - .3 Dielectric Fittings for pipe sizes 4 inch (100 mm) and Smaller: Use dielectric waterways.
 - .4 Dielectric Fittings for pipe sizes 5 inch (125 mm) and larger: Use dielectric flange kits.
 - .5 Dielectric Unions or Dielectric Nipples are not acceptable.
- .8 Pipe Hangers and Supports:
 - .1 Install in accordance with ASME B31.9; ASTM F708; MSS SP-58.
 - .2 Support horizontal piping as scheduled.
 - .3 Install hangers to provide minimum 1/2 inch (13 mm) space between finished covering and adjacent work.
 - .4 Place hangers within 12 inch (300 mm) of each horizontal elbow.
 - .5 Use hangers with 1-1/2 inch (38 mm) minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
 - .6 Support vertical piping at every other floor but not more than 10 feet. Support riser piping independently of connected horizontal piping.
 - .7 Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 - .8 Provide copper plated hangers and supports for copper piping.
 - .9 Prime coat exposed steel hangers and supports. See Section 09 91 23 - Interior Painting. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

3.4 FLUSHING AND CLEANING OF PIPING SYSTEMS

- .1 Clean piping systems thoroughly. Purge pipe of construction debris and contamination before placing the piping systems in service. Provide temporary connections for cleaning, purging, and circulating fluids through the piping system.
- .2 Use temporary strainers and temporary pumps that can create fluid velocities up to 10 feet per second to flush and clean the piping systems. Do not use Owner's permanent strainers to trap debris during pipe flushing operations. Fit the temporary construction strainers with a line size blowoff valve.
- .3 When constructing minor piping modifications or additions verify with Owner if the Owner's pumps and strainers can be used for flushing and chemical cleaning operations. When the flushing and cleaning operations are complete, ensure the strainer baskets and screens installed in the piping systems permanent strainers are replaced with clean elements. Keep temporary strainers in service until the equipment has been tested, then replace straining element with a new strainer and clean and deliver the old straining elements to Owner. Fit

- the Owner's strainers with a line size blowoff valve.
- .4 Install bypass piping or hoses at the supply and return piping connections at heat exchangers, chillers, boilers, heat pumps, cooling towers, pumps, terminal unit reheat coils and cooling coils, etc., to prevent debris from being caught or causing damage to equipment which will be connected to the piping system.
 - .5 Circulate a chemical cleaner in hydronic water piping systems to remove mill scale, grease, oil, and silt. Cleaner to be selected by chemical treatment vendor on project. Circulate for 48 hours, flush system and replace with clean water. Dispose of chemical solution in accordance with local codes. The hydronic water system should then be treated with chemicals and inhibitors to be selected by chemical treatment vendor on project. When the chemical cleaning is complete, remove, clean, and reinstall all permanent screens. Notify Owner so that the reinstallation of clean strainer screens may be witnessed.
 - .6 Do not fill hydronic/water piping systems without chemical treatment and circulation of water.
 - .7 SBISD personnel shall witness the system flush.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- .1 Valves.
 - .1 Plastic Ball Valves
 - .2 Plastic Butterfly Valves
 - .3 Plastic Check Valves
 - .4 Bronze, Calibrated-Orifice, Balancing Valves
 - .5 Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves
 - .6 Diaphragm-Operated, Pressure-Reducing Valves
 - .7 Diaphragm-Operated Safety Valves
 - .8 Automatic Flow-Control Valves
- .2 Air-Control Devices.
 - .1 Manual Air Vents
 - .2 Automatic Air Vents
 - .3 Expansion Tanks
 - .4 Bladder-Type Expansion Tanks:
 - .5 In-Line Combination Air & Dirt Separators
 - .6 Tangential-Type Air Separators
 - .7 In-Line Air Separators
 - .8 Air Purgers
- .3 Hydronic Piping Specialties.
 - .1 Y-Pattern Strainers
 - .2 Basket Strainers
 - .3 T-Pattern Strainers
 - .4 Stainless-Steel Bellow, Flexible Connectors
 - .5 Spherical, Rubber, Flexible Connectors
 - .6 Expansion Fittings
 - .7 Escutcheons
 - .8 Floor Plates

1.2 GENERAL REFERENCES

- .1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General Provisions.
- .2 Division 20, including all Common Mechanical Requirements in Section 20 00 00, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.

1.3 RELATED REQUIREMENTS

1.4 PERFORMANCE REQUIREMENTS

- .1 Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:
 - .1 Hot-Water Heating Piping: 125 psig (860 kPa) at 200 deg F (93 deg C).
 - .2 Chilled-Water Piping: 125 psig (860 kPa) at 200 deg F (93 deg C).

- .3 Dual-Temperature Heating and Cooling Water Piping: 125 psig (860 kPa) at 200 deg F (93 deg C).
- .4 Condenser-Water Piping: 125 psig (860 kPa) at 150 deg F (66 deg C).
- .5 Glycol Cooling-Water Piping: 125 psig (860 kPa) at 150 deg F (66 deg C).
- .6 Makeup-Water Piping: 80 psig (552 kPa) at 150 deg F (66 deg C).
- .7 Condensate-Drain Piping: 150 deg F (66 deg C).
- .8 Blowdown-Drain Piping: 200 deg F (93 deg C).
- .9 Air-Vent Piping: 200 deg F (93 deg C).
- .10 Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

1.5 SUBMITTALS

- .1 Action Submittals
 - .1 Product Data: Provide product data for manufactured products and assemblies required for this project. Include component sizes, rough-in requirements, service sizes, and finishes. Include product description and model.
 - .2 Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.
- .2 Informational Submittals
 - .1 Certificates: Inspection certificates for pressure vessels from authority having jurisdiction.
- .3 Operation and Maintenance Materials
 - .1 Maintenance Contract.
 - .2 Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.
- .4 Record Documents
 - .1 Project Record Documents: Record actual locations of flow controls.

1.6 QUALITY ASSURANCE

- .1 Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

1.7 COORDINATION

1.8 DELIVERY, STORAGE AND HANDLING

- .1 Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- .2 Provide temporary protective coating on cast iron and steel valves.
- .3 Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- .4 Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.9 EXTRA MATERIALS

- .1 Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - .1 Extra Glycol Solution: One container, 1 gallon (4 L) size.

PART 2 PRODUCTS

2.1 VALVES

- .1 General
 - .1 Gate, Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Division 20 Section 20 05 23 "General-Duty Valves for Piping."
 - .2 Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Division 23 Section 23 09 00 "Instrumentation and Control for HVAC."
- .2 Plastic Ball Valves:
 - .1 Manufacturers:
 - .1 American Valve.
 - .2 Asahi/America.
 - .3 Charlotte Pipe and Foundry Company.
 - .4 Colonial Engineering.
 - .5 George Fischer.
 - .6 Hayward Flow Control.
 - .7 IPEX USA.
 - .8 Jomar Valve.
 - .9 KBI (King Bros. Industries).
 - .10 Legend Valve & Fitting.
 - .11 Nibco.
 - .12 Plast-O-Matic Valves.
 - .13 SMC The Specialty Mfg. Co.
 - .14 Thermoplastic Valves.
 - .15 Watts.
 - .2 Body: One-, two-, or three-piece CPVC or PVC to match piping.
 - .3 Ball: Full-port CPVC or PVC to match piping.
 - .4 Seats: PTFE.
 - .5 Seals: EPDM.
 - .6 End Connections: Socket, union, or flanged.
 - .7 Handle Style: Tee shape.
 - .8 CWP Rating: Equal to piping service.
 - .9 Maximum Operating Temperature: Equal to piping service.
 - .10 Comply with MSS SP-122.
- .3 Plastic Butterfly Valves:
 - .1 Manufacturers:
 - .1 American Valve.
 - .2 Asahi/America.
 - .3 Charlotte Pipe and Foundry Company.
 - .4 Colonial Engineering.
 - .5 George Fischer.
 - .6 Hayward Flow Control.
 - .7 IPEX USA.
 - .8 Legend Valve & Fitting.
 - .9 Nibco.
 - .10 Plast-O-Matic Valves.

- .11 SMC The Specialty Mfg. Co.
 - .12 Thermoplastic Valves.
 - .13 Watts.
 - .2 Body: PVC or CPVC to match piping wafer type for installation between flanges.
 - .3 Disc: EPDM-coated steel.
 - .4 Seats: PTFE.
 - .5 Handle Style: Locking lever.
 - .6 CWP Rating: Equal to piping service.
 - .7 Maximum Operating Temperature: Equal to piping service.
- .4 Plastic Check Valves:
 - .1 Manufacturers:
 - .1 American Valve.
 - .2 Asahi/America.
 - .3 Charlotte Pipe and Foundry Company.
 - .4 Colonial Engineering.
 - .5 George Fischer.
 - .6 Hayward Flow Control.
 - .7 IPEX USA.
 - .8 KBI (King Bros. Industries).
 - .9 Legend Valve & Fitting.
 - .10 Nibco.
 - .11 Plast-O-Matic Valves.
 - .12 SMC The Specialty Mfg. Co.
 - .13 Thermoplastic Valves.
 - .14 Watts.
 - .2 Body: One-, two-, or three-piece PVC or CPVC to match piping.
 - .3 Ends: Socket or flanged.
 - .4 Seats: PTFE.
 - .5 Check Style: Swing or ball type.
 - .6 CWP Rating: Equal to piping service.
 - .7 Maximum Operating Temperature: Equal to piping service.
- .5 Bronze, Calibrated-Orifice, Balancing Valves:
 - .1 Manufacturers:
 - .1 Armstrong Pumps.
 - .2 Bell & Gossett.
 - .3 Flow Design.
 - .4 Griswold Controls.
 - .5 HCI (Hydronics Components Inc)
 - .6 Macon Balancing.
 - .7 Nexus Valve.
 - .8 Taco.
 - .9 Gerand Engineering.
 - .10 NuTech Hydronic Supply.

- .11 Oventrop Corporation.
 - .12 Tour & Andersson.
 - .13 Tunstall Corporation.
 - .14 Victaulic Company.
- .2 Body: Bronze or brass body, ball with calibrated orifice or venturi.
- .3 Ball: Stainless steel.
- .4 Plug: Resin.
- .5 Seat: PTFE.
- .6 End Connections: Threaded or socket.
- .7 Pressure Gage Connections: Integral seals for portable differential pressure meter.
- .8 Handle Style: Lever, with memory stop to retain set position.
- .9 CWP Rating: Minimum 125 psig (860 kPa).
- .10 Maximum Operating Temperature: 250 deg F (121 deg C).
- .6 Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:
 - .1 Manufacturers:
 - .1 Armstrong Pumps.
 - .2 Bell & Gossett.
 - .3 Flow Design.
 - .4 Griswold Controls.
 - .5 HCI (Hydronics Components Inc).
 - .6 Macon Balancing.
 - .7 Nexus Valve.
 - .8 Taco.
 - .9 Gerand Engineering.
 - .10 NuTech Hydronic Supply.
 - .11 Oventrop Corporation.
 - .12 Tour & Andersson.
 - .13 Tunstall Corporation.
 - .14 Victaulic Company.
 - .2 Body: Cast-iron or steel body, globe or butterfly pattern with calibrated orifice or venturi.
 - .3 Ball: Stainless steel.
 - .4 Butterfly Valve: Epoxy coated cast iron.
 - .5 Stem Seals: EPDM O-rings.
 - .6 Disc: Glass and carbon-filled PTFE.
 - .7 Seat: PTFE.
 - .8 End Connections: Flanged or grooved.
 - .9 Pressure Gage Connections: Integral seals for portable differential pressure meter.
 - .10 Handle Style: Lever, with memory stop to retain set position.
 - .11 CWP Rating: Minimum 125 psig (860 kPa).
 - .12 Maximum Operating Temperature: 250 deg F (121 deg C).
- .7 Diaphragm-Operated, Pressure-Reducing Valves: ASME labeled.
 - .1 Manufacturers:

- .1 Amtrol.
 - .2 Armstrong Pumps.
 - .3 Bell & Gossett.
 - .4 Conbraco Industries.
 - .5 Spence Engineering Company.
 - .6 Watts.
- .2 Body: Bronze or brass.
- .3 Disc: Glass and carbon-filled PTFE.
- .4 Seat: Brass.
- .5 Stem Seals: EPDM O-rings.
- .6 Diaphragm: EPT.
- .7 Low inlet-pressure check valve.
- .8 Inlet Strainer: , removable without system shutdown.
- .9 Valve Seat and Stem: Noncorrosive.
- .10 Valve Size, Capacity, and Operating Pressure: Selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.
- .8 Diaphragm-Operated Safety Valves: ASME labeled.
 - .1 Manufacturers:
 - .1 Amtrol.
 - .2 Armstrong Pumps.
 - .3 Bell & Gossett.
 - .4 Conbraco Industries.
 - .5 Spence Engineering Company.
 - .6 Watts.
 - .2 Body: Bronze or brass.
 - .3 Disc: Glass and carbon-filled PTFE.
 - .4 Seat: Brass.
 - .5 Stem Seals: EPDM O-rings.
 - .6 Diaphragm: EPT.
 - .7 Wetted, Internal Work Parts: Brass and rubber.
 - .8 Inlet Strainer: , removable without system shutdown.
 - .9 Valve Seat and Stem: Noncorrosive.
 - .10 Valve Size, Capacity, and Operating Pressure: Comply with ASME BPVC-IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.
- .9 Automatic Flow-Control Valves:
 - .1 Manufacturers:
 - .1 Flow Design.
 - .2 Griswold Controls.
 - .3 HCI (Hydronics Components Inc)
 - .4 Nexus Valve.
 - .5 Flowcon Americas.
 - .6 Hays Fluid Controls.
 - .7 NuTech Hydronic Supply.

- .8 Tunstall Corporation.
- .2 Body: Brass or ferrous metal.
- .3 Piston and Spring Assembly: Stainless steel, tamper proof, self-cleaning, and removable.
- .4 Combination Assemblies: Include bronze or brass-alloy ball valve.
- .5 Identification Tag: Marked with zone identification, valve number, and flow rate.
- .6 Size: Same as pipe in which installed.
- .7 Performance: Maintain constant flow, plus or minus 5 percent over system pressure fluctuations.
- .8 Minimum CWP Rating: 175 psig (1207 kPa).
- .9 Maximum Operating Temperature: 200 deg F (93 deg C).

2.2 AIR-CONTROL DEVICES

- .1 Manual Air Vents:
 - .1 Manufacturers:
 - .1 Amtrol.
 - .2 Armstrong Pumps.
 - .3 Bell & Gossett.
 - .4 Nexus Valve.
 - .5 Taco.
 - .6 NuTech Hydronic Supply.
 - .2 Body: Bronze.
 - .3 Internal Parts: Nonferrous.
 - .4 Operator: Screwdriver or thumbscrew.
 - .5 Inlet Connection: NPS 1/2 (DN 15).
 - .6 Discharge Connection: NPS 1/8 (DN 6).
 - .7 CWP Rating: 150 psig (1035 kPa).
 - .8 Maximum Operating Temperature: 225 deg F (107 deg C).
- .2 Automatic Air Vents:
 - .1 Manufacturers:
 - .1 Amtrol.
 - .2 Armstrong Pumps.
 - .3 Bell & Gossett.
 - .4 Nexus Valve.
 - .5 Taco.
 - .6 NuTech Hydronic Supply.
 - .2 Body: Bronze or cast iron.
 - .3 Internal Parts: Nonferrous.
 - .4 Operator: Noncorrosive metal float.
 - .5 Inlet Connection: NPS 1/2 (DN 15).
 - .6 Discharge Connection: NPS 1/4 (DN 8).
 - .7 Maximum Operating Temperature: 240 deg F (116 deg C).
- .3 Expansion Tanks:
 - .1 Manufacturers:

- .1 Amtrol.
 - .2 Armstrong Pumps.
 - .3 Bell & Gossett.
 - .4 Taco.
- .2 Air-Control Tank Fitting: Cast-iron body, copper-plated tube, brass vent tube plug, and stainless-steel ball check, 100-gal. (379-L) unit only; sized for compression-tank diameter. Provide tank fittings for 125-psig (860-kPa) working pressure and 240 deg F (116 deg C) maximum operating temperature.
- .3 Tank Drain Fitting: Brass body, nonferrous internal parts; 125-psig (860-kPa) working pressure and 240 deg F (116 deg C) maximum operating temperature; constructed to admit air to compression tank, drain water, and close off system.
- .4 Gage Glass: Full height with dual manual shutoff valves, 3/4-inch- (20-mm-) diameter gage glass, and slotted-metal glass guard.
- .4 Bladder-Type Expansion Tanks:
 - .1 Manufacturers:
 - .1 Amtrol.
 - .2 Armstrong Pumps.
 - .3 Bell & Gossett.
 - .4 Taco.
 - .2 Tank: Welded steel, rated for 125-psig (860-kPa) working pressure and 240 deg F (116 deg C) maximum operating temperature. Factory test after taps are fabricated and supports installed and are labeled according to ASME BPVC-VIII-1.
 - .3 Bladder: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
 - .4 Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.
- .5 In-Line Combination Air & Dirt Separators:
 - .1 Manufacturers:
 - .1 Spirotherm Spirovent.
 - .2 Bell & Gossett CRS.
 - .2 Full flow coalescing type combination air eliminator and dirt separator for hydronic systems based upon system flow with pipe size.
 - .3 Separator shall be fabricated steel, rated for 150 psig working pressure, stamped and registered in accordance with ASME BPVC-VIII-1 for unfired pressure vessels, and include two equal chambers above and below the inlet / outlet nozzles. The vessel diameter and height above and below the inlet / outlet connections must be equal to the basis of design.
 - .4 Unit shall include internal tube elements filling the entire vessel to suppress turbulence and provide air elimination efficiency of 100% free air, 100% entrained air, and 99.6% dissolved air at the installed location. Dirt separation efficiency shall be a minimum of 80% of all particles 30 micron and larger within 100 passes. The elements must consist of a copper or stainless steel core tube with continuous wound copper wire medium permanently attached and followed by a separate continuous wound copper wire permanently affixed.
 - .5 Each unit shall have a separate venting chamber to prevent system contaminants from harming the float and venting valve operation. At the top of the venting chamber shall be an integral full port float actuated brass venting mechanism.
 - .6 Units shall include a valved side tap to flush floating dirt or liquids and for quick bleeding of large amounts of air during system fill or refill.

- .7 Provide removable lower head for inspection.
- .6 Tangential-Type Air Separators:
 - .1 Manufacturers:
 - .1 Amtrol.
 - .2 Armstrong Pumps.
 - .3 Bell & Gossett.
 - .4 Taco.
 - .2 Tank: Welded steel; ASME constructed and labeled for 125-psig (860-kPa) minimum working pressure and 240 deg F (116 deg C) maximum operating temperature.
 - .3 Air Collector Tube: Perforated stainless steel, constructed to direct released air into expansion tank.
 - .4 Tangential Inlet and Outlet Connections: Threaded for NPS 2 (DN 50) and smaller; flanged connections for NPS 2-1/2 (DN 65) and larger.
 - .5 Blowdown Connection: Threaded.
 - .6 Size: Match system flow capacity.
- .7 In-Line Air Separators:
 - .1 Manufacturers:
 - .1 Amtrol.
 - .2 Armstrong Pumps.
 - .3 Bell & Gossett.
 - .4 Taco.
 - .2 Tank: One-piece cast iron with an integral weir constructed to decelerate system flow to maximize air separation.
 - .3 Maximum Working Pressure: Up to 175 psig (1207 kPa).
 - .4 Maximum Operating Temperature: Up to 300 deg F (149 deg C).
- .8 Air Purgers:
 - .1 Manufacturers:
 - .1 Amtrol.
 - .2 Armstrong Pumps.
 - .3 Bell & Gossett.
 - .4 Taco.
 - .2 Body: Cast iron with internal baffles that slow the water velocity to separate the air from solution and divert it to the vent for quick removal.
 - .3 Maximum Working Pressure: 150 psig (1035 kPa).
 - .4 Maximum Operating Temperature: 250 deg F (121 deg C) .

2.3 HYDRONIC PIPING SPECIALTIES

- .1 Y-Pattern Strainers:
 - .1 Body: ASTM A126, Class B, cast iron with bolted cover and bottom drain connection.
 - .2 Strainer Screen: Stainless-steel, 20-mesh strainer, or perforated stainless-steel basket.
 - .3 CWP Rating: 125 psig (860 kPa).
- .2 Basket Strainers:
 - .1 Body: ASTM A126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.

- .2 End Connections: Threaded ends for NPS 2 (DN 50) and smaller; flanged ends for NPS 2-1/2 (DN 65) and larger.
- .3 Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
- .4 CWP Rating: 125 psig (860 kPa).
- .3 T-Pattern Strainers:
 - .1 Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
 - .2 End Connections: Grooved ends.
 - .3 Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 57 percent free area.
 - .4 CWP Rating: 750 psig (5170 kPa).
- .4 Stainless-Steel Bellow, Flexible Connectors:
 - .1 Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
 - .2 End Connections: Threaded or flanged to match equipment connected.
 - .3 Performance: Capable of 3/4 inch (20 mm) misalignment.
 - .4 CWP Rating: 150 psig (1035 kPa).
 - .5 Maximum Operating Temperature: 250 deg F (121 deg C).
- .5 Spherical, Rubber, Flexible Connectors:
 - .1 Body: Fiber-reinforced rubber body.
 - .2 End Connections: Steel flanges drilled to align with Classes 150 and 300 steel flanges.
 - .3 Performance: Capable of misalignment.
 - .4 CWP Rating: 150 psig (1035 kPa).
 - .5 Maximum Operating Temperature: 250 deg F (121 deg C).
- .6 Expansion Fittings: Comply with requirements in Division 20 Section 20 05 16 "Expansion Fittings and Loops for HVAC Piping."
- .7 Escutcheons
 - .1 Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - .1 BrassCraft Manufacturing Co.; a Masco company.
 - .2 Dearborn Brass.
 - .3 Jones Stephens Corp.
 - .4 Keeney Manufacturing Company (The).
 - .5 Mid-America Fittings, Inc.
 - .6 ProFlo; a Ferguson Enterprises, Inc. brand.
 - .2 One-Piece, Steel Type: With polished, chrome-plated finish and setscrew fastener.
 - .3 One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
 - .4 One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped steel with polished, chrome-plated finish and spring-clip fasteners.
 - .5 Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; concealed hinge; and spring-clip fasteners.
- .8 Floor Plates

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

PART 3 EXECUTION

3.1 APPLICATION

- .1 General
 - .1 Provide side filtration units in hot and chilled water systems with full line size and capable of full design flow rates.
- .2 Valves
 - .1 Install shutoff-duty valves at each branch connection to supply mains and at supply connection to each piece of equipment.
 - .2 Install throttling-duty valves at each branch connection to return main.
 - .3 Install calibrated-orifice, balancing valves in the return pipe of each hydronic terminal.
 - .4 Install check valves at each pump discharge and elsewhere as required to control flow direction.
 - .5 Install safety valves at hot-water generators and elsewhere as required by ASME BPVC. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME BPVC-VIII-1, for installation requirements.
 - .6 Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.
- .3 Air Control Devices
 - .1 Manual Air Vents: Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.
 - .2 Automatic Air Vents: Install automatic air vents at high points of system piping in mechanical equipment rooms only. Install manual vents at heat-transfer coils and elsewhere as required for air venting.
 - .3 Air Separators:
 - .1 Install in-line air and dirt separators in pump suction. Install drain valve on air separators NPS 2 (DN 50) and larger.
 - .2 Install in-line air separators in pump suction. Install drain valve on air separators NPS 2 (DN 50) and larger.
 - .3 Install tangential air separator in pump suction. Install blowdown piping with gate or full-port ball valve; extend full size to nearest floor drain.
 - .4 Strainers:
 - .1 Provide strainers upstream of each connection to water to water heat pumps with mesh size complying with reviewed submittals.
 - .2 Provide in-line basket strainers at chillers (full line size).
 - .3 Strainers shall be installed on AHU coil connections.

3.2 INSTALLATION

- .1 General
 - .1 Install piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.
 - .2 All branch piping shall come off of the top or sides of the mains.
 - .3 Verify during phase with SBISD Planning & Construction if metering on make-up water systems is required.
 - .4 Provide a filter feeder with a sock. No PVC piping allowed to chemical feeders.

- .5 Provide air/dirt separator with isolatable air vent.
- .6 Water make-up station shall be tied into low pressure side of hydronic system (return), upstream of air/dirt separator.
- .2 Air Control Devices
 - .1 Expansion Tanks
 - .1 Install expansion tanks above the air separator. Install tank fitting in tank bottom and charge tank. Use manual vent for initial fill to establish proper water level in tank.
 - .1 Install tank fittings that are shipped loose.
 - .2 Support tank from floor or structure above with sufficient strength to carry weight of tank, piping connections, fittings, plus tank full of water. Do not overload building components and structural members.
 - .2 Install expansion tanks on the floor. Vent and purge air from hydronic system, and ensure that tank is properly charged with air to suit system Project requirements.
- .3 Escutcheons
 - .1 Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
 - .2 Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - .1 Escutcheons for New Piping **and Relocated or Existing Piping**:
 - .1 Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep pattern.
 - .2 Insulated Piping: One-piece cast brass with polished, chrome-plated finish.
 - .3 Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece cast brass with polished, chrome-plated finish.
 - .4 Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece cast brass with polished, chrome-plated finish.
 - .5 Bare Piping in Unfinished Service Spaces: One-piece cast brass with polished, chrome-plated finish.
 - .6 Bare Piping in Equipment Rooms: One-piece steel with polished, chrome-plated finish.
 - .2 Escutcheons for Existing Piping to Remain:
 - .1 Chrome-Plated Piping: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
 - .2 Insulated Piping: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
 - .3 Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
 - .4 Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
 - .5 Bare Piping in Unfinished Service Spaces: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
 - .6 Bare Piping in Equipment Rooms: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
 - .3 Floor Plates

- .1 Install floor plates for piping penetrations of equipment-room floors.
- .2 Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - .1 New Piping **and Relocated Existing Piping**: Split floor plate.
 - .2 Existing Piping to Remain: Split floor plate.
- .3 Use new materials, replace broken and damaged escutcheons and floor plates.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- .1 Metal Duct
 - .1 Material Requirements
 - .1 Galvanized Steel
 - .2 Rectangular Metal Duct
 - .1 Rectangular Double Wall Insulated Duct
 - .3 Round Metal Duct
 - .1 Round Single Wall Duct
 - .2 Round Double Wall Insulated Duct
 - .3 Round Connection System
 - .4 Round Spiral Duct
 - .4 Connectors, Fittings, Sealants, and Miscellaneous
 - .1 Fittings
 - .2 Transverse Duct Connection System
 - .3 Joint Sealers and Sealants
 - .4 Gasket Tape
 - .5 Round Duct Joint O-Ring Seals
- .2 Flexible Duct

1.2 GENERAL REFERENCES

- .1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.
- .2 Division 20, including all Common Mechanical Requirements in Section 20 00 00, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.

1.3 RELATED REQUIREMENTS

1.4 REFERENCE STANDARDS

- .1 ASTM A167 - Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
- .2 ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- .3 ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
- .4 ASTM C1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
- .5 ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- .6 ICC (IMC) - International Mechanical Code.
- .7 NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.
- .8 NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.
- .9 SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible.
- .10 SMACNA (LEAK) - HVAC Air Duct Leakage Test Manual.

- .11 UL 181 - Standard for Factory-Made Air Ducts and Air Connectors.
- .12 UL 2518 - Standard for Safety Air Dispersion Systems.

1.5 SUBMITTALS

- .1 Action Submittals
 - .1 Product Data: Provide data for duct materials, duct connections, and sealants.
 - .2 Shop Drawings: Indicate duct fitting types, gauges, sizes, welds, and configuration.
 - .3 Manufacturer's Installation Instructions: Indicate special procedures for glass fiber ducts.
- .2 Closeout Submittals
 - .1 Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate per appropriate seal class, following SMACNA (LEAK).
 - .2 Manufacturer's Certificate: Certify that the installation of glass fiber ductwork meets or exceeds the manufacturer's recommended fabrication and installation requirements.

PART 2 PRODUCTS

2.1 GENERAL

- .1 Provide ductwork, fittings, hangers, supports, and appurtenances in accordance with NFPA 90A, and SMACNA (DCS) guidelines unless stated otherwise.
- .2 Provide metal duct unless otherwise indicated.
- .3 Seismic Restraint: Fabricate in compliance with local Building and Mechanical Codes; SMACNA (SRM); ASCE 7 requirements; see Section 20 05 48 - Vibration and Seismic Controls.
- .4 Seal and install ductwork to seal Class A, except for welded ductwork.
- .5 Fabricate and install ductwork to achieve Leakage classes 3 and 6 for round and rectangular ductwork respectively, unless otherwise noted on Drawings.
- .6 Duct Fabrication Requirements:
 - .1 Duct and Fitting Fabrication and Support: SMACNA (DCS) including specifics for continuously welded round and oval duct fittings.
 - .2 At Contractor's option, ductwork may be resized to maintain an equivalent air velocity and friction rate, while maintaining a maximum aspect ratio of 4.
 - .3 Use reinforced and sealed sheet-metal materials at recommended gauges for indicated operating pressures or pressure class.
 - .4 Construct tees, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline.
 - .5 Where full radius elbows with a radius of not less than 1-1/2 times the width of the duct are not possible, provide round elbows with radius of not less than 1 times the width of the duct. If space conditions do not permit a radius elbow to be installed, use square elbows with multi-blade turning vanes and an access door for cleaning of turning vanes.
 - .6 Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
 - .7 Where ducts are connected to exterior wall louvers and duct outlet is smaller than louver frame, provide blank-out panels sealing louver area around duct. Use same material as duct, painted black on exterior side; seal to louver frame and duct.

2.2 METAL DUCTS

- .1 Material Requirements:
 - .1 Galvanized Steel: Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, with G90/Z275 coating, minimum 24 gauge except where heavier material is required or specified. Ducts to have mil phosphatized finish for surfaces exposed to view.
- .2 Rectangular Metal Ducts:
 - .1 Rectangular Double Wall Insulated Duct: Rectangular spiral lock seam duct with galvanized steel outer wall; perforated galvanized steel inner wall; fitting with solid outer wall.
 - .1 Insulation:
 - .1 Thickness: Indoor -1 inch (25 mm) (R-4), outdoor exposed 2-in (R-8).
 - .2 Material: Fiberglass.
 - .3 Insulation K Value: 0.25 BTU in/(hr-sf F).
- .3 Round Metal Ducts:
 - .1 General
 - .1 Transverse Joints:
 - .1 Transverse joints in ducts larger than 60 inches (1524 mm) in diameter: Flanged.
 - .2 Transverse joints in ducts 60 inches (1524 mm) and smaller in diameter: flanged, beaded sleeve, or draw band joint.
 - .2 Longitudinal Seams:
 - .1 Fabricate round ducts larger than 90 inches (2286 mm) in diameter with butt-welded longitudinal seams.
 - .2 Fabricate round ducts 90 inches and smaller in diameter with one of the following based on indicated pressure class:
 - .1 Equal to or greater than +/- 4 inches.
 - .1 Butt Weld Seam.
 - .2 Spiral Seam.
 - .2 Equal to or less than +/- 4 inches.
 - .1 Spiral Seam.
 - .2 Lap and Rivet.
 - .3 Grooved Seam.
 - .3 Exposed ductwork shall be spiral seam unless otherwise noted.
 - .2 Round Single Wall Duct: Round lock seam duct with galvanized steel outer wall.
 - .1 Manufacturers:
 - .1 EHG
 - .2 Elgen Manufacturing Company
 - .3 Linx Industries
 - .4 MKT Metal Manufacturing
 - .5 Nordfab Ducting
 - .3 Round Double Wall Insulated Duct: Round spiral lock seam duct with galvanized steel outer wall, perforated galvanized steel inner wall; fitting with the solid inner wall.
 - .1 Manufacturers:
 - .1 MKT Metal Manufacturing
 - .2 Insulation:
 - .1 Thickness: Indoor 1 inch (25 mm) (R-4), Outdoor Exposed 2-inch (R-8).

- .2 Material: Fibrous-glass liner complying with ASTM C1071, NFPA 90A or NFPA 90B and with NAIMA AH124, "Fibrous Glass Duct Liner Standard".
- .3 Insulation K Value: 0.25 BTU-in/(hr-sf F).
- .4 Round Connection System: Interlocking duct connection system per SMACNA (DCS).
- .5 Round Spiral Duct: Round spiral lock seam duct with galvanized steel outer wall.
- .4 Connectors, Fittings, Sealants, and Miscellaneous:
 - .1 Fittings: Manufacture with solid inner wall of perforated galvanized steel.
 - .2 Transverse Duct Connection System: SMACNA "E" rated rigid class connection, interlocking angle and duct edge connection system with sealant, gasket, cleats, and corner clips in accordance with SMACNA (DCS).
 - .1 Manufacturers:
 - .1 Carlisle HVAC Products
 - .2 Ductmate Industries
 - .3 Elgen Manufacturing Company
 - .4 MKT Metal Manufacturing
 - .3 Joint Sealers and Sealants:
 - .1 Non-hardening
 - .1 Manufacturers:
 - .1 Carlisle HVAC Products
 - .2 Water resistant
 - .1 Manufacturers:
 - .1 Ductmate Industries
 - .2 Design Polymerics
 - .3 Ductmate Industries
 - .4 Nordfab Ducting
 - .5 Elgen Manufacturing Company
 - .6 H.B. Fuller Construction Products
 - .3 Mildew and mold resistant
 - .1 Manufacturers:
 - .1 EHG
 - .4 Type: Heavy mastic or liquid used alone or with tape, suitable for joint configuration and compatible with substrates, and recommended by manufacturer for pressure class of ducts.
 - .5 VOC Content: Not more than 250 g/L, excluding water.
 - .1 Elgen Manufacturing Company
 - .2 GSI, a DMI Company
 - .6 Surface Burning Characteristics: Flame spread index of zero and smoke developed index of zero, when tested in accordance with ASTM E84.
 - .7 For Use with Flexible Ducts: UL labeled.
 - .1 Linx Industries
 - .2 MKT Metal Manufacturing
 - .4 Gasket Tape:
 - .1 Manufacturers:

- .1 Design Polymerics
- .2 Elgen Manufacturing Company
- .2 Provide butyl rubber gasket tape for a flexible seal between transfer duct connector (TDC), transverse duct flange (TDF), applied flange connections, and angle ring connections.
- .5 Round Duct Joint O-Ring Seals:
 - .1 Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch w.g. (0.14 L/s per sq. m at 250 Pa) and shall be rated for 10-inch w.g. (2500-Pa) static-pressure class, positive or negative.
 - .2 EPDM O-ring to seal in concave bead in coupling or fitting spigot.
 - .3 Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.3 FLEXIBLE DUCTS

- .1 Flexible Air Ducts:
 - .1 Manufacturers:
 - .1 Flexmaster USA, a brand of Masterduct, Inc; Type 1
 - .2 UL 181, Class 1, polyethylene film supported by helically wound spring steel wire.
 - .3 Insulation: Fiberglass insulation with polyethylene vapor barrier film.
 - .4 Pressure Rating: From 10 in-wc (2.50 kPa) to 5 in-wc (1.25 kPa) negative.
 - .5 Maximum Velocity: 5,500 fpm (27.9 m/s).
 - .6 R-Value: 4.2 when tested in accordance with ASTM C177
 - .7 Temperature Range: Minus 20 to 250 degrees F (Minus 28 to 121 degrees C).
 - .8 Insertion Loss: Minimum attenuation of 33 DB for 9-foot straight length at 8-inch diameter at 500Hz.

2.4 NON-METAL DUCTS

- .1 Textile Air Dispersion (Sock) Duct:
 - .1 Manufacturers:
 - .1 DuctSox Corporation (<https://www.ductsox.com/>)
 - .2 Fabricair
 - .3 KE Fibertec
 - .2 1/4 to 3.1 in-wc (62 to 772 Pa) static, linear-vent type with hangers, supports and appurtenances as listed per UL 2518.
 - .3 Listed by USDA as approved equipment for Meat & Poultry.
 - .4 Construction:
 - .1 Permeable polyester or non-permeable polyester with airflow orifices.
 - .2 Color: to be determined by Architect
 - .3 100% flame retardant polyester.
 - .4 Coating: non-air permeable.
 - .5 Weight: at least 5.5 oz. sq. yd. per ASTM D3776.
 - .6 Air permeability: 0 per ASTM D737, Frazier.
 - .7 Design Temperature: 0 to 180 deg. F.
 - .5 Fire Retardancy: Classified by Underwriters Laboratories in accordance with the requirements of NFPA 90-A.
 - .6 Accessories:

- .1 Inlet connection to metal duct via fabric draw band with anchor patches. Secure anchor patches to metal duct via zip screw fastener.
- .2 Zipper at inlet connection for easy removal and maintenance.
- .3 All required zippers as specified by manufacturer.
- .4 Connectors to accommodate suspension system.
- .5 System to include adjustable flow devices to balance airflow. Flow restriction devices to include the ability to adjust the airflow resistance from 0.06 to 0.60 in. w.g. static pressure.
- .6 Deviations from straight runs made with a minimum 5 piece gored elbow of centerline radius of 1.5 times the duct diameter or an efficient tee.
- .7 Suspension System:
 - .1 Tension cable system including multiple runs of cable attached to structure.
 - .2 Provide cable, eye bolts, thimbles, cable clamps, glides, track and turnbuckles as required.
 - .3 1.3 x 1 suspension system with a 3-row connection to fabric at 10, 12, and 2 o'clock positions.
 - .4 Powder coated aluminum hangers secured and connected to a single row tension cable every 3'-0" and connect to the fabric system at the 10 and 2 o'clock locations with detachable D-Clasps.
 - .5 Provide fabric system with intermediate glides located at 2 o'clock and between the hangers to attach directly to the single tension cable system located 3" (75 mm) above top-dead-center location to the fabric system.
 - .6 Tension cable hardware to include stainless steel cable, eye bolts, thimbles, cable clamps, and turnbuckles as required to make a complete suspension system.
 - .7 Adjustable mid-supports selected to suit the fabric duct layout.

PART 3 EXECUTION

3.1 APPLICATION

- .1 Duct Materials: Use the following materials in the design of ductwork specified in this Section unless otherwise noted on Drawings.
 - .1 General Supply, Return, Transfer, and Exhaust. – galvanized steel.
 - .2 General Exhaust Branch Serving Air Inlet in Shower Areas or Toilet Room with Shower 304 stainless steel.
 - .3 Ductwork for the first 15-feet Downstream of Humidifier 304L stainless steel.
- .2 Pressure Classes: Fabricate ductwork and casings to the following pressure classes unless otherwise noted on drawings:
 - .1 Medium pressure ductwork, from fan to terminal units: 0.5-inch higher than air handler's Discharge pressure; minimum 6-inch positive pressure class for supply air ductwork; Minimum 6-inch negative pressure class for exhaust or return air ductwork.
 - .2 Low-pressure ductwork, terminal units to air outlets: plus 2-inch class for supply ductwork, or minus 2-inch for return or exhaust ductwork.
 - .3 Return and exhaust air ducts on systems without terminal units: 0.5-inch more negative than air handler's design pressure; minimum 2-inch negative pressure class.
 - .4 Cryogen relief vent: 10-inch pressure class; maximum 5% leakage.

3.2 INSTALLATION

- .1 General

- .1 Install, support, and seal ducts in accordance with SMACNA (DCS).
- .2 Where welded ductwork is indicated, welding shall be continuous.
 - .1 Tack welding is unacceptable except as specifically noted.
 - .2 For galvanized sheet metal ducts, paint welded area and damaged areas with zinc coating after welding.
- .3 During construction, provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering the ductwork system.
- .4 Protect ductwork exposed to outside elements by painting or coating it with suitable weatherheat-resistant material.
- .5 Protect duct interiors from the elements and foreign materials until building is enclosed. Follow SMACNA's Duct Cleanliness for New Construction Advanced Level.
- .6 Provide ductwork taps and branches off of main and branch ducts at 45 degrees whether shown on Drawings or not (drawings are diagrammatic).
- .7 Do not cross-break bottom duct panels when ductwork is handling moisture.
- .8 Roof-mounted ducts shall have standing seams and shall be sealed weather tight.
- .9 Grade ductwork handling moisture, a minimum of 1:120 (1" in 10 ft) back to the source or at low points in the ductwork, provide a 6" deep drain sump and 1-1/4" dia. drain connection with deep seal trap and pipe to drain.
- .10 Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
- .11 Duct sizes indicated are precise inside dimensions. For lined ducts, maintain sizes inside lining.
- .12 Provide openings in ductwork as indicated to accommodate thermometers and controllers. Provide pilot tube openings as indicated for testing of systems, complete with metal can with spring device or screw to insure against air leakage. For openings, insulate ductwork and install insulation material inside a metal ring.
- .13 Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- .14 Use double nuts and lock washers on threaded rod supports.
- .15 Connect terminal units to supply ducts directly or with one one foot (300 mm) maximum length of flexible duct. Do not use flexible duct to change direction.
- .16 Connect diffusers or light troffer boots to low-pressure ducts directly or with 5 feet (1.5 m) maximum length of flexible duct held in place with strap or clamp.
- .17 Set plenum doors at 6 to 12 inches (150 to 300 mm) above floor. Arrange door swings so that fan static pressure holds door in closed position.
- .18 At exterior wall louvers, seal duct to louver frame and install blank-out panels.
- .19 Louver Fit-out:
 - .1 Provide blank-out panels sealing available area of wall-mounted exterior-faced louver when connected ductwork is smaller than actual louver free area, and duct outlet is smaller than the louver frame.
 - .2 Use the same duct material painted black on the exterior side, then seal louver frame and duct.
- .20 Fire Partitions: Provide firestopping sealing. See Section 07 84 00.
- .21 Duct Insulation: Provide duct insulation. See Section 23 07 13.
- .22 Painting: Provide surface finish as indicated on drawings. See Sections 09 91 13 and 09 91 23.

.23 Routing and Locations

- .1 The duct layout shown on the Contract Drawings is diagrammatic in nature. Coordinate ductwork routing and layout, and make alterations to the ductwork routing and layout to eliminate physical interferences. Where deviations in the ductwork routing as shown in the Contract Drawings are required, alterations may be made so as not to compromise the air flow, pressure drop, and sound characteristics of the duct fitting or duct run as shown on the Contract Drawings. In the event, Architect determines that the installed ductwork is inconsistent with the above-mentioned criteria, remove and replace it at no additional cost to the Owner.
- .2 Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.
- .3 Install ducts with a clearance of 1-inch, plus allowance for insulation thickness. Allow for easy removal of ceiling tiles.
- .4 Do not encase horizontal runs in solid partitions unless specifically indicated.
- .5 Coordinate layout with suspended ceiling, air duct accessories, lighting layout and similar finish work.
- .6 Electrical and IT Equipment Spaces: route ducts to avoid passing through transformer vaults, electrical equipment spaces, IDF/MPOE rooms, and enclosures.
- .7 Route ducts to avoid passing through required exit stairwells, exit passageways, elevator hoistways and machinery rooms, transformer vaults, and electrical equipment rooms and enclosures.

.2 Metal Duct

- .1 Paint interiors of metal ducts, that do not have duct liner, for 24-inches upstream of registers and grilles. Apply one coat of flat, black, latex finish coat over a compatible duct material.

.3 Flexible Duct

- .1 Flexible Ducts: Connect to metal ducts with adhesive.

.4 Non-Metal Duct

3.3 CLEANING

- .1 Clean thoroughly each duct system.
- .2 Clean duct system by forcing air at high velocity through duct to remove accumulated dust. Clean half the system at a time to obtain sufficient air. Protect equipment that could be harmed by excessive dirt with temporary filters or bypass during cleaning.
- .3 Clean duct systems with high-power vacuum machines. Protect equipment that could be harmed by excessive dirt with filters or bypass during cleaning. Provide adequate access to the ductwork for cleaning purposes.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- .1 Backdraft and Pressure Relief Dampers.
- .2 Pressure Relief Doors.
- .3 Barometric Relief Dampers.
- .4 Manual Volume Dampers.
- .5 Fire Dampers.
- .6 Ceiling Radiation Dampers.
- .7 Flange Connectors.
- .8 Turning Vanes.
- .9 Duct-Mounted Access Doors.
- .10 Duct Access Panel Assemblies.
- .11 Flexible Connectors.
- .12 Duct Accessory Hardware.

1.2 GENERAL REFERENCES

- .1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.
- .2 Division 20, including all Common Mechanical Requirements in Section 20 00 00, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.

1.3 RELATED REQUIREMENTS

- .1 Section 23 31 00 - HVAC Ducts and Casings.

1.4 SUBMITTALS

- .1 Action Submittals
 - .1 Product Data: Provide for shop-fabricated assemblies including volume control dampers, duct access doors, duct test holes, and hardware used. Include electrical characteristics and connection requirements.
 - .2 Shop Drawings: Indicate for shop fabricated assemblies including volume control dampers.
 - .3 Manufacturer's Installation Instructions: Provide instructions for fire dampers.
 - .4 Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.
 - .5 Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.
- .2 Record Documents
 - .1 Project Record Drawings: Record actual locations of access doors and test holes.

1.5 QUALITY ASSURANCE

- .1 Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.6 DELIVERY, STORAGE AND HANDLING

- .1 Protect dampers from damage to operating linkages and blades.

1.7 EXTRA MATERIALS

- .1 Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - .1 Extra Fusible Links: One of each type and size.

PART 2 PRODUCTS

2.1 ASSEMBLY DESCRIPTION

- .1 Frame: Hat-shaped, 0.05-inch- (1.3-mm-) thick, galvanized sheet steel, with welded corners or mechanically attached and mounting flange.
- .2 Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- .3 Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- .4 Comply with AMCA 500-D testing for damper rating.

2.2 MATERIALS

- .1 Galvanized Sheet Steel: Comply with ASTM A653/A653M.
 - .1 Galvanized Coating Designation: G90 (Z275).
 - .2 Exposed-Surface Finish: Mill phosphatized.
- .2 Stainless-Steel Sheets: Comply with ASTM A480/A480M, Type 304, and having a No. 2 finish for concealed ducts and finish for exposed ducts.
- .3 Aluminum Sheets: Comply with ASTM B209/B209M, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- .4 Extruded Aluminum: Comply with ASTM B221 (ASTM B221M), Alloy 6063, Temper T6.
- .5 Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- .6 Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm)

2.3 BACKDRAFT AND PRESSURE RELIEF DAMPERS

- .1 Manufacturers:
 - .1 Air Balance.
 - .2 American Warming and Ventilating.
 - .3 Cesco Products.
 - .4 Duro Dyne.
 - .5 Greenheck Fan Corporation.
 - .6 Nailor Industries.
 - .7 Pottorff.
 - .8 Ruskin Company.
 - .9 SEMCO.
 - .10 Vent Products Company.
- .2 Description: Gravity balanced.
- .3 Maximum Air Velocity: 1000 fpm (5.1 m/s).

- .4 Maximum System Pressure: 1-inch wg (0.25 kPa).
 - .1 Temperature Range:- 20 to + 250 deg F (- 29 to + 121 deg C)
- .5 Blades: Multiple single-piece blades, center pivoted, maximum 6-inch (150-mm) width, 0.025-inch- (0.6-mm-) thick, roll-formed aluminum with sealed edges.
- .6 Blade Action: Parallel.
- .7 Blade Seals: Felt.
- .8 Blade Axles:
 - .1 Material: Nonferrous metal.
 - .2 Diameter: 0.20 inch (5 mm).
- .9 Tie Bars and Brackets: Galvanized steel.
- .10 Return Spring: Adjustable tension.
- .11 Bearings: Steel ball.
- .12 Accessories:
 - .1 Adjustment device to permit setting for varying differential static pressure.
 - .2 Counterweights and spring-assist kits for vertical airflow installations.
 - .3 Electric actuators.
 - .4 Chain pulls.
 - .5 Screen Mounting: Front mounted in sleeve.
 - .1 Sleeve Thickness: 20-gage (1.0-mm) minimum.
 - .2 Sleeve Length: 6 inches (152 mm) minimum.
 - .6 Screen Mounting: Rear mounted.
 - .7 Screen Material: Galvanized steel.
 - .8 Screen Type: Bird.
 - .9 90-degree stops.

2.4 PRESSURE RELIEF DOORS

- .1 Manufacturers:
 - .1 Greenheck Fan Corporation.
 - .2 Kees.
 - .3 Ruskin.
- .2 Door and Frame Material: Galvanized sheet steel.
- .3 Door: Single wall or Double wall with insulation fill with metal thickness applicable for duct pressure class.
- .4 Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.
- .5 Factory set at 4-inch wg. (1.5 kPa) and adjustable in the field.
- .6 Doors close when pressures are within set-point range.
- .7 Hinge: Continuous piano.
- .8 Latches: Cam.
- .9 Seal: Neoprene or foam rubber.
- .10 Insulation Fill 1-inch (25.4 mm) fibrous-glass or polystyrene-foam board.

2.5 BAROMETRIC RELIEF DAMPERS

- .1 Manufacturers:
 - .1 Air Balance.

- .2 American Warming and Ventilating.
- .3 Cesco Products.
- .4 Duro Dyne.
- .5 Greenheck Fan Corporation.
- .6 Nailor Industries.
- .7 Pottorff.
- .8 Ruskin Company.
- .9 SEMCO.
- .10 Vent Products Company.
- .2 Suitable for horizontal or vertical mounting.
- .3 Maximum Air Velocity: 1000 fpm (5.1 m/s).
- .4 Maximum System Pressure: 2-inch wg (0.5 kPa).
- .5 Frame: Hat-shaped, 0.05-inch- (1.3-mm-) thick, galvanized sheet steel, with welded corners or mechanically attached and mounting flange.
- .6 Blades:
 - .1 Multiple, 0.025-inch- (0.6-mm-) thick, roll-formed aluminum.
 - .2 Maximum Width: .6 inches (150 mm)
 - .3 Action: Parallel.
 - .4 Balance: Gravity.
 - .5 Eccentrically pivoted.
- .7 Blade Seals: Vinyl.
- .8 Blade Axles: Galvanized steel.
- .9 Tie Bars and Brackets:
 - .1 Material: Aluminum.
 - .2 Rattle free with 90-degree stop.
- .10 Return Spring: Adjustable tension.
- .11 Bearings: Synthetic.
- .12 Accessories:
 - .1 Flange on intake.
 - .2 Adjustment device to permit setting for varying differential static pressures.

2.6 MANUAL VOLUME DAMPERS

- .1 Manufacturers:
 - .1 Air Balance.
 - .2 American Warming and Ventilating.
 - .3 Flexmaster U.S.A.
 - .4 Greenheck Fan Corporation.
 - .5 McGill AirFlow.
 - .6 METALAIRE.
 - .7 Nailor Industries.
 - .8 Pottorff.
 - .9 Ruskin Company.
 - .10 Vent Products Company.
- .2 Standard, Steel, Manual Volume Dampers:

- .1 Standard leakage rating , with linkage outside airstream .
- .2 Suitable for horizontal or vertical applications.
- .3 Frames:
 - .1 Frame: Hat-shaped, 0.094-inch- (2.4-mm-) thick, galvanized sheet steel.
 - .2 Mitered and welded corners.
 - .3 Flanges for attaching to walls and flangeless frames for installing in ducts.
- .4 Blades:
 - .1 Multiple or single blade.
 - .2 Parallel- or opposed-blade design.
 - .3 Stiffen damper blades for stability.
 - .4 Galvanized-steel, 0.064 inch (1.62 mm) thick.
- .5 Blade Axles: Galvanized steel.
- .6 Bearings:
 - .1 Oil-impregnated bronze.
 - .2 Dampers in ducts with pressure classes of 3-inch w.g. (750 Pa) or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
- .7 Tie Bars and Brackets: Galvanized steel.
- .3 Standard, Aluminum, Manual Volume Dampers:
 - .1 Manufacturers:
 - .1 Air Balance.
 - .2 American Warming and Ventilating.
 - .3 Flexmaster U.S.A.
 - .4 Greenheck Fan Corporation.
 - .5 McGill AirFlow.
 - .6 METALAIRE.
 - .7 Nailor Industries.
 - .8 Pottorff.
 - .9 Ruskin Company.
 - .10 Vent Products Company.
 - .11 Trox USA.
 - .2 Standard leakage rating, with linkage outside airstream.
 - .3 Suitable for horizontal or vertical applications.
 - .4 Frames: Hat-shaped, 0.10-inch (2.5-mm-) thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.
 - .5 Blades:
 - .1 Multiple or single blade.
 - .2 Parallel- or opposed-blade design.
 - .3 Stiffen damper blades for stability.
 - .4 Roll-Formed Aluminum Blades: 0.10-inch (2.5-mm-) thick aluminum sheet.
 - .5 Extruded-Aluminum Blades: 0.050-inch (1.2-mm) thick extruded aluminum.
 - .6 Blade Axles: Galvanized steel.
 - .7 Bearings:
 - .1 Oil-impregnated bronze.

- .2 Dampers in ducts with pressure classes of 3-inch w.g. (750 Pa) or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
- .8 Tie Bars and Brackets: Aluminum.
- .4 Low-Leakage, Steel, Manual Volume Dampers:
 - .1 Manufacturers:
 - .1 Air Balance.
 - .2 American Warming and Ventilating.
 - .3 Flexmaster U.S.A.
 - .4 Greenheck Fan Corporation.
 - .5 McGill AirFlow.
 - .6 METALAIRE.
 - .7 Nailor Industries.
 - .8 Pottorff.
 - .9 Ruskin Company.
 - .10 Vent Products Company.
 - .11 Flex-Tek Group.
 - .12 Trox USA.
 - .2 Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
 - .3 Suitable for horizontal or vertical applications.
 - .4 Frames:
 - .1 Hat shaped.
 - .2 94-inch- (2.4-mm-) thick, galvanized sheet steel.
 - .3 Mitered and welded corners.
 - .4 Flanges for attaching to walls and flangeless frames for installing in ducts.
 - .5 Blades:
 - .1 Multiple or single blade.
 - .2 Parallel- or opposed-blade design.
 - .3 Stiffen damper blades for stability.
 - .4 Galvanized, roll-formed steel, 0.064 inch (1.62 mm) thick.
 - .6 Blade Axles: Galvanized steel.
 - .7 Bearings:
 - .1 Oil-impregnated bronze.
 - .2 Dampers in ducts with pressure classes of 3-inch w.g. (750 Pa) or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
 - .8 Blade Seals: Felt.
 - .9 Jamb Seals: Cambered stainless steel.
 - .10 Tie Bars and Brackets: Galvanized steel.
 - .11 Accessories:
 - .1 Include locking device with 2" stand-off bracket to hold single-blade dampers in a fixed position without vibration.
- .5 Low-Leakage, Aluminum, Manual Volume Dampers:

- .1 Manufacturers:
 - .1 Air Balance Inc.
 - .2 American Warming and Ventilating.
 - .3 Flexmaster U.S.A.
 - .4 Greenheck Fan Corporation.
 - .5 McGill AirFlow.
 - .6 METALAIRE.
 - .7 Nailor Industries.
 - .8 Pottorff.
 - .9 Ruskin Company.
 - .10 Vent Products Company.
 - .11 Trox USA.
- .2 Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
- .3 Suitable for horizontal or vertical applications.
- .4 Frames: Hat-shaped, 0.10-inch (2.5-mm-) thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.
- .5 Blades:
 - .1 Multiple or single blade.
 - .2 Parallel- or opposed-blade design.
 - .3 Roll-Formed Aluminum Blades: 0.10-inch (2.5-mm-) thick aluminum sheet.
- .6 Blade Axles: Galvanized steel.
- .7 Bearings:
 - .1 Oil-impregnated bronze.
 - .2 Dampers in ducts with pressure classes of 3-inch w.g (750 Pa) less shall have axles full length of damper blades and bearings at both ends of operating shaft.
- .8 Blade Seals: Felt.
- .9 Jamb Seals: Cambered Stainless steel.
- .10 Tie Bars and Brackets: Galvanized steel.
- .11 Accessories:
 - .1 Include locking device with 2" stand-off bracket to hold single-blade dampers in a fixed position without vibration.
- .6 Jackshaft:
 - .1 Size: 1-inch (25-mm) diameter.
 - .2 Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
 - .3 Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.
- .7 Damper Hardware:
 - .1 Zinc-plated, die-cast core with dial and handle made of 3/32-inch (2.4-mm) thick zinc-plated steel, and a 3/4-inch (19-mm) hexagon locking nut.
 - .2 Include center hole to suit damper operating-rod size.
 - .3 Include elevated platform for insulated duct mounting.

2.7 FIRE DAMPERS

- .1 Manufacturers:
 - .1 Air Balance Inc.
 - .2 Cesco Products.
 - .3 Greenheck Fan Corporation.
 - .4 McGill AirFlow.
 - .5 METALAIRE.
 - .6 Nailor Industries.
 - .7 Ruskin Company.
 - .8 Vent Products Company,
 - .9 Ward Industries.
- .2 Type: Dynamic Static; rated and labeled according to UL 555 by an NRTL.
- .3 Fire Rating: 1-1/2 hours.
- .4 Frame: Curtain type with blades outside airstream Curtain type with blades inside airstream; fabricated with roll-formed, 0.034-inch- (0.85-mm-) thick galvanized steel; with mitered and interlocking corners.
- .5 Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
 - .1 Minimum Thickness: 0.05 (1.3 mm) thick, as indicated, and of length to suit application.
 - .2 Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.
- .6 Mounting Orientation: Vertical or horizontal as indicated.
- .7 Blades: Roll-formed, interlocking, 0.024-inch- (0.61-mm) thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- (0.85-mm-) thick, galvanized-steel blade connectors.
- .8 Horizontal Dampers: Include blade lock and stainless-steel closure spring.
- .9 Heat-Responsive Device: Replaceable, 165 deg F (74 deg C) 212 deg F (100 deg C) rated, fusible links.
- .10 Heat-Responsive Device: Electric link and switch package, factory installed, 165 deg F (74 deg C) rated.

2.8 CEILING RADIATION DAMPERS

- .1 Manufacturers:
 - .1 Air Balance Inc.
 - .2 Cesco Products.
 - .3 Greenheck Fan Corporation.
 - .4 McGill AirFlow.
 - .5 METALAIRE.
 - .6 Nailor Industries.
 - .7 Ruskin Company.
 - .8 Vent Products Company.
 - .9 Ward Industries, Inc.
- .2 General Requirements:
 - .1 Labeled according to UL 555C by an NRTL.
 - .2 Comply with construction details for tested floor- and roof-ceiling assemblies as indicated in UL's "Fire Resistance Directory."

- .3 Frame: Galvanized sheet steel, round or rectangular, style to suit ceiling construction.
- .4 Blades: Galvanized sheet steel with refractory insulation.
- .5 Heat-Responsive Device: Replaceable, 165 deg F (74 deg C) rated, fusible links.
- .6 Fire Rating: 1 hours.

2.9 FLANGE CONNECTORS

- .1 Manufacturers:
 - .1 Ductmate Industries.
 - .2 Elgen.
 - .3 Nexus PDQ.
 - .4 Ward Industries, Inc.
- .2 Description: Add-on, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.
- .3 Material: Galvanized steel.
- .4 Gage and Shape: Match connecting ductwork.

2.10 TURNING VANES

- .1 Manufacturers:
 - .1 Ductmate Industries.
 - .2 Duro Dyne.
 - .3 METALAIRE.
 - .4 SEMCO.
 - .5 Ward Industries.
- .2 Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
 - .1 Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.
- .3 Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
- .4 General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."
- .5 Vane Construction: Single wall.
- .6 Vane Construction: Single wall for ducts up to 48 inches (1200 mm) wide and double wall for larger dimensions.

2.11 DUCT-MOUNTED ACCESS DOORS

- .1 Manufacturers:
 - .1 American Warming and Ventilating.
 - .2 Cesco Products.
 - .3 Ductmate Industries.
 - .4 Flexmaster U.S.A.
 - .5 Greenheck Fan Corporation.
 - .6 McGill AirFlow.
 - .7 Nailor Industries.

- .8 Pottorff.
- .9 Ruskin.
- .10 Ventfabrics.
- .11 Ward Industries.
- .2 Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2 (7-2M), "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."
 - .1 Door:
 - .1 Double wall, rectangular.
 - .2 Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
 - .3 Vision panel.
 - .4 Hinges and Latches: 1-by-1-inch (25-by-25-mm) butt or piano hinge and cam latches.
 - .5 Fabricate doors airtight and suitable for duct pressure class.
 - .2 Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
 - .3 Number of Hinges and Locks:
 - .1 Access Doors Less Than 12 Inches (300 mm) Square: No hinges and two sash locks.
 - .2 Access Doors up to 18 Inches (460 mm) Square: Two hinges and two sash locks.
 - .3 Access Doors up to 24 by 48 Inches (600 by 1200 mm) : Three hinges and and two compression latches with outside and inside handles.
 - .4 Access Doors Larger Than 24 by 48 Inches (600 by 1200 mm) : Four hinges and two compression latches with outside and inside handles.
- .3 Pressure Relief Access Door:
 - .1 Door and Frame Material: Galvanized sheet steel.
 - .2 Door: Single wall with metal thickness applicable for duct pressure class.
 - .3 Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.
 - .4 Factory set at 3.0- to 8.0-inch wg (800 to 2000 Pa).
 - .5 Doors close when pressures are within set-point range.
 - .6 Hinge: Continuous piano.
 - .7 Latches: Cam.
 - .8 Seal: Neoprene or foam rubber.
 - .9 Insulation Fill: 1 inch (25 mm) thick, fibrous-glass or polystyrene-foam board.

2.12 DUCT ACCESS PANEL ASSEMBLIES

- .1 Manufacturers:
 - .1 Ductmate Industries.
 - .2 Flame Gard.
 - .3 3M.
- .2 Labeled according to UL 1978 by an NRTL.
- .3 Panel and Frame: Minimum thickness 0.0528-inch (1.3-mm) carbon steel.
- .4 Fasteners: Carbon steel. Panel fasteners shall not penetrate duct wall.

- .5 Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum .2000 deg F (1093 deg C)
- .6 Minimum Pressure Rating: 10-inch w.g. (2500 Pa), positive or negative.

2.13 FLEXIBLE CONNECTORS

- .1 Manufacturers:
 - .1 Ductmate Industries.
 - .2 Duro Dyne.
 - .3 Ventfabrics.
 - .4 Ward Industries.
- .2 Materials: Flame-retardant or noncombustible fabrics.
- .3 Coatings and Adhesives: Comply with UL 181, Class 1.
- .4 Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches (89 mm) wide attached to 2 strips of 2-3/4-inch- (70-mm-) wide, 0.028-inch- (0.7-mm-) thick, galvanized sheet steel or 0.032-inch- (0.8-mm-) thick aluminum sheets. Provide metal compatible with connected ducts.
- .5 Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
 - .1 Minimum Weight: 26 oz./sq. yd. (880 g/sq. m)
 - .2 Tensile Strength: 480 lbf/inch (84 N/mm) in the warp and 360 lbf/inch (63 N/mm) in the filling.
 - .3 Service Temperature: - 40 to + 200 deg F (- 40 to + 93 deg C)
- .6 Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
 - .1 Minimum Weight: 24 oz./sq. yd (810 g/sq. m).
 - .2 Tensile Strength: 530 lbf/inch (93 N/mm) in the warp and 440 lbf/inch (77 N/mm) in the filling.
 - .3 Service Temperature: Minus 50 to plus 250 deg F (Minus 45 to plus 121 deg C).
- .7 High-Temperature System, Flexible Connectors: Glass fabric coated with silicone rubber.
 - .1 Minimum Weight: 16 oz./sq. yd. (542 g/sq. m) .
 - .2 Tensile Strength: 285 lbf/inch (50 N/mm) in the warp and 185 lbf/inch (32 N/mm) in the filling.
 - .3 Service Temperature: Minus 67 to plus 500 deg F (Minus 55 to plus 260 deg C).
- .8 High-Corrosive-Environment System, Flexible Connectors: Glass fabric with chemical-resistant coating.
 - .1 Minimum Weight: 14 oz./sq. yd. (474 g/sq. m) .
 - .2 Tensile Strength: 450 lbf/inch (79 N/mm) in the warp and 340 lbf/inch (60 N/mm) in the filling.
 - .3 Service Temperature: Minus 67 to plus 500 deg F (Minus 55 to plus 260 deg C) .
- .9 Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.
 - .1 Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
 - .2 Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 - .3 Minimum Additional Travel: 50 percent of the required deflection at rated load.

- .4 Lateral Stiffness: More than 80 percent of rated vertical stiffness.
- .5 Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
- .6 Elastomeric Element: Molded, oil-resistant rubber or neoprene.
- .7 Coil Spring: Factory set and field adjustable for a maximum of 1/4 inch (6 mm) movement at start and stop.

2.14 DUCT ACCESSORY HARDWARE

- .1 Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of Pitot tube and other testing instruments and of length to suit duct-insulation thickness.
- .2 Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 EXECUTION

3.1 APPLICATION

- .1 Backdraft and Pressure Relief Dampers
 - .1 Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- .2 Manual Volume Dampers
 - .1 Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
 - .1 Install steel volume dampers in steel ducts.
 - .2 Install aluminum volume dampers in aluminum ducts.
 - .3 Install stainless steel volume dampers in stainless steel ducts and PVC coated steel ducts.
- .3 Duct-Mounted Access Doors:
 - .1 Provide in the following locations
 - .1 On both sides of duct coils.
 - .2 Upstream and downstream from duct filters.
 - .3 At outdoor-air intakes and mixed-air plenums.
 - .4 At drain pans and seals.
 - .5 Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
 - .6 Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
 - .7 At each change in direction and at maximum 50-foot (15-m) spacing.
 - .8 Upstream and downstream from turning vanes.
 - .9 Upstream or downstream from duct silencers.
 - .10 Control devices requiring inspection.
 - .11 Elsewhere as indicated.
 - .2 Access Door Sizes:

- .1 Two-Hand Access: 12 by 6 inches (300 by 150 mm).
- .2 Head and Hand Access: 18 by 10 inches (460 by 250 mm).
- .3 Head and Shoulders Access: 21 by 14 inches (530 by 355 mm).
- .4 Body Access: 25 by 14 inches (635 by 355 mm).
- .5 Body plus Ladder Access: 25 by 17 inches (635 by 430 mm).
- .4 Flexible Connectors
 - .1 Install flexible connectors to connect ducts to equipment.
- .5 Duct Accessory Hardware
 - .1 Instrument Test Holes:
 - .1 Install test holes at fan inlets and outlets and elsewhere as indicated.
 - .2 Install duct test holes where required for testing and balancing purposes.

3.2 INSTALLATION

- .1 General
 - .1 Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
 - .2 Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
 - .3 Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch (6-mm) movement during start and stop of fans.
- .2 Manual Volume Dampers: Set dampers to fully open position before testing, adjusting, and balancing.
- .3 Fire, Smoke and Combination Fire and Smoke Dampers: Install according to UL listing.
- .4 Duct-Mounted Access Doors:
 - .1 Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
 - .2 Label access doors according to Division 20 Section 20 05 53 "Mechanical Identification" to indicate the purpose of access door.
- .5 Flexible Connectors: For fans developing static pressures of 5-inch w.g. (1250 Pa) and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

3.3 FIELD QUALITY CONTROL

- .1 Tests and Inspections:
 - .1 Manual and Control Dampers: Operate dampers to verify full range of movement.
 - .2 Duct-Mounted Access Doors: Inspect locations of access doors and verify that purpose of access door can be performed.
 - .3 Fire, Smoke, and Combination Fire and Smoke Dampers: Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
 - .4 Turning Vanes: Inspect turning vanes for proper and secure installation.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- .1 Single-Duct Air Terminal Units.
- .2 Single-Duct Bypass Air Terminal Units.
- .3 Parallel Fan-Powered Air Terminal Units.
- .4 Series Fan-Powered Air Terminal Units.
- .5 Dual-Duct Air Terminal Units.
- .6 Diffuser-Type Air Terminal Units.
- .7 Balancing Air Terminal Units.
- .8 Pressure Control Air Terminal Units.
- .9 Critical Environment Control Valve.
- .10 Exhaust Single Duct Terminal.
- .11 Casing Liner.

1.2 GENERAL REFERENCES

- .1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.
- .2 Division 20, including all Common Mechanical Requirements in Section 20 00 00, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.

1.3 RELATED REQUIREMENTS

- .1 Section 23 33 00 - Air Duct Accessories.
- .2 Section 23 37 00 - Air Outlets and Inlets.

1.4 SUBMITTALS

- .1 Action Submittals
 - .1 Product Data: Provide data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings that indicate airflow, static pressure, and NC designation. Include electrical characteristics and connection requirements.
 - .2 Shop Drawings: Indicate configuration, general assembly, and materials used in fabrication, and electrical characteristics and connection requirements.
 - .1 Include schedules listing discharge and radiated sound power level for each of the second through sixth-octave bands at inlet static pressures of 1 to 4 in-wc (250 to 1000 Pa).
 - .3 Certificates: Certify that coils are tested and rated in accordance with AHRI 410.
 - .4 Manufacturer's Installation Instructions: Indicate support and hanging details, installation instructions, recommendations, and service clearances required.
- .2 Operation and Maintenance Materials
 - .1 Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists. Include directions for resetting constant-volume regulators.
- .3 Record Documents
 - .1 Project Record Documents: Record actual locations of units and locations of access doors required for access of valving.

1.5 WARRANTIES

- .1 Warranty Documentation: Submit manufacturer warranty with Operation and Maintenance Materials and ensure forms have been completed in Owner's name and registered with manufacturer.
- .2 Air Terminal Units: Provide five year manufacturer warranty for air terminal units.

1.6 QUALITY ASSURANCE

- .1 Provide five year manufacturer warranty for air terminal units.

1.7 COORDINATION

- .1 Preinstallation Meeting: Conduct a preinstallation meeting one week before to the start of the work of this section; require attendance by affected installers.

1.8 EXTRA MATERIALS

- .1 Furnish the following for Owner's use in maintenance of project.
 - .1 Extra Motors: One of each type and size.

PART 2 PRODUCTS

2.1 GENERAL

- .1 Source Quality Control
 - .1 Factory Tests: Test assembled air terminal units according to AHRI 880 (I-P).
 - .1 Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and AHRI certification seal.

2.2 SINGLE-DUCT AIR TERMINAL UNITS

- .1 Manufacturers:
 - .1 Johnson Controls.
 - .2 Nailor Industries.
 - .3 Price Industries.
 - .4 Titus.
 - .5 Trane.
 - .6 Tuttle & Bailey.
- .2 Configuration: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.
- .3 Casing: 0.034-inch- (0.85-mm-) thick galvanized steel, single wall.
 - .1 Casing Liner: Comply with requirements in "Casing Liner" Article for fibrous-glass duct liner.
 - .2 Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
 - .3 Air Outlet: S-slip and drive connections , size matching inlet size.
 - .4 Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.
 - .5 Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE Std 62.1.
 - .6 Provide mounting brackets on casing.
- .4 Regulator Assembly: System-air-powered bellows section incorporating polypropylene bellows for volume regulation and thermostatic control. Bellows shall operate at temperatures from zero to 140 deg F (minus 18 to plus 60 deg C), shall be impervious to

- moisture and fungus, shall be suitable for 10-inch wg (2500-Pa) static pressure, and shall be factory tested for leaks.
- .5 Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
 - .1 Maximum Damper Leakage: AHRI 880 (I-P) rated, 2 percent of nominal airflow at 3-inch wg (750-Pa) 6-inch wg (1500-Pa) inlet static pressure.
 - .2 Damper Position: Normally open.
 - .3 The damper shaft shall incorporate a visual position indicator etched into the end of the damper shaft to clearly indicate damper position over the full range of 90 degrees.
 - .6 Attenuator Section: 0.034-inch (0.85-mm) steel sheet.
 - .1 Attenuator Section Liner: Comply with requirements in "Casing Liner" Article for fibrous-glass duct liner.
 - .2 Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE Std 62.1.
 - .7 Multioutlet Attenuator Section: With two diameter collars, each with locking butterfly balancing damper.
 - .8 Hydronic Heating Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm), and rated for a minimum working pressure of 200 psig (1380 kPa) and a maximum entering-water temperature of 220 deg F (104 deg C). Include manual air vent and drain valve.
 - .9 Electric-Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with primary automatic, and secondary manual, reset thermal cutouts. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware.
 - .1 Stage(s): 1.
 - .2 SCR controlled.
 - .3 Access door interlocked disconnect switch.
 - .4 Downstream air temperature sensor with local connection to override discharge-air temperature to not exceed a maximum temperature set point (adjustable).
 - .5 Nickel chrome 80/20 heating elements.
 - .6 Airflow switch for proof of airflow.
 - .7 Fan interlock contacts.
 - .8 Fuses in terminal box for overcurrent protection (for coils more than 48 A).
 - .9 Mercury contactors.
 - .10 Pneumatic-electric switches and relays.
 - .11 Magnetic contactor for each step of control (for three-phase coils).
 - .10 DDC Controls: Single-package unitary controller and actuator specified in Division 23 Section 23 09 00 "Instrumentation and Control for HVAC."
 - .11 Control devices shall be compatible with temperature controls system specified in Division 23 Section 23 09 00 "Instrument and Control for HVAC."
 - .1 Electric Damper Actuator: 24 V, powered open, spring return.
 - .2 Pneumatic Damper Operator: 0- to 13-psig (0- to 90-kPa) spring range.
 - .3 Electronic Damper Actuator: 24 V, powered open, spring return.
 - .4 Electric Thermostat: Wall-mounted electronic type with clock display, temperature display in Fahrenheit and Celsius, and space temperature set point.
 - .5 Pneumatic Thermostat: Wall-mounted, pneumatic type, direct acting with appropriate mounting hardware.

- .6 Electronic Thermostat: Wall-mounted electronic type with temperature set-point display in Fahrenheit and Celsius.
- .7 Pneumatic Velocity Controller: Factory calibrated and field adjustable to minimum and maximum air volumes; shall maintain constant airflow dictated by thermostat within 5 percent of set point while compensating for inlet static-pressure variations up to 4-inch wg (1000 Pa); and shall have a multipoint velocity sensor at air inlet.
- .8 Electronic Velocity Controller: Factory calibrated and field adjustable to minimum and maximum air volumes; shall maintain constant airflow dictated by thermostat within 5 percent of set point while compensating for inlet static-pressure variations up to 4-inch wg (1000 Pa); and shall have a multipoint velocity sensor at air inlet.
- .9 Terminal Unit Controller: Pressure-independent, variable-air-volume (VAV) controller with electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes, and having the following features:
 - .1 Occupied and unoccupied operating mode.
 - .2 Remote reset of airflow or temperature set points.
 - .3 Adjusting and monitoring with portable terminal.
 - .4 Communication with temperature-control system specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."
- .10 Room Sensor: Wall mounted with temperature set-point adjustment and access for connection of portable operator terminal.
- .12 Controls:
 - .1 Suitable for operation with duct pressures between 0.25- and 3.0-inch wg (60- and 750-Pa) inlet static pressure.
 - .2 System-powered, wall-mounted thermostat.
- .13 Control Sequences:
 - .1 Occupied:
 - .1 In a call for cooling, airflow will increase as the damper opens towards maximum setting to satisfy set point.
 - .2 In a call for less cooling, airflow will decrease as the damper closes towards minimum setting to satisfy set point.
 - .2 Unoccupied:
 - .1 Damper closes to minimum maximum setting.

2.3 SINGLE-DUCT BYPASS AIR TERMINAL UNITS

- .1 Manufacturers:
 - .1 Carnes Company.
 - .2 Carrier Corporation.
 - .3 Krueger.
 - .4 Titus.
 - .5 Trane.
 - .6 Tuttle & Bailey.
- .2 Configuration: Diverting-damper assembly inside unit casing with control components inside a protective metal shroud.
- .3 Casing: 0.034-inch- (0.85-mm-) thick galvanized steel, single wall.
 - .1 Casing Liner: Comply with requirements in "Casing Liner" Article for fibrous-glass duct liner.
- .4 Diverter Assembly: Galvanized-steel gate, with polyethylene linear bearings.

- .5 Multioutlet Attenuator Section: With two diameter collars, each with locking butterfly balancing damper.
 - .1 Attenuator Section Liner: Comply with requirements in "Casing Liner" Article for fibrous-glass duct liner.
 - .2 Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE Std 62.1.
- .6 Hydronic Heating Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm), and rated for a minimum working pressure of 200 psig (1380 kPa) and a maximum entering-water temperature of 220 deg F (104 deg C). Include manual air vent and drain valve.
- .7 Electric-Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with primary automatic, and secondary manual, reset thermal cutouts. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware.
 - .1 Stage(s): 1 .
 - .2 SCR controlled.
 - .3 Access door interlocked disconnect switch.
 - .4 Downstream air temperature sensor with local connection to override discharge-air temperature to not exceed a maximum temperature set point (adjustable).
 - .5 Nickel chrome 80/20 heating elements.
 - .6 Airflow switch for proof of airflow.
 - .7 Fuses in terminal box for overcurrent protection (for coils more than 48 A).
 - .8 Mercury contactors.
 - .9 Pneumatic-electric switches and relays.
 - .10 Magnetic contactor for each step of control (for three-phase coils).
- .8 Electric Controls: Damper actuator and thermostat.
 - .1 Damper Actuator: 24 V, powered closed, powered open with microswitch to energize heating control circuit.
 - .2 Thermostat: Wall-mounted electric type with temperature display in Fahrenheit and Celsius, and space temperature set point.
 - .3 Changeover Thermostat: Duct-mounted, field-adjustable, electric type reverses action of zone thermostat when air temperature reaches 70 deg F (21 deg C).
- .9 Electronic Controls: Bidirectional damper operator and microprocessor-based thermostat. Control devices shall be compatible with temperature controls specified in Section 230923 "Direct Digital Control (DDC) System for HVAC" and shall have the following features:
 - .1 Damper Actuator: 24 V, powered open, spring return.
 - .2 Thermostat: Wall-mounted electronic type with the following features:
 - .1 Temperature set-point display in Fahrenheit and Celsius.
 - .2 Auxiliary switch to energize heating control circuit.
 - .3 Changeover thermistor to reverse action.
- .10 Direct Digital Controls: Single-package unitary controller and actuator specified in Division 23 Section 23 09 00 "Instrumentation and Control HVAC."

2.4 PARALLEL FAN-POWERED AIR TERMINAL UNITS

- .1 Manufacturers:
 - .1 Nailor Industries.
 - .2 Price Industries.

- .3 Titus.
- .4 Trane.
- .5 Tuttle & Bailey.
- .2 Configuration: Volume-damper assembly and fan in parallel arrangement inside unit casing with control components inside a protective metal shroud. Designed for quiet operation.
- .3 Casing: 0.034-inch- (0.85-mm-) thick galvanized steel, single wall.
 - .1 Casing Liner: Comply with requirements in "Casing Liner" Article for fibrous-glass duct liner.
 - .2 Air Inlets: Round stub connections or S-slip and drive connections for duct attachment.
 - .3 Air Outlet: S-slip and drive connections.
 - .4 Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket and quarter-turn latches.
 - .5 Fan: Forward-curved centrifugal, located at plenum air inlet.
 - .6 Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE Std 62.1.
- .4 Volume Damper: Galvanized steel with flow-sensing ring and peripheral gasket and self-lubricating bearings.
 - .1 Maximum Damper Leakage: AHRI 880 (I-P) rated, 2 percent of nominal airflow at 3-inch wg (750-Pa) inlet static pressure.
 - .2 Damper Position: Normally open.
- .5 Velocity Sensors: Multipoint array with velocity sensors.
- .6 Motor:
 - .1 Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Division 20 Section 20 05 13"Common Motor Requirements for Mechanical Equipment."
 - .2 Type: Permanent-split capacitor with SCR for speed adjustment.
 - .3 Fan-Motor Assembly Isolation: Rubber isolators.
 - .4 Enclosure: Open dripproof.
 - .5 Enclosure Materials: Cast iron.
 - .6 Motor Bearings: .
 - .7 Unusual Service Conditions:
 - .1 Ambient Temperature: .
 - .2 Altitude: above sea level.
 - .3 High humidity.
 - .8 Efficiency: Premium efficient.
 - .9 NEMA Design: .
 - .10 Service Factor: .
 - .11 Motor Speed: Single speed.
 - .1 Speed Control: Infinitely adjustable with pneumatic-electric and electronic controls.
 - .12 Electrical Characteristics:
 - .1 Horsepower: .
 - .2 Volts: 120.
 - .3 Phase: Single.

- .4 Hertz: 60.
- .5 Full-Load Amperes: .
- .6 Minimum Circuit Ampacity: .
- .7 Maximum Overcurrent Protection: .
- .7 Filters: Minimum arrestance and a minimum efficiency reporting value (MERV) according to ASHRAE Std 52.2.
 - .1 Material: Polyurethane foam having 70 percent arrestance and 3 MERV.
 - .2 Material: Glass fiber treated with adhesive; having 80 percent arrestance and 5 MERV.
 - .3 Wiring Terminations: Fan and controls to terminal strip. Terminal lugs to match quantities, sizes, and materials of branch-circuit conductors. Enclose terminal lugs in terminal box that is sized according to NFPA 70.
 - .4 Material: Pleated cotton-polyester media having 90 percent arrestance and 7 MERV.
 - .5 Thickness: 2 inches (50 mm).
- .8 Attenuator Section: 0.034-inch (0.85-mm) galvanized steel sheet.
 - .1 Attenuator Section Liner: Comply with requirements in "Casing Liner" Article for fibrous-glass duct liner.
 - .2 Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE Std 62.1.
- .9 Hydronic Heating Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm), and rated for a minimum working pressure of 200 psig (1380 kPa) and a maximum entering-water temperature of 220 deg F (104 deg C). Include manual air vent and drain valve.
 - .1 Location: Plenum air inlet.
- .10 Electric-Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with primary automatic, and secondary manual, reset thermal cutouts. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware.
 - .1 Location: Plenum air inlet.
 - .2 Stage(s): 1.
 - .3 SCR controlled.
 - .4 Access door interlocked disconnect switch.
 - .5 Downstream air temperature sensor with local connection to override discharge-air temperature to not exceed a maximum temperature set point (adjustable).
 - .6 Nickel chrome 80/20 heating elements.
 - .7 Airflow switch for proof of airflow.
 - .8 Fan interlock contacts.
 - .9 Fuses in terminal box for overcurrent protection (for coils more than 48 A).
 - .10 Mercury contactors.
 - .11 Pneumatic-electric switches and relays.
 - .12 Magnetic contactor for each step of control (for three-phase coils).
- .11 Factory-Mounted and -Wired Controls: Electrical components mounted in control box with removable cover. Incorporate single-point electrical connection to power source.
 - .1 Control Transformer: Factory mounted for control voltage on electric and electronic control units with terminal strip in control box for field wiring of thermostat and power source.

- .2 Wiring Terminations: Fan and controls to terminal strip. Terminal lugs to match quantities, sizes, and materials of branch-circuit conductors. Enclose terminal lugs in terminal box that is sized according to NFPA 70.
- .3 Disconnect Switch: Factory-mounted, fuse type.
- .12 Control Panel Enclosure: NEMA 250, Type 1, with access panel sealed from airflow and mounted on side of unit.
- .13 Control devices shall be compatible with temperature controls system specified in Division 23 Section 23 09 00 "Instrumentation and Control for HVAC."
 - .1 Electric Damper Actuator: 24 V, powered open, spring return.
 - .2 Pneumatic Damper Operator: 0- to 13-psig (0- to 90-kPa) spring range.
 - .3 Electronic Damper Actuator: 24 V, powered open, spring return.
 - .4 Electric Thermostat: Wall-mounted electronic type with clock display, temperature display in Fahrenheit and Celsius, and space temperature set point.
 - .5 Pneumatic Thermostat: Wall-mounted pneumatic type direct acting with appropriate mounting hardware.
 - .6 Electronic Thermostat: Wall-mounted electronic type with temperature set-point display in Fahrenheit and Celsius.
 - .7 Pneumatic Velocity Controller: Factory calibrated and field adjustable to minimum and maximum air volumes; shall maintain constant airflow dictated by thermostat within 5 percent of set point while compensating for inlet static-pressure variations up to 4-inch wg (1000 Pa); and shall have a multipoint velocity sensor at air inlet.
 - .8 Electronic Velocity Controller: Factory calibrated and field adjustable to minimum and maximum air volumes; shall maintain constant airflow dictated by thermostat within 5 percent of set point while compensating for inlet static-pressure variations up to 4-inch wg (1000 Pa); and shall have a multipoint velocity sensor at air inlet.
 - .9 Terminal Unit Controller: Pressure-independent, VAV controller with electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes, and having the following features:
- .14 Control Sequence:
 - .1 Occupied (Primary Airflow On):
 - .1 Operate as throttling control for cooling.
 - .2 As cooling requirement decreases, control valve throttles toward minimum airflow.
 - .3 As heating requirement increases, fan energizes to draw in warm plenum air and electric heat is energized in steps.
 - .2 Unoccupied (Primary Airflow Off):
 - .1 When pressure at primary inlet is zero or less, fan is de-energized.
 - .2 As heating requirement increases, fan energizes to draw in warm plenum air and electric heat is energized in steps.

2.5 SERIES FAN-POWERED AIR TERMINAL UNITS

- .1 Manufacturers:
 - .1 Nailor Industries.
 - .2 Price Industries.
 - .3 Titus.
 - .4 Trane.
 - .5 Tuttle & Bailey.

- .2 Configuration: Volume-damper assembly and fan in series arrangement inside unit casing with control components inside a protective metal shroud for installation above a ceiling.
 - .1 Designed for quiet operation.
 - .2 Low-profile design.
- .3 Casing: 0.034-inch- (0.85-mm-) thick galvanized steel, single wall.
 - .1 Casing Liner: Comply with requirements in "Casing Liner" Article for fibrous-glass duct liner.
 - .2 Air Inlets: Round stub connections or S-slip and drive connections for duct attachment.
 - .3 Air Outlet: S-slip and drive connections.
 - .4 Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket and quarter-turn latches.
 - .5 Fan: Forward-curved centrifugal.
 - .6 Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE Std 62.1.
- .4 Volume Damper: Galvanized steel with flow-sensing ring and peripheral gasket and self-lubricating bearings.
 - .1 Maximum Damper Leakage: AHRI 880 (I-P) rated, 2 percent of nominal airflow at 3-inch wg (750-Pa) inlet static pressure.
 - .2 Damper Position: Normally open.
- .5 Velocity Sensors: Multipoint array with velocity sensors in air inlets and air outlets.
- .6 Motor:
 - .1 Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Division 20 Section 20 05 13 "Common Motor Requirements for Mechanical Equipment."
 - .2 Type: Permanent-split capacitor with SCR for speed adjustment.
 - .3 Fan-Motor Assembly Isolation: Rubber isolators.
 - .4 Enclosure: Open dripproof.
 - .5 Enclosure Materials: Cast iron.
 - .6 Motor Bearings: .
 - .7 Unusual Service Conditions:
 - .1 Ambient Temperature: .
 - .2 Altitude: above sea level.
 - .3 High humidity.
 - .8 Efficiency: Premium efficient.
 - .9 NEMA Design: .
 - .10 Service Factor: .
 - .11 Motor Speed: Single speed.
 - .1 Speed Control: Infinitely adjustable with pneumatic-electric and electronic controls.
 - .12 Electrical Characteristics:
 - .1 Horsepower: .
 - .2 Volts: 120.
 - .3 Phase: Single.
 - .4 Hertz: 60.

- .5 Full-Load Amperes: .
- .6 Minimum Circuit Ampacity: .
- .7 Maximum Overcurrent Protection: .
- .7 Filters: Minimum arrestance according to ASHRAE Std 52.1 and a minimum efficiency reporting value (MERV) according to ASHRAE Std 52.2.
 - .1 Material: Polyurethane foam having 70 percent arrestance and 3 MERV.
 - .2 Material: Glass fiber treated with adhesive; having 80 percent arrestance and 5 MERV.
 - .3 Material: Pleated cotton-polyester media having 90 percent arrestance and 7 MERV.
 - .4 Thickness: 2 inches (50 mm).
- .8 Attenuator Section: 0.034-inch (0.85-mm) galvanized steel sheet.
 - .1 Attenuator Section Liner: Comply with requirements in "Casing Liner" Article for fibrous-glass duct liner.
 - .2 Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE Std 62.1.
- .9 Hydronic Heating Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm), and rated for a minimum working pressure of 200 psig (1380 kPa) and a maximum entering-water temperature of 220 deg F (104 deg C). Include manual air vent and drain valve.
- .10 Electric-Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with primary automatic, and secondary manual, reset thermal cutouts. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware.
 - .1 Stage(s): 1.
 - .2 SCR controlled.
 - .3 Access door interlocked disconnect switch.
 - .4 Downstream air temperature sensor with local connection to override discharge-air temperature to not exceed a maximum temperature set point (adjustable).
 - .5 Nickel chrome 80/20 heating elements.
 - .6 Airflow switch for proof of airflow.
 - .7 Fan interlock contacts.
 - .8 Fuses in terminal box for overcurrent protection (for coils more than 48 A).
 - .9 Mercury contactors.
 - .10 Pneumatic-electric switches and relays.
 - .11 Magnetic contactor for each step of control (for three-phase coils).
- .11 Factory-Mounted and -Wired Controls: Electrical components mounted in control box with removable cover. Incorporate single-point electrical connection to power source.
 - .1 Control Transformer: Factory mounted for control voltage on electric and electronic control units with terminal strip in control box for field wiring of thermostat and power source.
 - .2 Wiring Terminations: Fan and controls to terminal strip. Terminal lugs to match quantities, sizes, and materials of branch-circuit conductors. Enclose terminal lugs in terminal box that is sized according to NFPA 70.
 - .3 Disconnect Switch: Factory-mounted, fuse type.
- .12 Control Panel Enclosure: NEMA 250, Type 1, with access panel sealed from airflow and mounted on side of unit.

- .13 Control devices shall be compatible with temperature controls system specified in Division 23 Section 23 09 00 "Instrumentation and Control for HVAC."
 - .1 Electric Damper Actuator: 24 V, powered open, spring return.
 - .2 Pneumatic Damper Operator: 0- to 13-psig (0- to 90-kPa) spring range.
 - .3 Electronic Damper Actuator: 24 V, powered open, spring return.
 - .4 Electric Thermostat: Wall-mounted electronic type with clock display, temperature display in Fahrenheit and Celsius, and space temperature set point.
 - .5 Pneumatic Thermostat: Wall-mounted pneumatic type direct acting with appropriate mounting hardware.
 - .6 Electronic Thermostat: Wall-mounted electronic type with temperature set-point display in Fahrenheit and Celsius.
 - .7 Pneumatic Velocity Controller: Factory calibrated and field adjustable to minimum and maximum air volumes; shall maintain constant airflow dictated by thermostat within 5 percent of set point while compensating for inlet static-pressure variations up to 4-inch wg (1000 Pa); and shall have a multipoint velocity sensor at air inlet.
 - .8 Electronic Velocity Controller: Factory calibrated and field adjustable to minimum and maximum air volumes; shall maintain constant airflow dictated by thermostat within 5 percent of set point while compensating for inlet static-pressure variations up to 4-inch wg (1000 Pa); and shall have a multipoint velocity sensor at air inlet.
 - .9 Terminal Unit Controller: Pressure-independent, VAV controller with electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes, and having the following features:
- .14 Control Sequence:
 - .1 Occupied (Primary Airflow On):
 - .1 Operate as throttling control for cooling.
 - .2 As cooling requirement decreases, control valve throttles toward minimum airflow.
 - .3 As heating requirement increases, fan energizes to draw in warm plenum air and electric heat is energized in steps.
 - .2 Unoccupied (Primary Airflow Off):
 - .1 When externally initiated, begin the morning warm-up/cool-down function. Damper drives to the fully open position without regard for the preset maximum.
 - .2 When pressure at primary inlet is zero or less, fan is de-energized.
 - .3 As heating requirement increases, fan energizes to draw in warm plenum air and electric heat is energized in steps.

2.6 DUAL-DUCT AIR TERMINAL UNITS

- .1 Manufacturers:
 - .1 Nailor Industries.
 - .2 Price Industries.
 - .3 Titus.
 - .4 Trane.
 - .5 Tuttle & Bailey.
- .2 Configuration: Mixing with two volume dampers inside unit casing with mixing attenuator section and control components inside a protective metal shroud with a third primary air inlet with volume damper.
- .3 Casing: 0.034-inch- (0.85-mm-) thick galvanized steel, single wall.

- .1 Casing Liner: Comply with requirements in "Casing Liner" Article for fibrous-glass duct liner.
- .2 Air Inlets: Round stub connections or S-slip and drive connections for duct attachment.
- .3 Air Outlet: S-slip and drive connections.
- .4 Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.
- .5 Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE Std 62.1.
- .4 Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
 - .1 Maximum Damper Leakage: AHRI 880 (I-P) rated, 3 percent of nominal airflow at 3-inch wg (750-Pa) inlet static pressure.
 - .2 Damper Position: Normally open.
- .5 Velocity Sensors: Multipoint array with velocity sensors in air inlets and air outlets.
- .6 Attenuator Section: 0.034-inch (0.85-mm) galvanized steel sheet.
 - .1 Attenuator Section Liner: Comply with requirements in "Casing Liner" Article for fibrous-glass duct liner.
 - .2 Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE Std 62.1.
- .7 Multioutlet Attenuator Section: With two diameter collars, each with locking butterfly balancing damper.
 - .1 Attenuator Section Liner: Comply with requirements in "Casing Liner" Article for fibrous-glass duct liner.
- .8 Control devices shall be compatible with temperature controls system specified in Division 23 Section 23 09 00 "Instrumentation and Control for HVAC."
 - .1 Electric Damper Actuator: 24 V, powered open, spring return.
 - .2 Pneumatic Damper Operator: 0- to 13-psig (0- to 90-kPa) spring range.
 - .3 Electronic Damper Actuator: 24 V, powered open, spring return.
 - .4 Electric Thermostat: Wall-mounted electronic type with clock display, temperature display in Fahrenheit and Celsius, and space temperature set point.
 - .5 Pneumatic Thermostat: Wall-mounted pneumatic type with appropriate mounting hardware.
 - .6 Electronic Thermostat: Wall-mounted electronic type with temperature set-point display in Fahrenheit and Celsius.
 - .7 Pneumatic Velocity Controller: Factory calibrated and field adjustable to minimum and maximum air volumes; shall maintain constant airflow dictated by thermostat within 5 percent of set point while compensating for inlet static-pressure variations up to 4-inch wg (1000 Pa); and shall have a multipoint velocity sensor at air inlet.
 - .8 Electronic Velocity Controller: Factory calibrated and field adjustable to minimum and maximum air volumes; shall maintain constant airflow dictated by thermostat within 5 percent of set point while compensating for inlet static-pressure variations up to 4-inch wg (1000 Pa) ; and shall have a multipoint velocity sensor at air inlet.
 - .9 Terminal Unit Controller: Pressure-independent, VAV controller with electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes, and having the following features:
- .9 Control Sequence:
 - .1 System modulates VAV damper and dual-duct damper. Room sensor reports temperature.

- .2 When Space Temperature Is below Set Point: Close VAV damper, open hot-deck dampers and close cold-deck dampers, then open VAV damper.
- .3 When Space Temperature Is above Set Point: Close VAV damper, close hot-deck dampers and open cold-deck dampers, then open VAV damper.
- .4 Occupancy sensor reports occupancy and enables occupied temperature set point.
- .5 Occupancy sensor switches set point from occupied setting to unoccupied setting.

2.7 DIFFUSER-TYPE AIR TERMINAL UNITS

- .1 Manufacturers:
 - .1 Carnes Company.
 - .2 Jackson Systems.
 - .3 Rickard Air Diffusion.
 - .4 Warren Technologies.
- .2 Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
- .3 Diffuser: Galvanized steel with white baked-enamel finish.
- .4 Control Sequence: Diffusion dampers open and close to regulate airflow into the room in response to room temperature. The dampers are mechanically actuated by internal, factory-set thermal element thermostats with limited field adjustment.

2.8 BALANCING AIR TERMINAL UNITS

- .1 Manufacturers:
 - .1 Price Industries.
 - .2 Titus.
- .2 Configuration: Manually operated volume-damper assembly with locking mechanism inside unit casing with multipoint, center-averaging velocity sensors for installation above a ceiling.
- .3 Casing: 0.034-inch- (0.85-mm-) thick galvanized steel, single wall.
 - .1 Leakage: Maximum 2 percent of nominal airflow at 3-inch wg (750-Pa) static pressure.
 - .2 Air Inlet: Round stub connection for duct attachment.
 - .3 Air Outlet: S-slip and drive connections.
 - .4 Casing Liner: Comply with requirements in "Casing Liner" Article for fibrous-glass duct liner.
 - .5 Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE Std 62.1.
- .4 Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
 - .1 Maximum Damper Leakage: AHRI 880 (I-P) rated, 2 percent of nominal airflow at 3-inch wg (750-Pa) inlet static pressure.
- .5 Direct Digital Controls: Single-package unitary controller and actuator specified in Division 23 Section 23 09 00 "Instrumentation and Control for HVAC."

2.9 PRESSURE CONTROL AIR TERMINAL UNITS

- .1 Manufacturers:
 - .1 Carnes Company.
 - .2 Carrier Corporation.
 - .3 Price Industries.
 - .4 Titus.
- .2 Configuration: Volume damper assembly inside unit casing with control components inside a protective metal shroud.

- .3 Casing: 0.034-inch- (0.85-mm-) thick galvanized steel, single wall.
 - .1 Casing Liner: Comply with requirements in "Casing Liner" Article for fibrous-glass duct liner.
 - .2 Air Inlet: Round stub connection for duct attachment.
 - .3 Air Outlet: S-slip and drive connections.
 - .4 Access: Removable panels for access to diverting damper and other parts requiring service, adjustment, or maintenance; with airtight gasket.
 - .5 Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE Std 62.1.
- .4 Diverter Assembly: Galvanized-steel gate, with polyethylene linear bearings .
- .5 Multioutlet Attenuator Section: With two diameter collars, each with locking butterfly balancing damper.
 - .1 Attenuator Section Liner: Comply with requirements in "Casing Liner" Article for fibrous-glass duct liner.
- .6 Electronic Controls: Bidirectional damper operator and microprocessor-based thermostat. Control devices shall be compatible with temperature controls specified in Division 23 Section 23 09 00 "Instrumentation and Control for HVAC" and shall have the following features:
 - .1 Static pressure tap for field installation.
 - .2 Adjustable control module.
- .7 Direct Digital Controls: Single-package unitary controller and actuator specified in Division 23 Section 23 09 00 "Instrumentation and Control for HVAC".
- .8 Control Sequence:
 - .1 Under the control of a static pressure sensor, damper opens or closes to maintain static pressure downstream branch duct.

2.10 CRITICAL ENVIRONMENT CONTROL VALVE

- .1 Manufacturers:
 - .1 Price Industries.
- .2 Configuration: Volume damper assembly inside an externally insulated unit casing with control components inside a protective metal shroud.
- .3 Casing:
 - .1 Type 316 stainless steel, 0.0375 inch (0.95 mm), with continuously welded seams.
 - .2 Aluminum.
 - .3 Galvanized steel.
 - .4 Casing Liner: Comply with requirements in "Casing Liner" Article for fibrous-glass duct liner.
- .4 Sensors: Multipoint, Type 316 stainless steel, removable.
- .5 Hydronic Heating Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm) , and rated for a minimum working pressure of 200 psig (1380 kPa) and a maximum entering-water temperature of 220 deg F (104 deg C). Include manual air vent and drain valve.
- .6 Electric-Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with primary automatic, and secondary manual, reset thermal cutouts. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware.
 - .1 Stage(s): 1.

- .2 SCR controlled.
- .3 Access door interlocked disconnect switch.
- .4 Downstream air temperature sensor with local connection to override discharge-air temperature to not exceed a maximum temperature set point (adjustable).
- .7 Control Sequence:
 - .1 Occupied (Primary Airflow On):
 - .1 Operate as throttling control for cooling.
 - .2 As cooling requirement decreases, control valve throttles toward minimum airflow.
 - .3 As heating requirement increases, fan energizes to draw in warm plenum air and electric heat is energized in steps.
 - .2 Unoccupied (Primary Airflow Off):
 - .1 When externally initiated, begin the morning warm-up/cool-down function. Damper drives to the fully open position without regard for the preset maximum.
 - .2 When pressure at primary inlet is zero or less, fan is de-energized.
 - .3 As heating requirement increases, fan energizes to draw in warm plenum air and electric heat is energized in steps.

2.11 EXHAUST SINGLE DUCT TERMINAL

- .1 Manufacturers:
 - .1 Anemostat.
 - .2 Carnes Company.
 - .3 Environmental Technologies.
 - .4 Krueger.
 - .5 METALAIRE.
 - .6 Nailor Industries.
 - .7 Phoenix Controls Corporation.
 - .8 Price Industries.
 - .9 Titus.
 - .10 Trane.
 - .11 Trox USA.
 - .12 Tuttle & Bailey.
 - .13 Warren Technologies.
- .2 Configuration: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.
- .3 Casing: 0.034-inch- (0.85-mm-) thick galvanized steel, single wall. Casing includes removable aluminum linear grille and plenum.
 - .1 Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
 - .2 Air Outlet: S-slip and drive connections, size matching inlet size.
 - .3 Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.
 - .4 Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE Std 62.1.
- .4 Regulator Assembly: System-air-powered bellows section incorporating polypropylene bellows for volume regulation and thermostatic control. Bellows shall operate at temperatures from zero to 140 deg F (minus 18 to plus 60 deg C), shall be impervious to

- moisture and fungus, shall be suitable for 10-inch wg (2500-Pa) static pressure, and shall be factory tested for leaks.
- .5 Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
 - .1 Maximum Damper Leakage: AHRI 880 (I-P) rated, 2 percent of nominal airflow at 3-inch wg (750-Pa) inlet static pressure.
 - .2 Damper Position: Normally open.
 - .6 Attenuator Section: 0.034-inch (0.85-mm) galvanized steel sheet.
 - .1 Casing Liner: Comply with requirements in "Casing Liner" Article for fibrous-glass duct liner.
 - .7 Multioutlet Attenuator Section: With two diameter collars, each with locking butterfly balancing damper.
 - .1 Attenuator Section Liner: Comply with requirements in "Casing Liner" Article for fibrous-glass duct liner.
 - .8 Electric Controls: Damper actuator and thermostat.
 - .1 Damper Actuator: 24 V, powered open, spring return.
 - .2 Thermostat: Wall-mounted electronic type with clock display, temperature display in Fahrenheit and Celsius, and space temperature set point.
 - .9 Electronic Controls: Bidirectional damper operator and microprocessor-based thermostat with integral airflow transducer and room sensor. Control devices shall be compatible with temperature controls specified in Division 23 Section 23 09 00 "Instrumentation and Control for HVAC" and shall have the following features:
 - .1 Damper Actuator: 24 V, powered open, spring return.
 - .2 Velocity Controller: Factory calibrated and field adjustable to minimum and maximum air volumes; shall maintain constant airflow dictated by thermostat within 5 percent of set point while compensating for inlet static-pressure variations up to 4-inch wg (1000 Pa); and shall have a multipoint velocity sensor at air inlet.
 - .3 Thermostat: Wall-mounted electronic type with temperature set-point display in Fahrenheit and Celsius.
 - .10 Direct Digital Controls: Single-package unitary controller and actuator specified in Division 23 Section 23 09 00 "Instrumentation and Control for HVAC".
 - .11 Direct Digital Controls: Bidirectional damper operators and microprocessor-based controller and room sensor. Control devices shall be compatible with temperature controls specified in Division 23 Section 23 09 00 "Instrumentation and Control for HVAC" and shall have the following features:
 - .1 Damper Actuator: 24 V, powered open, spring return.
 - .2 Terminal Unit Controller: Pressure-independent, VAV controller with electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes, and having the following features:
 - .1 Occupied and unoccupied operating mode.
 - .2 Remote reset of airflow or temperature set points.
 - .3 Adjusting and monitoring with portable terminal.
 - .4 Communication with temperature-control system specified in Division 23 Section 23 09 00 "Instrumentation and Control for HVAC".
 - .3 Pressure Sensor: Duct mounted with pressure set-point adjustment and access for connection of portable operator terminal .
 - .12 Controls:
 - .1 Suitable for operation with duct pressures between 0.25- and 3.0-inch wg (60- and 750-Pa) inlet static pressure.

- .2 System-powered, wall-mounted thermostat.
- .13 Control Sequence:
 - .1 Damper blade opens or closes to maintain differential pressure set point in response to upstream and downstream differential pressure sensors.

2.12 CASING LINER

- .1 Casing Liner: Fibrous-glass duct liner, complying with ASTM C1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
 - .1 Minimum Thickness: 3/4 inch (19 mm).
 - .1 Maximum Thermal Conductivity:
 - .1 Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F (0.039 W/m x K) at 75 deg F (24 deg C) mean temperature.
 - .2 Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F (0.033 W/m x K) at 75 deg F (24 deg C) mean temperature.
 - .2 Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
 - .3 Solvent-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C916.
 - .1 Adhesive VOC Content: 80 g/L or less.
 - .2 Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
 - .2 Casing Liner: Flexible elastomeric duct liner fabricated of preformed, cellular, closed-cell, sheet materials complying with ASTM C534/C534M, Type II, Grade 1; and with NFPA 90A or NFPA 90B.
 - .1 Minimum Thickness: 3/4 inch (19 mm).
 - .2 Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723 ; certified by an NRTL.
 - .3 Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
 - .1 Adhesive VOC Content: 50 g/L or less.
 - .2 Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

PART 3 EXECUTION

3.1 INSTALLATION

- .1 Hangers and Support
 - .1 Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 5, "Hangers and Supports" and with Division 20 Section 20 05 29 "Hangers and Supports."
 - .2 Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

- .1 Where practical, install concrete inserts before placing concrete.
- .2 Install powder-actuated concrete fasteners after concrete is placed and completely cured.
- .3 Use powder-actuated concrete fasteners for standard-weight aggregate concretes and for slabs more than 4 inches (100 mm) thick.
- .4 Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes and for slabs less than 4 inches (100 mm) thick.
- .5 Do not use powder-actuated concrete fasteners for seismic restraints.
- .3 Hangers Exposed to View: Threaded rod and angle or channel supports.
- .4 Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- .2 Seismic-Restraint-Device
 - .1 Install hangers and braces designed to support the air terminal units and to restrain against seismic forces required by applicable building codes. Comply with SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems." Comply with requirements for seismic-restraint devices in Division 20 Section 20 05 48 "Vibration and Seismic Controls."
 - .2 Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.
 - .3 Install cables so they do not bend across edges of adjacent equipment or building structure.
 - .4 Install cable restraints on air terminal units that are suspended with vibration isolators.
 - .5 Install seismic-restraint devices using methods approved by an evaluation service member of the ICC Evaluation Service.
 - .6 Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.
 - .7 Drilling for and Setting Anchors:
 - .1 Identify position of reinforcing steel and other embedded items before drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify Architect if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
 - .2 Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 - .3 Wedge Anchors: Protect threads from damage during anchor installation. Install heavy-duty sleeve anchors with sleeve fully engaged in the structural element to which anchor is to be fastened.
 - .4 Set anchors to manufacturer's recommended torque, using a torque wrench.
 - .5 Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.
- .3 Terminal Unit
 - .1 Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."
 - .2 Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.
 - .3 Install wall-mounted thermostats.

3.2 CONNECTIONS

- .1 Piping Connections
 - .1 Where installing piping adjacent to air terminal unit, allow space for service and maintenance.
 - .2 Hot-Water Piping: Comply with requirements in Division 23 Section 23 21 13 "Hydronic Piping" and Division 23 Section 23 21 16 "Hydronic Piping Specialties," and connect heating coils to supply with shutoff valve, strainer, control valve, and union or flange; and to return with balancing valve and union or flange.
- .2 Duct Connections
 - .1 Make connections to air terminal units with flexible connectors

3.3 FIELD QUALITY CONTROL

- .1 Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- .2 Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - .1 After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
 - .2 Leak Test: After installation, fill water coils 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.
- .3 Air terminal unit will be considered defective if it does not pass tests and inspections.
- .4 Prepare test and inspection reports.

3.4 START UP SERVICE

- .1 Engage a factory-authorized service representative to perform startup service.
 - .1 Complete installation and startup checks according to manufacturer's written instructions.
 - .2 Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
 - .3 Verify that controls and control enclosure are accessible.
 - .4 Verify that control connections are complete.
 - .5 Verify that nameplate and identification tag are visible.
 - .6 Verify that controls respond to inputs as specified.

3.5 IDENTIFICATION

- .1 Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Division 20 Section 20 05 53 "Mechanical Identification" for equipment labels and warning signs and labels.

3.6 DEMONSTRATION AND TRAINING

- .1 Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air terminal units.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- .1 General Grilles, Registers and Diffusers
 - .1 Round Ceiling Diffusers.
 - .2 Rectangular Ceiling Diffusers.
 - .3 Perforated Face Ceiling Diffusers.
 - .4 Duct-Mounted Supply And Return Registers/Louvers.
 - .5 Ceiling Supply Registers/Grilles.
 - .6 Ceiling Exhaust And Return Registers/Grilles.
 - .7 Ceiling Linear Exhaust And Return Grilles.
 - .8 Ceiling Egg Crate Exhaust And Return Grilles.
 - .9 Door Grilles.

1.2 GENERAL REFERENCES

- .1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.
- .2 Division 20, including all Common Mechanical Requirements in Section 20 00 00, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.

1.3 RELATED REQUIREMENTS

- .1 Section 09 91 23 - Interior Painting: Painting of ducts visible behind outlets and inlets.

1.4 SUBMITTALS

- .1 Action Submittals
 - .1 Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.
- .2 Record Documents
 - .1 Record actual locations of air outlets and inlets.

1.5 QUALITY ASSURANCE

- .1 Test and rate air outlet and inlet performance in accordance with ASHRAE Std 70.
- .2 Test and rate louver performance in accordance with AMCA 500-L.

1.6 MOCK-UPS AND SAMPLES

- .1 Samples: Submit two of each required air outlet and inlet type.
- .2 Provide mock-up of typical exterior ceiling module with supply and return air outlets.
- .3 Locate where directed.
- .4 Mock-up may remain as part of the Work.

PART 2 PRODUCTS

2.1 GENERAL GRILLES, REGISTERS AND DIFFUSERS

- .1 Manufacturers

- .1 American Louver Company
- .2 Carnes
- .3 EHG
- .4 Krueger
- .5 Linx Industries
- .6 Metalaire
- .7 Price Industries
- .8 Prihoda
- .9 Ruskin
- .10 Titus
- .11 Tuttle and Bailey
- .2 Round Ceiling Diffusers
 - .1 Type: Round, adjustable pattern, stamped or spun, multicore diffuser to discharge air in 360-degree pattern, with sectorizing baffles where indicated. Project diffuser collar not more than 1 inch (25 mm) above ceiling. In plaster ceilings, provide plaster ring and ceiling plaque.
 - .2 Fabrication: Steel with baked enamel finish.
 - .3 Color: As indicated.
 - .4 Color: As selected by Architect from manufacturer's standard range.
 - .5 Accessories: Radial opposed blade damper and multi-louvered equalizing grid with damper adjustable from diffuser face.
- .3 Rectangular Ceiling Diffusers
 - .1 Type: Provide rectangular and square formed adjustable, backpan stamped, core removable, and multi-louvered ceiling diffusers constructed to maintain 360 degree discharge air pattern with sectorizing baffles where indicated.
 - .2 Devices shall be designed for variable.
 - .3 Connections: Round.
 - .4 Frame: Provide surface mount, snap-in, inverted T-bar, and spline type. In plaster ceilings, provide plaster frame and ceiling frame.
 - .5 Fabrication: Steel with baked enamel finish.
 - .6 Color: As indicated.
 - .7 Color: As selected by Architect from manufacturer's standard range.
 - .8 Accessories: Provide radial opposed blade, butterfly, and combination splitter volume control damper; removable core, sectorizing baffle, safety chain, wire guard, equalizing grid, operating rod extension, anti-smudging device, and gaskets for surface mounted diffusers with damper adjustable from diffuser face.
- .4 Perforated Face Ceiling Diffusers
- .5 Duct-Mounted Supply and Return Registers/Louvers
 - .1 Type: Duct-mounted, rectangular register for round-spiral duct with adjustable pivot-ended blades, end caps, built-in volume damper, and dual cover flanges to lay flush on duct surface regardless of diameter. Performance to match manufacturer's catalog data.
 - .2 Material: 22 gauge, 0.0299 inch (0.76 mm).
 - .1 Provide crossing spiral fitting-body of matching duct diameter.
 - .3 Color: As indicated on drawings.
- .6 Ceiling Supply Registers/Grilles

- .1 Type: Streamlined and individually adjustable curved blades to discharge air along face of grille, one-way deflection.
- .2 Frame: 1-1/4 inch (32 mm) margin with countersunk screw mounting and gasket.
- .3 Construction: Made of aluminum extrusions with factory enamel finish.
- .4 Construction: Made of stainless steel.
- .5 Color: As indicated.
- .6 Color: As selected by Architect from manufacturer's standard range.
- .7 Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face.
- .7 Ceiling Exhaust and Return Registers/Grilles
 - .1 Type: Streamlined blades, 3/4 inch (19 mm) minimum depth, 3/4 inch (19 mm) maximum spacing, with blades set at 45 degrees, vertical face.
 - .2 Frame: 1-1/4 inch (32 mm) margin with countersunk screw mounting.
 - .3 Fabrication: Steel with 20 gauge, 0.0359 inch (0.91 mm) minimum frames and 22 gauge, 0.0299 inch (0.76 mm) minimum blades, steel and aluminum with 20 gauge, 0.0359 inch (0.91 mm) minimum frame, or aluminum extrusions, with factory baked enamel finish.
 - .4 Fabrication: Stainless steel with 20 gauge, 0.0359 inch (0.91 mm) minimum frames and 22 gauge, 0.0299 inch (0.76 mm) minimum blades, steel and aluminum with 20 gauge, 0.0359 inch (0.91 mm) minimum frame.
 - .5 Color: As indicated.
 - .6 Color: To be selected by Architect from manufacturer's standard range.
 - .7 Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face where not individually connected to exhaust fans.
 - .8 Gymnasiums: Provide front pivoted or welded in place blades, securely fastened to be immobile.
- .8 Ceiling Linear Exhaust and Return Grilles
 - .1 Type: Streamlined blades with 90 degree one-way deflection, 1/8 by 3/4 inch (3.2 by 19 mm) on 1/4 inch (6 mm) centers.
 - .2 Frame: 1-1/4 inch (32 mm) margin, extra heavy for floor mounting, with countersunk screw mounting.
 - .3 Fabrication: Steel with 20 gauge, 0.0359 inch (0.91 mm) minimum frames and 22 gauge, 0.0299 inch (0.76 mm) minimum blades, steel and aluminum with 20 gauge, 0.0359 inch (0.91 mm) minimum frame, or aluminum extrusions, with factory baked enamel finish.
 - .4 Color: As indicated.
 - .5 Color: To be selected by Architect from manufacturer's standard range.
 - .6 Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face.
- .9 Ceiling Egg Crate Exhaust and Return Grilles
 - .1 Manufacturers
 - .1 Krueger-HVAC; EGCX: www.krueger-hvac.com/#sle.
 - .2 Titus; 50F
 - .3 Price; Series 80
 - .2 Type: Egg crate style face consisting of 1/2 by 1/2 by 1/2 inch (13 by 13 by 13 mm) grid core.
 - .3 Fabrication: Grid core consists of aluminum with mill aluminum finish.

- .4 Color: To be selected by Architect from manufacturer's standard range.
- .5 Frame: 1-1/4 inch (32 mm) margin with countersunk screw mounting.
- .6 Frame: Channel lay-in frame for suspended grid ceilings.
- .7 Accessories: Provide integral gang and face operated opposed blade damper, 2 inch filter frame (50 mm), plaster frame, square mesh insect screen, square mesh debris screen, prescored molded fiberglass back, and 45 degree angled eggcrate or other similar provisions for visual blocking such as angled louver or 90 degree duct elbow.
- .10 VAV Diffusers
- .11 Door Grilles
 - .1 Type: V-shaped louvers of 20 gauge, 0.0359 inch (0.91 mm) thick steel, 1 inch (25 mm) deep on 1/2 inch (13 mm) centers.
 - .2 Frame: 20 gauge, 0.0359 inch (0.91 mm) steel with auxiliary frame to give finished appearance on both sides of door, with factory prime coat finish.
- .12 High Capacity Drum Louver Diffusers
 - .1 Type: Rotatable 60-degrees (30-degrees up or down)
 - .2 Frame: 1-1/4 inch (32 mm) heavy margin frame with countersunk screw mounting, and mounting frame.
 - .3 Fabrication: Heavy gauge aluminum extrusions with factory baked enamel finish.
 - .4 Color: White.
 - .5 The finish shall be an anodic acrylic paint, baked at 315°F for 30 minutes. The pencil hardness must be HB to H. The paint must pass a 100-hour ASTM B117 Corrosive Environments Salt Spray Test without creepage, blistering or deterioration of film. The paint must pass a 250-hour ASTM D870 Water Immersion Test. The paint must also pass the ASTM D2794 Reverse Impact Cracking Test with a 50-inch pound force applied.
 - .6 Damper: Integral gang-operated opposed blade damper with removable key operator, operable from face or air scoop or motorized operation
 - .7 Blades: Airfoil, individually adjusted horizontally

PART 3 EXECUTION

3.1 INSTALLATION

- .1 Install in accordance with manufacturer's instructions.
- .2 Comply with SMACNA (ASMM) for flashing/counter-flashing of roof penetrations and supports for roof curbs and roof mounted equipment.
- .3 Check location of outlets and inlets and make necessary adjustments in position to comply with architectural features, symmetry, and lighting arrangement.
- .4 Install diffusers to ductwork with air tight connection.
- .5 Provide balancing dampers on duct take-off to diffusers and grilles and registers, despite whether dampers are specified as part of diffuser, or grille and register assembly.
- .6 Paint ductwork visible behind air outlets and inlets matte black, see Section 09 91 23.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- .1 Hydronic Radiant Heating and Cooling Panels.
- .2 Electric Radiant Heaters.

1.2 GENERAL REFERENCES

- .1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.
- .2 Division 20, including all Common Mechanical Requirements in Section 20 00 00, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.

1.3 SUBMITTALS

- .1 Action Submittals
 - .1 Product Data: Include rated capacities, specialties, and accessories for each product indicated.
 - .2 Shop Drawings:
 - .1 Include plans, elevations, sections, details, and attachments to other work. Detail equipment assemblies and suspension and attachment.
 - .2 Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - .3 Include diagrams for power, signal, and control wiring.
 - .3 Field quality-control reports.
- .2 Informational Submittals
 - .1 Seismic Qualification Certificates: Submit certification that suspended radiant heaters and panels, accessories, and components will withstand seismic forces defined in Division 20 Section "Vibration and Seismic Controls for Piping and Equipment." Include the following:
 - .1 Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - .1 The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 - .2 Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - .3 Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- .3 Operation and Maintenance Materials
 - .1 For electric radiant heaters to include in emergency, operation, and maintenance manuals.

1.4 MOCK-UPS AND SAMPLES

- .1 Samples for Initial Selection: For units with factory-applied color finishes.
- .2 Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.

- .3 Radiant Heater Finishes: 4/4 inch (100/100 mm).
- .1 Radiant Panel Finishes: 12/12 inch (300/300 mm).

1.5 COORDINATION

- .1 Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - .1 Suspended ceiling components.
 - .2 Structural members to which heaters and suspension systems will be attached.
 - .3 Size and location of initial access modules for acoustical tile.
 - .4 Items penetrating finished ceiling, including the following:
 - .1 Lighting fixtures.
 - .2 Air outlets and inlets.
 - .3 Speakers.
 - .4 Sprinklers.
 - .5 Access panels.
 - .5 Perimeter moldings.

PART 2 PRODUCTS

2.1 HYDRONIC RADIANT HEATING AND COOLING PANELS

- .1 Manufacturers:
 - .1 Aero Tech Mfg.
 - .2 AIRTEX Radiant Systems.
 - .3 Sterling.
 - .4 Sun-El Corporation.
- .2 Description: Linear sheet-metal panel with serpentine water piping, suitable for lay-in installation flush with T-bar ceiling grid.
 - .1 Panels: Fluted extruded aluminum, approximately 0.115 inches thick. Furnish blank filler pieces at corners and other locations required to form a continuous line.
 - .2 Panels: Minimum 0.0336-inch- (0.86-mm-) thick, galvanized-steel sheet.
 - .3 Backing Insulation: Minimum 2 inch (50 mm) 1 inch (25 mm) thick, mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C612, Type IA or Type IB with factory-applied jacket.
 - .4 Exposed-Side Panel Finish: Baked-enamel finish in manufacturer's standard paint color as selected by Architect.
 - .5 Exposed-Side Panel Finish: Factory prime coated, ready for field painting.
 - .6 Exposed-Side Panel Finish: Apply silk-screened finish to match appearance of acoustical ceiling tiles selected by Architect.
 - .7 Factory Piping: ASTM B88, Type L (ASTM B88M, Type B) copper tube with ASME B16.22 wrought-copper fittings and brazed joints. Piping shall be mechanically bonded to panel.
 - .8 Surface-Mounted Trim: Sheet metal with baked-enamel finish in manufacturer's standard paint color as selected by Architect.
 - .9 Accessories:
 - .1 5 inch (127 mm) panel with drape track recess.
 - .2 5 inch (127 mm) male bullnose panel.

- .3 5inch (127 mm) female bullnose panel.
- .4 4 inch (102 mm) male corner panel.
- .5 4 inch (102 mm) female corner panel.
- .6 Inside corner panel.
- .7 1/2 inch (13 mm) filler panel.

2.2 ELECTRIC RADIANT HEATERS

- .1 Manufacturers:
 - .1 Berko.
 - .2 Chromalox.
 - .3 Markel Products.
 - .4 QMark.
- .2 Quartz Lamp Heating Elements: Coiled tungsten-wire heating element enclosed in clear quartz tube.
- .3 Quartz Tube Heating Elements: Nickel-chromium-wire heating element enclosed in quartz tube.
- .4 Metal-Sheathed Heating Elements: Nickel-chromium-wire heating element embedded in magnesium oxide powder enclosed in metal sheath. Comply with UL 1030.
- .5 Comply with UL 499.
- .6 Enclosures: Aluminized-steel housing with anodized-aluminum reflector.
 - .1 Finish: Baked-enamel finish in manufacturer's standard paint color as selected by Architect.
- .7 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.
- .8 Unit Controls:
 - .1 Line-voltage thermostat.
 - .2 Enclosed contactor for remote thermostat.
 - .3 Snow and ice detector with moisture sensor and integral temperature sensor.

PART 3 EXECUTION

3.1 EXAMINATION

- .1 Examine areas to receive radiant heating and cooling units for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- .2 Examine roughing-in for hydronic piping connections to verify actual locations before radiant heating and cooling unit installation.
- .3 Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- .1 Install radiant heating and cooling units level and plumb.
- .2 Suspend radiant heaters from structure.
- .3 Coordinate layout and installation of radiant heaters and suspension-system components with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, communications system, security system, and partition assemblies.
- .4 Support for Radiant Heating Panels in or on Grid-Type Suspended Ceilings: Use grid as a support element.

- .1 Install a minimum of four ceiling support-system rods or wires for each panel. Locate not more than 6 inch (150 mm) from panel corners.
- .2 Support Clips: Fasten to panel and to ceiling grid members at or near each panel corner with clips designed for the application.
- .3 Panels of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans, or center in acoustical panel and support panels independently with at least two 3/4 inch (19 mm) metal channels spanning and secured to ceiling tees.
- .4 Install at least one independent support rod or wire from structure to a tab on panel. Wire or rod shall have breaking strength of the weight of panel at a safety factor of three.
- .5 Install devices 48 inch (1220 mm) above finished floor.

3.3 CONNECTIONS

- .1 Piping installation requirements are specified in Division 23 Section 23 21 13 "Hydronic Piping" and Division 23 Section 23 21 16 "Hydronic Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.
- .2 Unless otherwise indicated, install shutoff valve and union or flange at each connection.
- .3 Install piping adjacent to unit to allow service and maintenance.
- .4 Ground electric units according to Division 26 Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- .5 Connect wiring according to Division 26 Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- .1 Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - .1 Operate electric heating elements through each stage to verify proper operation and electrical connections.
 - .2 Test and adjust controls and safeties. Replace damaged and malfunctioning controls and units.
- .2 After installing panels, inspect unit cabinet for damage to finish. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.
- .3 Prepare test and inspection reports.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- .1 Hydronic coils.
- .2 Electric coils.

1.2 GENERAL REFERENCES

- .1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.
- .2 Division 20, including all Common Mechanical Requirements in Section 20 00 00, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.

1.3 RELATED REQUIREMENTS

1.4 SUBMITTALS

- .1 Action Submittals
 - .1 Product Data: Provide coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions.
 - .2 Shop Drawings: Indicate coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions.
- .2 Closeout Submittals
 - .1 Warranty: Submit manufacturer's warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.5 WARRANTIES

- .1 Provide five year manufacturer warranty for _____.

1.6 QUALITY ASSURANCE

- .1 Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
- .2 Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.7 DELIVERY, STORAGE AND HANDLING

- .1 Protect coil fins from crushing and bending by leaving in shipping cases until installation, and by storing indoors.
- .2 Protect coils from entry of dirt and debris with pipe caps or plugs.

PART 2 PRODUCTS

2.1 HYDRONIC COILS

- .1 Manufacturers:
 - .1 Aerofin.
 - .2 Carrier Corporation.
 - .3 Daikin.
 - .4 Greenheck Fan Corporation.
 - .5 Heatcraft Worldwide Refrigeration.
 - .6 Johnson Controls.

- .7 Trane.
- .2 Performance Ratings: Tested and rated according to AHRI 410 and ASHRAE 33.
- .3 Minimum Working-Pressure/Temperature Ratings: 200 psig (1380 kPa) , 325 deg F (163 deg C) .
- .4 Source Quality Control: Factory tested to 300 psig (2070 kPa).
- .5 Tubes: ASTM B743 copper, minimum 0.020 inch (0.508 mm) thick.
- .6 Tubes: ASTM B743 copper, minimum 0.035 inch (0.889 mm) thick.
- .7 Fins: Aluminum, minimum 0.010 inch (0.254 mm) thick.
- .8 Headers: Seamless copper tube with brazed joints, prime coated Cast iron with drain and air vent tapings.
- .9 Frames, Hot Water Coils: Galvanized-steel channel frame, minimum 0.052 inch (1.3 mm) 0.064 inch (1.6 mm) thick for slip-in mounting.
- .10 Frames, Chilled Water Coils: ASTM A666, Type 304 stainless steel, minimum 0.0625 inch (1.6 mm) thick for slip-in mounting.
- .11 Special Coating: Heresite P-403 baked phenolic for coils installed in stainless steel ductwork.
- .12 Hot-Water Coil, Face-and-Bypass Dampers: Alternating arrangement of coil segments and dampers.
 - .1 Coil Configuration: Horizontal tubes.
 - .2 Dampers: Extruded-aluminum blades with edge and end seals; full-length drive rod and mount for actuator in the airstream.

2.2 ELECTRIC COILS

- .1 Manufacturers:
 - .1 Brasch Manufacturing Co.
 - .2 INDEECO.
 - .3 Markel Products Company
 - .4 Trane.
- .2 Coil Assembly: Comply with UL 1995.
- .3 Heating Elements: Coiled resistance wire of 80 percent nickel and 20 percent chromium; surrounded by compacted magnesium-oxide powder in tubular-steel sheath; with spiral-wound, copper-plated, steel fins continuously brazed to sheath.
- .4 Heating Elements: Open-coil resistance wire of 80 percent nickel and 20 percent chromium, supported and insulated by floating ceramic bushings recessed into casing openings, and fastened to supporting brackets.
- .5 High-Temperature Coil Protection: Disk-type, automatically reset, thermal-cutout, safety device; serviceable through terminal box without removing heater from duct or casing.
 - .1 Secondary Protection: Load-carrying, manually reset or manually replaceable, thermal cutouts; factory wired in series with each heater stage.
- .6 Frames: Galvanized-steel channel frame, minimum 0.052 inch (1.3 mm) thick for slip-in mounting.
- .7 Control Panel: Unit mounted with disconnecting means and overcurrent protection. Include the following controls:
 - .1 Magnetic contactor.
 - .2 Mercury contactor.
 - .3 Toggle switches; one per step.
 - .4 Step controller.

- .5 Time-delay relay.
- .6 Pilot lights; one per step.
- .7 Airflow proving switch.
- .8 Refer to Division 23 Division 23 09 00 "Instrumentation and Control for HVAC" for thermostat.
- .9 Thermostats: Wall-mounted thermostats, with temperature range from 50 to 90 deg F (10 to plus 32 deg C), and 2.5 deg F (1.4 deg C) throttling range.
- .10 DRAIN PANS
 - .1 Provide a drain pan under each cooling coil, and where indicated. Provide intermediate drain pans at each level of stacked coils. Drain pans shall capture all condensate from coil assembly; including pipe header, pipe return bends, upstream run-off, and downstream carryover.
 - .2 Drain Pan Construction: 304 stainless steel, self-supporting, sloped in two directions minimum, leak-tight with welded seams. Design, fabricate and install to prevent standing water.
 - .3 Provide rigidly supported, leak tight copper downcomer drains from each intermediate pan to pan below.
 - .4 Above Floor Bottom Pan: Minimum 16 gauge construction. Insulate between pan and floor with 1/2 in. thick flexible closed cell elastomeric insulation. Provide threaded outlet at pan low point.
 - .5 Flexible Closed Cell Elastomeric Drain Pan Insulation: Armacell-Armaflex or equivalent. Composite flame spread / smoke density not to exceed 25/50. Fully adhere to the pan bottom with insulation manufacturer's recommended adhesive.

PART 3 EXECUTION

3.1 EXAMINATION

- .1 Examine ducts, plenums, and casings to receive air coils for compliance with requirements for installation tolerances and other conditions affecting coil performance.
- .2 Examine roughing-in for piping systems to verify actual locations of piping connections before coil installation.
- .3 Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- .1 Install coils level and plumb.
- .2 Install coils in metal ducts and casings constructed according to SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."
- .3 Install stainless-steel drain pan under each cooling coil.
 - .1 Construct drain pans with connection for drain; insulated and complying with ASHRAE Std 62.1.
 - .2 Construct drain pans to extend beyond coil length and width and to connect to condensate trap and drainage.
 - .3 Extend drain pan upstream and downstream from coil face.
 - .4 Extend drain pan under coil headers and exposed supply piping.
- .4 Install moisture eliminators for cooling coils. Extend drain pan under moisture eliminator.
- .5 Straighten bent fins on air coils.
- .6 Clean coils using materials and methods recommended in writing by manufacturers, and clean inside of casings and enclosures to remove dust and debris.

3.3 CONNECTIONS

- .1 Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- .2 Install piping adjacent to coils to allow service and maintenance.
- .3 Connect water piping with unions and shutoff valves to allow coils to be disconnected without draining piping. Control valves are specified in Division 23 Section 23 09 00 "Instrumentation and Control for HVAC," and other piping specialties are specified in Division 23 Section 23 21 13 "Hydronic Piping."
- .4 Connect steam piping with gate valve and union and steam condensate piping with union, strainer, trap, and gate valve to allow coils to be disconnected without draining piping. Control valves are specified in Division 23 Section 23 09 00 Section "Instrumentation and Control for HVAC," and other piping specialties are specified in Division 23 Section 23 22 13 Section "Steam and Condensate Heating Piping."
- .5 Connect refrigerant piping according to Division 23 Section 23 23 00 "Refrigerant Piping."
- .6 Ground equipment according to Division 26 Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- .7 Connect wiring according to Division 26 Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- .1 Perform the following field tests and inspections with the assistance of a factor-authorized service representative:
 - .1 Operational Test: After electrical circuitry has been energized, operate electric coils to confirm proper unit operation.
 - .2 Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- .2 Prepare test and inspection reports.

END OF SECTION

PART 1 GENERAL

1.1 SECTION INCLUDES

- .1 PEX Pipe and Fittings.
- .2 PEX/AL/PEX Pipe and Fittings.
- .3 EDPM Pipe and Fittings.
- .4 Distribution Manifolds.
- .5 Piping Specialties.
- .6 Controls.

1.2 GENERAL REFERENCES

- .1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.
- .2 Division 20, including all Common Mechanical Requirements in Section 20 00 00, apply to this Section. Requirements noted in this Section are supplemental to the requirements of these General References.

1.3 RELATED REQUIREMENTS

1.4 ABBREVIATIONS AND ACRONYMS

- .1 CWP: Cold working pressure.
- .2 PEX: Crosslinked polyethylene.
- .3 PEX/AL/PEX: Crosslinked polyethylene/aluminum/crosslinked polyethylene.
- .4 PTFE: Polytetrafluoroethylene plastic.

1.5 SUBMITTALS

- .1 Action Submittals
 - .1 Product Data: For each type of product.
 - .1 Include data for piping, fittings, manifolds, specialties, and controls; include pressure and temperature ratings, oxygen-barrier performance, fire-performance characteristics, and water-flow and pressure-drop characteristics.
 - .2 Shop Drawings: Show piping layout and details drawn to scale, including valves, manifolds, controls, and support assemblies, and their attachments to building structure.
 - .1 Shop Drawing Scale: 1/4 inch = 1 foot (1:50).
- .2 Operation and Maintenance Materials
 - .1 For radiant-heating piping valves and equipment to include in operation and maintenance manuals.

1.6 COORDINATION

- .1 Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - .1 Suspended ceiling components.
 - .2 Structural members to which radiant-heating piping will be attached.
 - .3 Items penetrating finished ceiling, including the following:
 - .1 Lighting fixtures.

- .2 Air outlets and inlets.
- .3 Speakers.
- .4 Sprinklers.
- .5 Access panels.
- .4 Perimeter moldings.

1.7 SUMMARY DESCRIPTION

- .1 Section includes radiant-heating piping, including pipes, fittings, and piping specialties.

PART 2 PRODUCTS

2.1 PEX PIPE AND FITTINGS

- .1 Manufacturers:
 - .1 FloorHeat Company.
 - .2 Heat Innovations.
 - .3 HeatLink Group.
 - .4 Infloor Radiant Heating.
 - .5 IPEX USA.
 - .6 MrPex Systems.
 - .7 REHAU.
 - .8 Slant/Fin Corp.
 - .9 Uponor.
 - .10 Viega.
 - .11 Warmboard.
 - .12 Watts Radiant.
 - .13 Zurn Industries.
- .2 Pipe Material: PEX plastic according to ASTM F876.
- .3 Oxygen Barrier: Limit oxygen diffusion through the tube to maximum 0.10 mg per cu. m/day at 104 deg F (40 deg C) according to DIN 4726.
- .4 Fittings: ASTM F1807 , metal insert and copper crimp rings.
- .5 Pressure/Temperature Rating: Minimum 100 psig (690 kPa) and 180 deg F (82 deg C) .

2.2 PEX/AL/PEX PIPE AND FITTINGS

- .1 Manufacturers:
 - .1 Heat Innovations.
 - .2 IPEXUSA.
 - .3 Uponor.
 - .4 Viega.
- .2 Pipe Material: PEX plastic bonded to the inside and outside of a welded aluminum tube according to {RS#1172}.
- .3 Oxygen Barrier: Limit oxygen diffusion through the pipe to maximum 0.10 mg per cu. m/day at 104 deg F (40 deg C) according to DIN 4726.
- .4 Fittings: ASTM F1974, metal insert fittings with split ring and compression nut (compression joint) or metal insert fittings with copper crimp rings (crimp joint).
- .5 Flame-Spread and Smoke-Developed Indices: 25 and 50 or less, respectively, tested according to ASTM E84.

- .6 Pressure/Temperature Rating: Minimum 100 psig (690 kPa) and 210 deg F (99 deg C) .

2.3 EPDM PIPE AND FITTINGS

- .1 Manufacturers:
 - .1 Watts Radiant.
- .2 Pipe Material: Crosslinked EPDM inner and outer tubes.
- .3 Wall Thickness: Minimum 0.125 inch (3.2 mm).
- .4 Oxygen Barrier: Ductile aluminum foil layer applied to the inner tube to limit oxygen diffusion through the pipe to maximum 0.10 mg per cu. m/day at 104 deg F (40 deg C) according to DIN 4726.
- .5 Reinforcing Braid: Braided-aluminum wire between the inner and outer tube.
- .6 Fittings: ASTM F1807, copper with stainless-steel crimps or clamps.
- .7 Pressure/Temperature Rating: Minimum 100 psig (690 kPa) and 210 deg F (99 deg C) .

2.4 DISTRIBUTION MANIFOLDS

- .1 Manifold: Minimum NPS 1 (DN 25), brass.
- .2 Main Shutoff Valves:
 - .1 Factory installed on supply and return connections.
 - .2 Two-piece body.
 - .3 Body: Brass or bronze.
 - .4 Ball: Chrome-plated bronze.
 - .5 Seals: PTFE.
 - .6 CWP Rating: 150 psig (1035 kPa)
 - .7 Maximum Operating Temperature: 225 deg F (107 deg C) .
- .3 Manual Air Vents:
 - .1 Body: Bronze.
 - .2 Internal Parts: Nonferrous.
 - .3 Operator: Key furnished with valve, or screwdriver bit.
 - .4 Inlet Connection: NPS 1/2 (DN 15) .
 - .5 Discharge Connection: NPS 1/8 (DN 6) .
 - .6 CWP Rating: 150 psig (1035 kPa) .
 - .7 Maximum Operating Temperature: 225 deg F (107 deg C).
- .4 Balancing Valves:
 - .1 Body: Plastic or bronze, ball or plug, or globe cartridge type.
 - .2 Ball or Plug: Brass or stainless steel.
 - .3 Globe Cartridge and Washer: Brass with EPDM composition washer.
 - .4 Seat: PTFE.
 - .5 Visual Flow Indicator: Flowmeter with visible indication in a clear plastic cap at top of valve.
 - .6 Differential Pressure Gage Connections: Integral seals for portable meter to measure loss across calibrated orifice.
 - .7 Handle Style: Lever or knob, with memory stop to retain set position if used for shutoff.
 - .8 CWP Rating: Minimum 125 psig (860 kPa) .
 - .9 Maximum Operating Temperature: 250 deg F (121 deg C) .

- .5 Zone Control Valves:
 - .1 Body: Plastic or bronze, ball or plug, or globe cartridge type.
 - .2 Ball or Plug: Brass or stainless steel.
 - .3 Globe Cartridge and Washer: Brass with EPDM composition washer.
 - .4 Seat: PTFE.
 - .5 Actuator: Replaceable electric motor.
 - .6 CWP Rating: Minimum 125 psig (860 kPa) .
 - .7 Maximum Operating Temperature: 250 deg F (121 deg C) .
- .6 Thermometers:
 - .1 Mount on supply and return connections.
 - .2 Case: Dry type, metal or plastic, 2 inch (50 mm) diameter.
 - .3 Element: Bourdon tube or other type of pressure element.
 - .4 Movement: Mechanical, connecting element and pointer.
 - .5 Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
 - .6 Pointer: Black metal.
 - .7 Window: Plastic.
 - .8 Connector: Rigid, back type.
 - .9 Thermal System: Liquid- or mercury-filled bulb in copper-plated steel, aluminum, or brass stem.
 - .10 Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.
- .7 Mounting Brackets: Copper, or plastic- or copper-clad steel, where in contact with manifold.

2.5 PIPING SPECIALTIES

- .1 Cable Ties:
 - .1 Fungus-inert, self-extinguishing, one-piece, self-locking, Type 6/6 nylon cable ties.
 - .2 Minimum Width: 1/8 inch (3 mm).
 - .3 Tensile Strength: 20 lb (9 kg) , minimum.
 - .4 Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C) .
- .2 Floor Mounting Staples:
 - .1 Steel, with corrosion-resistant coating and smooth finish without sharp edges.
 - .2 Minimum Thickness: 3/32 inch (2.4 mm).
 - .3 Width: Minimum, wider than tubing.
- .3 Floor Mounting Clamps:
 - .1 Two bolts, steel, with corrosion-resistant coating and smooth finish without sharp edges.
 - .2 Minimum Thickness: 3/32 inch (2.4 mm).
 - .3 Width: Minimum, wider than tubing.
- .4 Floor Mounting Tracks:
 - .1 Aluminum or plastic channel track with smooth finish and no sharp edges.
 - .2 Minimum Thickness: 1/16 inch (1.6 mm).
 - .3 Slot Width: Snap fit to hold tubing.
 - .4 Slot Spacing: 2-inch (50-mm) intervals.
- .5 Channeled Subfloor:

- .1 Plywood, APA-rated subfloor panel, composed of premium, tongue-and-groove, seven-layer, Douglas fir structural subfloor panels.
- .2 Particleboard manufactured to comply with Federal Housing Authority standards of less than 0.3-ppm formaldehyde.
- .3 Clad panel with minimum 0.025 inch (0.635 mm) thick aluminum recessed in the grooves sized to maintain contact with radiant piping.
- .6 Modular Interlocking Blocks:
 - .1 Polypropylene snap-together blocks with grooves to support piping.
 - .2 Galvanized sheet metal or aluminum emission plates.
 - .3 Natural mineralboard cover panel.
- .7 Heat-Emission Plates:
 - .1 Formed aluminum suitable for radiant-heating piping.
 - .2 Minimum Thickness: 1/16 inch (1.6 mm).
 - .3 Slot Width: Snap fit to maintain pressure fit on tubing.

2.6 CONTROLS

- .1 Temperature-control devices and sequence of operations are specified in Division 23 Section 23 09 00 "Instrumentation and Control for HVAC."
- .2 Manufacturers:
 - .1 Danfoss.
 - .2 HeatLink Group.
 - .3 Honeywell Building Solutions.
 - .4 Infloor Radiant Heating.
 - .5 IPEX USA.
 - .6 REHAU.
 - .7 Slant/Fin Corp.
 - .8 Tekmar Control Systems.
 - .9 Uponor.
 - .10 Viega.
 - .11 Watts Radiant.
 - .12 Zurn Industries.
- .3 Wall-Mounted Thermostat:
 - .1 Minimum temperature range from 50 to 90 deg F (10 to 32 deg C) .
 - .2 Manually operated with on-off switch.
 - .3 Day and night setback and clock program with minimum four periods per day.
 - .4 Operate pumps or open zone control valves if room temperature falls below the thermostat setting, and stop pumps or close zone control valves when room temperature rises above the thermostat setting.
- .4 Heated-Panel Thermostat:
 - .1 Remote bulb unit with adjustable temperature range from 50 to 90 deg F (10 to 32 deg C) .
 - .2 Snap action; open-on-rise, single-pole switch with minimum current rating adequate for connected pump or zone control valve.
 - .3 Remote bulb on capillary tube, resistance temperature device, or thermistor for directly sensing radiant-panel temperature.

- .4 Stop pump or close zone control valves if heated-panel thermostat setting is exceeded.
- .5 Corrosion-resistant, waterproof control enclosure.
- .5 Heated-Panel Thermostat with Outdoor Temperature Reset:
 - .1 Remote bulb unit with adjustable temperature range from 50 to 90 deg F (10 to 32 deg C) .
 - .2 Snap action; open-on-rise, single-pole switch with minimum current rating adequate for connected pump or zone control valve.
 - .3 Remote bulb on capillary tube, resistance temperature device, or thermistor for directly sensing radiant-panel and outdoor-air temperature.
 - .4 Operate zone control valves to reset supply-water temperature inversely with outdoor-air temperature as follows:
 - .1 Low outdoor-air temperature, zero deg F (minus 18 deg C) with high supply-water temperature 110 deg F (43 deg C) .
 - .2 High outdoor-air temperature, 60 deg F (16 deg C) with low supply-water temperature 70 deg F (21 deg C) .
 - .5 Corrosion-resistant, waterproof control enclosure.
- .6 Precipitation and Temperature Sensor:
 - .1 Microprocessor-based control with manual on, automatic, and standby/reset switch.
 - .2 Precipitation and temperature sensors shall sense the surface conditions of pavement and shall be programmed to operate pump and zone control valves as follows:
 - .1 Temperature Span: 34 to 44 deg F (1 to 7 deg C) .
 - .2 Adjustable Delay Off Span: 30 to 90 minutes.
 - .3 Start Pump or Open Zone Control Valves: Following two-minute delay if ambient temperature is below set point and precipitation is detected.
 - .4 Stop Pump or Close Zone Control Valves: On detection of a dry surface plus time delay.
 - .3 Corrosion-proof and waterproof enclosure suitable for outdoor mounting, for controls and precipitation and temperature sensors.
 - .4 Minimum 30-A contactor to start pump and open valves.
 - .5 Precipitation sensor shall be mounted in pavement.
 - .6 Provide relay with contacts to indicate operational status, on or off, for interface with central HVAC control-system workstation.

PART 3 EXECUTION

3.1 APPLICATION

- .1 Install the following types of radiant-heating piping for the applications described:
 - .1 Piping in Ceilings: EPDM.

3.2 EXAMINATION

- .1 Examine surfaces and substrates to receive radiant-heating piping for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
 - .1 Ensure that surfaces and pipes in contact with radiant-heating piping are free of burrs and sharp protrusions.
 - .2 Ensure that surfaces and substrates are level and plumb.
- .2 Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION

- .1 Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings or coordination drawings.
- .2 Install radiant-heating piping continuous from the manifold through the heated panel and back to the manifold without piping joints in heated panels.
- .3 Connect radiant piping to manifold in a reverse-return arrangement.
- .4 Do not bend pipes in radii smaller than manufacturer's minimum bend radius dimensions.
- .5 Install manifolds in accessible locations, or install access panels to provide maintenance access as required in Division 08 Section 08 31 13 "Access Doors and Frames."
- .6 Comply with requirements in Division 23 Section 23 21 13 "Hydronic Piping" and Division 23 Section 23 21 16 "Hydronic Piping Specialties" for pipes and connections to hydronic systems and for glycol-solution fill requirements.
- .7 Fire- and Smoke-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials according to Division 07 Section 07 84 13 "Penetration Firestopping."
- .8 Piping in Ceiling:
 - .1 Secure piping by attaching pipes to ceiling substrate using clamps or staples.
 - .2 Space clamps or staples a maximum of 18 inch (457 mm) o.c. and at center of turns or bends.
 - .3 Maintain 1-1/2 inch (38 mm) minimum plaster cover.
 - .4 Maintain minimum 40-psig (275-kPa) pressure in piping during the plaster application and continue for 24 hours during curing.
- .9 Revise locations and elevations from those indicated as required to suit field conditions and ensure integrity of piping and as approved by Architect.
- .10 After system balancing has been completed, mark balancing valves to permanently indicate final position.
- .11 Perform the following adjustments before operating the system:
 - .1 Open valves to fully open position.
 - .2 Check operation of automatic valves.
 - .3 Set temperature controls so all zones call for full flow.
 - .4 Purge air from piping.
- .12 After concrete or plaster heating panel has cured as recommended by concrete or plaster supplier, operate radiant-heating system as follows:
 - .1 Start system heating at a maximum of 10 deg F (6 deg C) above the ambient radiant-panel temperature and increase 10 deg F (6 deg C) each following day until design temperature is achieved.
 - .2 For freeze protection, operate at a minimum of 60 deg F (16 deg C) supply-water temperature.

3.4 FIELD QUALITY CONTROL

- .1 Prepare radiant-heating piping for testing as follows:
 - .1 Open all isolation valves and close bypass valves.
 - .2 Open and verify operation of zone control valves.
 - .3 Flush with clean water and clean strainers.

- .2 Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - .1 Leak Test: After installation, charge system and test for leaks. Subject piping to hydrostatic test pressure that is not less than 1.5 times the design pressure but not more than 100 psig (690 kPa) . Repair leaks and retest until no leaks exist.
 - .2 Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- .3 Radiant-heating piping will be considered defective if it does not pass tests and inspections.
- .4 Prepare test and inspection reports.
- .5 Protect hydronic piping system from damage during construction.

END OF SECTION

PART 1 GENERAL**1.1 SECTION INCLUDES**

- .1 This section provides General, Product, and Execution Requirements for Common Work for Integrated Automation (Controls) systems.
- .2 Provide Integrated Automation (Controls) for all Fire Suppression, Plumbing and HVAC Systems throughout the buildings as indicated.
- .3 The Integrated Automation (Controls) Contractor shall furnish all materials, including all central computer hardware and software, operator input/output peripherals, standalone DDC panels, automation sensors, and carrier system.
 - .1 The controls contractor shall be responsible for the design, installation, supervision and labour services, calibration, all software programming, and checkout necessary for a complete and fully operational Building Automation System.
- .4 The control system is to be fully microprocessor based, including web-based facility and energy management system access interface.
- .5 The new control system while being a completely stand-alone system, shall be an expansion of the existing Building Automation System.
- .6 This specification provides requirements for a fully integrated control systems that service the new Reverse Osmosis Water system upgrades and to be interconnected with the existing control systems.
- .7 The control system shall be a modular, flexible, and fully commissioned Direct Digital Control (DDC) System except that controls not scheduled on the points list may be electric.
 - .1 Items identified in the sequence of operation as being under DDC control, but which are not included in the points list shall be included in the DDC system.
- .8 This section is a performance specification clarified in certain sections to establish minimum standard of equipment, installation, or level of control.
 - .1 The specification describes the basic functions required but not all installation details or components.
 - .2 This Trade is expected to have sufficient experience to be able to design and estimate the cost of an appropriate control system.
 - .3 Materials and work necessary to achieve a satisfactory result will not be considered extra to the contract.
- .9 The control will be coordinated and provided, including the generation of new graphics for all control components.

1.2 GENERAL REFERENCES

- .1 Read this section in conjunction with Division 01 General Requirements, Conditions of Contract, all related Technical Specifications and associated drawings of this Contract.
- .2 In conjunction with Division 01 and Division 20, this Division shall govern all Division 25 Sections of the work.
- .3 Refer to Section 20 05 06 - Commissioning, Demonstration, and Instruction for additional responsibilities of Division 25.

1.3 RELATED REQUIREMENTS

- .1 Refer to and comply with the following sections:
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- .1 General Requirements - Division 01
 - .2 Common Work for Mechanical Systems – Division 20
 - .3 Fire Suppression Systems - Division 21
 - .4 Plumbing Systems - Division 22
 - .5 Heating, Ventilation and Air Conditioning Systems - Division 23
 - .6 Integrated Automation (Controls) Systems - Division 25
 - .7 Electrical - Division 26/27/28
 - .2 The new system shall be fully integrated with the existing system and operator interface shall be through the existing operator's workstation located in workstations (main plant room).
 - .1 In addition, the new system will provide access to Facility & Energy Management Software Use through the xxxx system.
 - .2 The intent is to centralize the facilities building management operation and collect real-time data about energy use for the xxx facility.
 - .3 The controls system is to be complete with all necessary control components and connections to achieve the specified functions and to permit the Mechanical systems to perform properly in the manner described and specified.
 - .4 The control system shall be set up and adjusted to achieve optimum operation of the H.V.A.C. and Plumbing systems.
 - .1 This includes sequencing, timing, and readjustment, as required.
 - .2 Modifications to the sequence of operation using points indicated will not be considered as extra to the Contract.
 - .3 These modifications to continue through the construction period, commissioning period and warranty period as required to achieve optimum operation of the mechanical system.
 - .5 Work with the other parties involved in commissioning, assess how the programming can be modified to improve function, review this with the Consultant and modify the programming as instructed by the Consultant.
 - .6 The control system and all controllers and hardware including third party devices shall be BACnet Testing Laboratories (BTL) certified.
 - .7 This section shall review the shop drawings of the fire alarm system as provided by Division 28, with respect to the devices affecting the mechanical control system (an integral part of the Fire Fighters Central Control Facility).
 - .8 The Controls Contractor shall review all contract documents and visit the site, if possible, prior to the closing date of the tender and site confirm the requirements regarding the routing of interconnecting transmission network, etc.

1.4 APPLICABLE CODES AND STANDARDS

- .1 This project is deemed to be a post-disaster design.
 - .2 Refer to Section 20 05 01 Codes, Bylaws and Standards.
 - .3 Where multiple versions of the same code/standard are published, the most recent version shall be applied, unless noted otherwise by building codes and local by-laws.
 - .4 All installation, execution, and testing shall conform to the following standards as a minimum:
 - .1 Provincial Building Code
 - .2 Local Building By-Laws
-

1.5 SUSTAINABILITY

- .1 Refer to Division 01 for Sustainability Design Requirements and Section 20 02 00 - General Provisions for Mechanical, Sustainability

1.6 SUBMITTALS

- .1 Comply with Division 01 and Section 20 05 05 Documentation and Submittals.
 - .2 Refer to Section 20 99 60 Mechanical Forms and submit all documentation therein that is applicable to Division 25.
 - .3 Shop Drawings
 - .1 Submit shop drawings in accordance with Section 20 05 05 Documentation and Submittals.
 - .2 Shop drawings shall include, but not limited to the following:
 - .1 Control centre layouts.
 - .2 Manufacturer's descriptive technical literature for all equipment and devices.
 - .3 Interconnection schematics.
 - .4 Wiring and piping diagrams.
 - .5 One-line diagram from sensor and control points to Field Interface device and/or standalone DDC panel including all components and cables.
 - .6 Terminal cabinets, including termination listing.
 - .7 Written description indicating sequence of operation.
 - .1 Shop drawings will be rejected if the written description is not included with the submission.
 - .2 Sequences should reference English descriptors and labels for each point described.
 - .8 All input/output points which shall include the following information associated with each point.
 - .1 Sensing element type and location.
 - .2 Details of associated field wiring schematics and schedules.
 - .3 Software and programming details.
 - .9 Detailed block diagrams of transmission trunk routing and configuration.
 - .10 Valve and damper schedules indicating size, configuration, capacity, and locations.
 - .1 If size varies greater than 10%, obtain approval of the Consultant.
 - .11 Copies of all system graphics complete with system specific point labels.
 - .12 When preparing shop drawings, review the proposed sequences, suggest improvements, and review these with the Consultant.
 - .13 When submitting the controls shop drawings arrange a time to review these in detail in the Consultants office.
 - .4 Product Options and Substitutions
 - .1 Refer to Section 20 02 00, for requirements pertaining to product options and substitutions.
 - .5 Samples
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- .1 Refer to Division 01 and Section 20 05 05 Documentation and Submittals.
 - .6 LEED Submittals
 - .1 Refer to Division 01 for Sustainability Design Requirements and Section 20 02 00 - General Provisions for Mechanical, Sustainability
 - .7 Operation and Maintenance Materials
 - .1 Refer to Division 01 and Section 20 05 05 Documentation and Submittals.
 - .2 The maintenance manual data is intended to cover the operation and maintenance of all control systems and equipment installed.
 - .1 Forward three (3) copies of the Controls and Instrumentation section of the operating and maintenance manuals (Electronic PDF) to the Owner, the Commissioning Agency, and the Balancing Agency, to ensure the binding and format of material are compatible.
 - .3 Ensure sufficient time has been given to the Commissioning Agency and the Balancing Agency for the compiling of the complete operating and maintenance manuals by the commissioning deadline established.
 - .1 One complete manual shall be furnished prior to the time that system or equipment tests are performed.
 - .4 The manuals shall include the name, address, e-mail, and telephone number of the control subcontractor installing the systems and a list of emergency numbers for service personnel.
 - .1 The manuals shall have a table of contents and be assembled to conform to the table of contents with the tab sheets placed before instructions covering the subject.
 - .5 Manuals shall be furnished which provide full and complete coverage of the following subjects:
 - .1 Operational Requirements:
 - .1 This document shall describe, in concise English terms, all the functional and operational requirements for the system and its functions that have been established.
 - .2 It shall not require knowledge of digital processor programming or electronic techniques or control system theory.
 - .2 System Operation:
 - .1 Complete guidance and procedures for operation of the system, including required actions at each operator station; operation of computer peripherals; input and output formats and procedures; and emergency, alarm, and failure recovery procedures.
 - .2 Provide step-by-step instructions for system startup, back-up equipment operation, and execution of all system functions and operating modes.
 - .3 Functional Description:
 - .1 Detailed documentation, in language readily understandable to engineering personnel, of the theory of operation and specific functions of the system.
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- .2 Provide full details of data communications, including data types and formats, data processing and disposition data link components and interfaces and operator test or self-test of data link integrity for all system components and computer peripherals during each system function and operating mode.
 - .3 Hardware and software functions, interfaces, and requirements shall be explicitly detailed for all system components in all system functions and operating modes.
 - .4 Any operating procedures currently implemented or planned for implementation in an automatic mode shall be stated and described.
 - .4 Software:
 - .1 Documentation of the theory, design, interface requirements, and functions of all software modules and systems for all digital processors.
 - .2 Include test and verification procedures and detailed descriptions of program requirements and capabilities.
 - .3 Provide all data necessary to permit modification, relocation, or other reprogramming and to permit combination of new and existing software modules to respond to changing system functional requirements without disrupting normal control system operation.
 - .4 Include, as a minimum, for all software modules:
 - .1 fully annotated source code listings,
 - .2 error-free object code files ready for loading via a peripheral device,
 - .3 complete program cross reference,
 - .4 any calling requirements, data exchange requirements, necessary subroutine lists, data file requirements, and other information necessary to ensure proper loading, integration, interfacing, and program execution.
 - .5 All DDC panel software shall be provided individually for each DDC panel while a single section shall reference all DDC panel common parameters and functions.
 - .5 Operation and Maintenance Materials
 - .1 Provide Documentation of all maintenance on all system components including inspection, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective units.
 - .2 Include calibration, maintenance, and repair of all sensors and controls, plus diagnosis and repair or replacement of all system hardware.
 - .6 Test Procedures and Reports:
 - .1 The test implementation shall be recorded with a description of the test exercise script of events and documented as Test Procedures.
 - .2 A provision for the measurement or observation results, based on the previously published Test Specification, forms the Test Reports.
 - .3 The procedures record and the results of these exercises shall be conveniently bound and documented together.
 - .8 Record Documents
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- .1 Refer to Division 01 and Section 20 05 05 Documentation and Submittals.
 - .9 Occupancy Documentation Requirements
 - .1 Refer to Division 01 and Section 20 05 05 Documentation and Submittals.
 - 1.7 WARRANTIES**
 - .1 Refer to Division 01 and Section 20 02 00 General Provisions for additional information.
 - .2 The system including all hardware and software components shall be warranted for a period of one year two years following the date of final acceptance per department.
 - .1 Any manufacturing defects arising during this warranty period shall be corrected without cost to the Owner.
 - .3 All applicable software as detailed in this specification shall be updated by the Controls Contractor free of charge during the warranty period.
 - .1 This will ensure that all system software will be the most up-to-date software available from the Controls Contractor.
 - .2 All future patches to the software shall be made available to the Owner.
 - .4 Repairs required by a total system failure, or the malfunction of any priority portion of the system shall be considered an emergency repair and shall be performed within eight (8) hours of the report of the failure.
 - .5 Repairs of a non-emergency nature shall be promptly repaired on the next normal business day.
 - .6 Provide written assurance that a local service centre will be maintained with a complete stock of replacement parts, and capable of servicing all troubles in the system.
 - .7 Use of installed equipment during construction shall not shorten or alter the warranty period as specified in the General Conditions.
 - .8 Take note of and provide any extended warranties specified.
 - 1.8 QUALITY ASSURANCE**
 - .1 Refer to Section 20 02 00 - General Provisions for Mechanical, Quality Assurance, for additional details.
 - .2 Manufacturer shall specialize in development and production of the products specified in this Section.
 - .3 Employ only Tradespeople holding valid Provincial Trade Qualification Certificates.
 - .1 Tradespeople shall perform only work that their certificate permits.
 - .2 Certificates shall be available for inspection by the Consultant.
 - .4 Follow manufacturer's recommended installation details and procedures for equipment, supplemented by requirements of Contract Documents.
 - 1.9 COORDINATION**
 - .1 Drawings are diagrammatic and approximately to scale.
 - .1 They establish the scope of the work and the general location and orientation of the HVAC systems.
 - .2 The systems shall be installed generally in the locations and generally along the routings shown, close to the building structure and coordinated with other services.
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- .3 Piping shall be concealed within walls, ceilings or other spaces and shall be routed to maximize head room and the intended use of the space through which they pass, unless specifically noted otherwise.

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PART 2 PRODUCTS

2.1 EQUIPMENT SUPPLIED FOR INSTALLATION UNDER OTHER SECTIONS

- .1 The following equipment shall be supplied by Division 25 and installed under the applicable trade Divisions:
 - .1 Automatic control valves.
 - .2 Temperature sensor wells.
 - .3 Automatic control dampers.
 - .4 Pressure tappings.
 - .5 Static pressure sensors.
 - .6 Flow switches.
- .2 Division 25 shall be responsible for arranging, coordinating and supervising the installation of the above devices in a suitable manner and readily accessible location.

2.2 ELECTRICAL COMPONENTS, CONDUIT, AND WIRING

- .1 By Division 25:
 - .1 All control system components to make a complete and operable system, except those supplied as part of packaged equipment controls, but including all auto-sequencing devices and electrical interlocks required to accomplish the sequences specified hereafter.
 - .1 Refer to the electrical equipment schedule, the electrical drawings, and the electrical specification, which describes the limits of the extent to the work in Division 26 serving mechanical systems.
 - .2 Materials, equipment, connections and power not provided by Division 26 but required for the Control System shall be provided under this section.
 - .2 All control circuit transformers (120/1/60 or 24/1/60 and as designated).
 - .3 All control wiring and metallic conduit for mechanical system controls.
 - .4 Supply, installation and connection of all electric control items including: damper motors, relays, outside sensors, sub-master control circuits, safety devices, electric thermostats, aquastats, flow switches, wiring to terminal strips, proportional controllers, controllers, etc.

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- .5 All wiring and conduit from power distribution system to any control devices needing power (including B.M.S components)
 - .6 Be responsible for coordinating with Division 26.
 - .7 Electrical work installed under Division 25 shall be to the standards specified under Division 26.
- .2 By Division 26:
- .1 All power wiring and conduit from power distribution system up to and including connection to all motors and starters.
 - .2 All disconnect switches required (unless specified in schedules as being integral with equipment).
 - .3 All motor protection switches, stop-start switches, magnetic starters, contactors and hand-off-automatic selector switches except those supplied as part of packaged equipment.
 - .4 Terminal strips within the motor control centres (MCC) for control connections.
 - .5 Fire alarm signals.
 - .6 Note:
 - .1 All magnetic starters for equipment shall have the following features supplied under Division 25:
 - .1 Hand-off-automatic selector or on-off selector or start-stop buttons in cover with hand-automatic bridge if applicable.
 - .2 Pilot light,
 - .3 120-volt coils,
 - .4 120-volt control transformer and,
 - .5 Four auxiliary dry contacts for interlocks; two normally open and two normally closed.
 - .2 Division 25 is responsible for reading Division 26, Division 27, and Division 28 plans and specifications to determine scope of responsibility and standards.
- .3 Wiring:
- .1 General:
 - .1 Run carrier system parallel to building lines.
 - .2 Support conduit carrier system one meter on centre independent of piping, ductwork and equipment.
 - .3 Seal all penetrations through fire separations or walls as per code requirements.
 - .4 Identify all junction box covers with control company label.
 - .5 Identify with colour bands, all conduits at all junction and pull boxes, at both sides of wall and floors and at not more than 7.5 m (25 ft) intervals along the length.
 - .1 Identification bands to be sprayed on and not less than 100 mm (4") wide.
 - .2 Bands to be pink in colour unless in conflict with Division 26 colours.
 - .6 Use colour coded conductors.
 - .7 Adhere to all applicable electrical codes and regulations.
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- .8 Obtain electrical permit.
 - .9 For non-CSA equipment where required by electrical code, submit to Inspection Authorities and obtain approval prior to installation of equipment on site.
 - .10 Refer to Division 26 Electrical for overall wiring requirements.
 - .11 Wiring shall match electrical wiring requirements to ensure consistent wiring is provided throughout the project.
 - .2 Carrier System – In stud walls, and all open, exposed areas including mechanical, electrical and equipment rooms:
 - .1 All wiring for 24 volts or less shall be run in EMT conduit except wiring to all operators and to all sensors subject to vibration shall be run in flexible metallic conduit for the final 900mm (3 feet).
 - .2 All wiring for over 24 volts shall be run in EMT conduit.
 - .3 All wiring between the fire alarm panel and the DDC panels. shall be run in EMT conduit.
 - .4 Provide steel fittings with nylon throats for all conduit connections.
 - .5 All conduit containing control wiring shall loaded to a maximum of 75% full upon project completion
 - .6 Wires not in conduit shall be organized using Panduit or similar.
 - .3 Carrier System – Concealed, accessible areas.
 - .1 Wires not in conduit shall be organized using Panduit or similar.
 - .2 Class II low voltage BMS open cable, neatly bundled, shall be routed parallel to building lines.
 - .3 Cable may follow ductwork routing and may be tied to the side or top of the ducting at duct supports, using suitable cable ties.
 - .1 If cabling does not follow ducting, it shall be fixed to the structure, supported at a minimum of every 5m.
 - .4 Open cable must be rated plenum cable.
 - .4 Wire:
 - .1 Line voltage power or switched power wiring - #12 gauge copper wire minimum.
 - .2 Line voltage control wiring - #14 gauge copper wire, length not to exceed 50 meters; #12 gauge copper wire, lengths exceeding 50 meters.
 - .3 Low voltage – wire as directed by applicable electrical codes and requirements but minimum #20 gauge.
 - .4 All DDC wiring ran in ceiling spaces must be strapped every 3 feet, and not run through sharp edges or corners, cables should not be ran crisscross but in a straight organized fashion.
 - .5 All DDC wiring to have wire tags at both ends.
 - .5 Cable:
 - .1 Data transmission cable shall be minimum 18-gauge twisted pairs (shielding as per manufacturers recommendations).
 - .2 All new cabling used for network installation shall be a minimum of CAT6 or as recommended by the equipment manufacturer.
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- .4 Wiring for B.M.S Life Safety Systems:
 - .1 Coordinate with Division 28.
 - .2 Conductors for communications between the front-end CPU and standalone DDC panels and between DDC panels shall be high temperature, 200C, Teflon FEP insulated and jacketed, shielded twisted cable pairs of minimum 18 gauge provided by the controls contractor for the distances involved.
 - .1 Wiring shall be fully redundant for separate channels of communication to the CPU via a different route (to protect the communication links in the event of a fire in a particular area).

2.3 ALARMS - GENERAL

- .1 No alarm shall be triggered for a device until the device has been started and is in stable operation.
 - .1 Use software time delays to achieve this effect.
- .2 Generate an alarm on the B.M.S. if any equipment is not in the intended operating condition or if any analog input is not within the intended operating range.

PART 3 EXECUTION

3.1 INSTALLATION

- .1 Install all work so as to be readily accessible for adjustment, operation, and maintenance. Furnish access doors where required in building surfaces for installation by building trades. Refer to Section 20 05 33 Access Doors.

3.2 SYSTEM COMMISSIONING AND CALIBRATION

- .1 Program each standalone DDC panel immediately following installation.
- .2 Set up and calibrate all control loops and sensors during the initial start-up of the systems and check, recalibrate and readjust as necessary during the Owner's Demonstration and Instruction period.
- .3 Upon completion of the installation, perform all necessary testing and debugging operations satisfactorily.
- .4 Perform all modifications and alterations as required to correct any deficiencies noted during these tests.
- .5 Check sensor calibration and control system operation during the first heating season and prior to the first cooling season.
- .6 Following each visit submit printed graphs of trend logs one week in duration with hourly samples for all analog inputs connected to each DDC panel.

3.3 FIELD TESTING

- .1 Verification of System Commissioning
 - .1 Preliminary Tests
 - .1 After installation of each part of the system and completion of mechanical and electrical hook-up, perform tests to confirm correct installation and functioning of equipment.
 - .2 Notify the Consultant in writing at least seven days before testing is to take place stating the following:

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- .1 Location and part of system to be tested.
 - .2 Describe testing procedure and anticipated results.
 - .3 Provide all necessary testing equipment and personnel.
 - .4 Provide portable 2-way radios for communications during demonstrations.
 - .1 Provide three units on the same frequency and of sufficient power and quality as to be useful throughout the building.
 - .5 Perform tests in presence of the Consultant.
 - .6 Demonstrate the proper operation of each component.
 - .7 Correct any deficiencies and re-test in the presence of the Consultant, until designated part of the system performs satisfactorily.
 - .2 Final Operational Acceptance Test
 - .1 A final operational test of not less than thirty (30) consecutive days, twenty-four (24) hours per day, shall be conducted on the complete and total installed and operational Control System to demonstrate that it is functioning properly in accordance with all requirements of this specification.
 - .2 The correct operation of all monitored and controlled points shall be demonstrated as well as the operation and capabilities of all sequences, reports, specialized control algorithms, diagnostics, and all other software.
 - .1 If the equipment operates at an average effectiveness level (AEL) of at least 95% during the performance test period of thirty (30) consecutive calendar days, it will be deemed to have met the Acceptable Standard of Performance, and final acceptance of the system shall be made, provided the contractor has satisfied all other requirements of this specification.
 - .2 The average effectiveness level (AEL) is defined as the ratio between the total thirty-day test period less any system downtime accumulated within that period, and the thirty-day test period.
 - .3 In the event the required AEL is not reached during the initial thirty (30) consecutive calendar day period, the final operational acceptance test period shall be extended on a day-to-day basis until the required AEL is reached for thirty (30) consecutive calendar days.
 - .3 Downtime shall result whenever the control system is unable to fulfill all required functions detailed within this specification due to any malfunction of either BMS hardware or software.
 - .1 Any defect of hardware or software shall be corrected when it occurs before the test may be resumed.
 - .2 Downtime created by non-BMS equipment or activities will not be considered as downtime for the AEL calculation.
 - .3 Refer to Fire Fighters Pressurization Control (FFPC) system for commissioning and performance tests.

3.4 IDENTIFICATION

- .1 Identify all panels and points with a numbering system consistent throughout the DDC network.
 - .2 Identify all controls with symbols relating directly to the control diagram.
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- .1 Use plasticized tags, engraved brass, aluminum, metal-photo, or laminated plastic labels and secure them to, or adjacent to the control devices with key chains.
- .3 Identify all junction box covers with control company label.
 - .1 Paint junction box covers to match conduit colour coding pink.
- .4 Identify with colour bands, all conduits at all junction and pull-boxes, at both sides of wall and floors and at not more than 7.5 m (25 ft.) intervals along the length.
 - .1 Identification bands to be sprayed on and not less than 100mm (4") wide.
- .5 Use colour coded conductors, white for neutral.
- .6 All manual switches, unless they come with standard nameplates, shall be labelled with engraved plastic laminate nameplates to clearly indicate the service.
 - .1 Wording on nameplates shall be subject to approval by the Consultant.
- .7 Identify all DDC panels and associated devices with symbols relating directly to the control diagram.
 - .1 Provide plastic labels for each input and output point with the following information:
 - .1 Point descriptor.
 - .2 Point type and channel number.
 - .3 Corresponding DDC panel number.
- .8 Mount an input-output legend sheet within each DDC panel.
 - .1 This sheet shall include the name of the points connected to each controller, the end device manufacture, part number, model number and shall describe the I/O range.
 - .2 If an I/O module is remotely located, a separate legend sheet for that module shall be included at both locations.
- .9 All relays shall be labeled and have wire tags.
- .10 Motor control centre and motor starters shall be provided with labels identifying those motors are under remote control.

3.5 DEMONSTRATION AND TRAINING

- .1 The Controls Contractor shall provide the services of competent instructors who will give full instruction to designated personnel in the adjustment, operation and maintenance, including pertinent safety requirements, of the equipment and system specified.
 - .2 The training shall be oriented toward the system installed rather than being a general (canned) training course.
 - .1 Instructors shall be thoroughly familiar with all aspects of the subject matter they are to teach.
 - .3 The number of person-days (eight hours) of instruction furnished shall be as specified below as a minimum.
 - .4 A training manual shall be provided for each trainee which describes in detail the data included in each training program.
 - .1 All equipment and material required for classroom training shall be provided by the Contractor.
 - .5 Training Program: The training program shall be accomplished in two phases.
 - .6 Phase 1:
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- .1 This phase shall be for a period of at ten, five days at a time mutually agreeable between the Contractor and Owner.
- .2 Operating personnel will be trained in the functional operations of the system installed and the procedures that the operators will employ for system operation.
- .3 First phase training shall include the following:
 - .1 General control system architecture.
 - .2 System communications.
 - .3 Operation of computer and peripherals.
 - .4 Elementary preventative maintenance.
 - .5 Report generation.
 - .6 Operator control functions.
 - .7 Colour graphics generation.
- .7 Phase 2:
 - .1 This phase of training shall be conducted four to eight weeks after system acceptance for a period of six, three days.
 - .2 The training shall include as a minimum, but not limited to:
 - .1 A review of Phase 1 training.
 - .2 Equipment maintenance - this training shall include:
 - .1 General equipment layout.
 - .2 Trouble shooting of all control system components.
 - .3 Preventative maintenance of all control system components.
 - .4 Sensors and controls maintenance and calibration.
 - .3 Programming - this training shall include:
 - .1 System architecture.
 - .2 Application programs.
 - .3 DDC panel programming.
 - .4 Software access code review.
- .8 Demonstration of the Life Safety System:
 - .1 Perform all tests as required by the authorities having jurisdiction, of the firefighter's pressurization control system.

3.6 MAINTENANCE SERVICE DURING THE WARRANTY PERIOD

- .1 The Contractor shall provide all services, materials, and equipment necessary for the maintenance of the entire Control System, for a period concurrent with the warranty period.
 - .2 Any necessary material required for the maintenance work shall be provided by the Contractor.
 - .3 The Controls Contractor shall provide one minor and major inspection per quarter or as required by the manufacturer and two major inspections per year, and all service for the required maintenance.
 - .4 Major Inspections
 - .1 These inspections shall include but not be limited to the following:
 - .1 Work as detailed hereinafter for minor inspections.
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- .2 Clean all peripheral equipment, CPU, interface panels, multiplexing panels and microprocessor interior and exterior surfaces.
 - .3 Provide signal, voltage and system isolation checks of all CPU, interface panels, multiplexing panels and peripherals.
 - .4 Provide mechanical adjustments, new ribbons and necessary maintenance on printers.
 - .5 Check and/or calibrate each field input/output device.
 - .6 Run system software diagnostics as required.
 - .5 Minor Inspections
 - .1 These inspections shall include but not be limited to the following:
 - .1 Provide visual and operational checks to all CPU, peripheral equipment, interface panels, multiplexing panels, and field devices.
 - .1 Change filter and check fan for all CPU's peripheral equipment as required.
 - .2 Provide complete back up of BMS system.
 - .3 Regular service calls: these calls shall be performed during regular working hours, 8:00 a.m. to 4:30 p.m. Monday through Friday excluding legal holidays.
 - .6 Emergency Service
 - .1 The Owner will initiate service calls when there is indication that the control system is not functioning properly.
 - .2 The Contractor shall have qualified control personnel available during the warranty period to provide service to the "critical" control system components whenever required at no additional cost to the Owner.
 - .3 The Contractor shall furnish the Owner with a telephone number where the service mechanic can be reached at all times.
 - .1 The service mechanic shall be on the job ready to service the control system within the next eight (8) hours, after receiving a request for service and the work shall be performed continuously until the control system is back in reliable operating condition.
 - .4 Repairs of a non-emergency nature shall be promptly repaired on the next normal business day.
 - .7 Records and Logs
 - .1 Records and logs shall be kept of each maintenance task.
 - .8 System Modifications
 - .1 Recommendations for system modification shall be provided in writing to the Consultant.
 - .2 No system modification, including operating parameters and control settings, shall be made without prior approval.
 - .9 Software
 - .1 Provide implementation of all software maintenance updates.
 - .2 These shall be accomplished as required and full coordination with control system supervisory personnel shall be maintained.
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END OF SECTION 25 05 00

PART 1 GENERAL

1.1 SECTION INCLUDES

- .1 This section provides guidance and requirements for the General Structure of the Integrated Automation Network of the Building Automation System (BAS).
- .2 The control system while being a completely stand-alone system must be compatible with, and be connected to, the Building Automation System installed in the existing facility.
 - .1 The new facility shall be monitored, controlled, and programmed from the existing facility.
 - .2 Include for the programming required to incorporate the stand-alone system into the existing system.
- .3 The Integrated Automation Network shall be either:
 - .1 Compatible with, and be connected to, the Building Automation System installed in the existing facility or,
 - .2 Be a completely stand-alone system complete with head end CPU, keyboard, colour monitor and printer.
- .4 The Integrated Automation system shall be a real-time, online, multitasking, multi-user, microprocessor-based system.

1.2 GENERAL REFERENCES

- .1 Performance requirements of the Building Automation System (B.A.S.) and associated hardware and software are specified in this section and defines the minimum hardware and performance requirements.
- .2 All of the specified and required programming features must be written by Division 25 and available for use by the Owner.
 - .1 These features shall be tested and verified during commissioning.
 - .2 It is not acceptable to provide software that is capable of these features only if programmed by the Owner.

1.3 RELATED REQUIREMENTS

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted, and coordinated with all other parts.
- .2 Refer to and comply with the following sections:
 - .1 General Requirements - Division 01
 - .2 Common Work for Mechanical Systems – Division 20
 - .3 Fire Suppression Systems - Division 21
 - .4 Plumbing Systems - Division 22
 - .5 Heating, Ventilation and Air Conditioning Systems - Division 23
 - .6 Integrated Automation (Controls) Systems - Division 25
 - .7 Electrical - Division 26/27/28

1.4 SUBMITTALS

- .1 Action Submittals
 - .2 Informational Submittals
 - .3 LEED Submittals
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- .4 Operation and Maintenance Materials
- .5 Record Documents

1.5 QUALITY ASSURANCE

- .1 Refer to Section 20 02 00 - General Provisions for Mechanical, Quality Assurance, for additional details.

1.6 EXTRA MATERIALS

- .1 Spare Parts
 - .1 Provide written assurance that in the event of a catastrophic failure of the system or portion thereof, the manufacturer or the system sub-contractor is able to obtain components for replacement with a maximum turn-around of 24 hours.

1.7 SOFTWARE UPDATES

- .1 Patches to the software package shall be provided at no cost for the lifetime of the system. These shall include all patches and fixes to the original software package supplied but shall not necessarily include new software products subsequently released by the manufacturer after substantial completion.

PART 2 PRODUCTS

2.1 GENERAL PRODUCT DESCRIPTION

- .1 The Building Management System (BMS) shall be capable of integrating multiple building functions including equipment supervision and control, alarm management, energy management, and historical data collection and archiving.
- .2 The Building Management System shall consist of the following:
 - .1 Standalone Panels (SAPs).
 - .2 Terminal Unit Controllers (TUCs).
 - .3 Portable Operator's Terminals (POTs).
 - .4 Personal Computer Operator Workstation(s) (OWSs).
- .3 The system shall be modular in nature and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, SAPs, applicable TUCs and operator devices.
- .4 System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. Each SAP shall operate independently by performing its own specified control, alarm management, operator I/O, and historical data collection. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.
- .5 SAPs shall be able to access any data from or send control commands and alarm reports directly to any other DDC panel or combination of panels on the network without dependence upon a central processing device. SAPs shall also be able to send alarm reports to multiple operator workstations without dependence upon a central processing device.
- .6 All new outputs shall each have an integral H-O-A toggle switch.
- .7 New controllers shall have a minimum 10% spare points at each location.
- .8 Program a trend log and, where appropriate, totalization for each point.

- .9 The Building Management System shall be capable of accepting Autocad drawing files. The Autocad drawings shall be interfaced with the control system graphics software via stripped down DWG files, which are converted into Windows Metafiles for use as graphics for BMS.

2.2 ENVIRONMENTAL CONDITIONS

- .1 The BAS and its immediate associated devices shall be able to operate properly under environmental conditions of 0C to 44C and a relative humidity of 10% to 95% RH noncondensing.

2.3 RADIO FREQUENCY INTERFERENCE (R.F.I.)

- .1 Ensure that all equipment installed under this division is capable of operating properly when subjected to the ambient radio frequency signals existing at the site and in accordance with the Radio Interference Regulations (RIR).
- .2 Take into consideration all A.M., F.M., T.V., U.H.F. and V.H.F. signals generated by private and commercial transmitters as well as spurious signals generated by hospital equipment such as X-ray and linear accelerator treatment equipment, etc.
- .3 Provide traps as required to reduce all radio frequency and electromagnetic interference signals to acceptable levels.

2.4 NETWORKING/COMMUNICATIONS CAPABILITIES

- .1 Networking/Communications capabilities shall consist of:
 - .1 Peer to Peer Communications between SAPs:
 - .1 SAPs shall communicate with one another over a high-speed peer to peer protocol communications bus.
 - .1 All devices on the bus shall be peers and no specific device shall be designated as the master for communications purposes.
 - .2 The failure of any one device on the peer bus shall not result in a loss of communications between any of the other devices on the bus.
 - .2 The system shall have the ability to establish priority levels in terms of accessing the peer bus.
 - .1 The peer protocol shall be able to distinguish between alarms, automatic data transfer, manual commands and database transfers and the relative priorities between these events shall determine their access to the bus and consequently the relative speeds of these transactions.
 - .2 Operator Workstation Interconnection:
 - .1 Operator workstations shall access the peer bus by either directly connection to a SAP via an RS232 port or directly to the peer bus.
 - .1 If directly connected, it shall be via a device that resides on the bus as a true peer with only one OWS per such device.
 - .2 The systems shall support multiple OWSs connected to the peer bus either through multiple SAPs or multiple peer devices or a combination of both.
 - .1 When changes are made to datafiles at one OWS (including but not limited to graphics files, graphics link files, point datafiles, point labels and panel datafiles), they shall be automatically updated at all other OWSs (except those that are off-site).
 - .2 This shall be accomplished directly over the peer bus or via a parallel Local Area Network (LAN).

- .3 Terminal Unit Controller (TUC) communications:
 - .1 TUCs shall communicate with one another and a higher order device on the peer bus via a communications bus.
 - .1 The TUC communications bus shall access the main peer bus via an SAP or a node device that acts as a full peer on the main bus.
 - .2 The TUC communication protocol shall be either poll / response (with the peer device acting as the master) or peer to peer.
- .4 Off-site modem communications.

2.5 PROCESSING SPEED

- .1 Effective Panel Processing Speed (All Panels):
 - .1 The maximum permissible execution time is TWO (2) seconds and is defined as follows:
 - .1 The time required for the CPU in the stand-alone panel to execute all application software in the panel, from the same point in the software back to the same point, assuming full memory usage as defined in 1.3, while simultaneously responding to operator or terminal display requests and carrying on normal inter-panel communications averaged over a ONE (1) minute period.
 - .2 The execution time will be verified by setting up a counter in each panel and monitoring the counting rate.
 - .3 Provide with the proposal the estimated execution time for each panel in the system as configured to this job.
- .2 Effective System Processing Speed:
 - .1 The effective system processing speed applies to multi-panel systems only.
 - .1 The system processing speed is intended to address inter-panel communications and will be monitored by evaluating the delays in inter-panel data transfer.
 - .2 The effective system processing speed will be verified by initiating a cyclical flag in one panel every minute.
 - .1 This flag will initiate a counter and at the same time command a flag in a remote panel.
 - .2 The remote flag will be used to terminate the counter in the original panel.
 - .3 The value of the counter will be compared to a continuous counter over a one-hour period to determine the average delay in inter-panel data transfer.
 - .4 The test will be carried out with the system fully commissioned and all memory requirements specified herein invoked.
 - .3 The maximum allowable delay for data transfer between SAPs shall be 5 seconds for normal data and 1 second for alarms (not including panel cycle times).
 - .4 If critical alarm generating points are connected to TUCs then the maximum delays for getting the information to the applicable SAP shall be as per 2.3.2.3 above.
 - .5 The maximum delay between an alarm event in a SAP or TUC and having that alarm annunciated to the OWS(s) shall be four (4) seconds including panel cycle time.
 - .1 This will be verified with the system fully loaded and commissioned.

2.6 STANDALONE PANELS (SAP'S)

- .1 General:

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- .1 SAPs shall be microprocessor based, multi-tasking, multi-user, real-time digital control processors.
 - .2 Each SAP shall consist of all required hardware including but not limited to processors, communication controllers, power supplies, and input/output modules.
 - .3 A sufficient number of controllers shall be supplied to fully meet the requirements of this specification and the attached point list.
 - .2 Memory: Each DDC panel shall have sufficient memory to support its own operating system and databases including:
 - .1 Control processes
 - .2 Energy Management Applications
 - .3 Alarm Management
 - .4 Historical/Trend Data for all points
 - .5 Maintenance Support Applications
 - .6 Custom Processes
 - .7 Operator I/O
 - .8 Dial-Up Communications
 - .9 In addition to the memory required to accommodate all of the points and sequences specified, each SAP shall have memory capacity to accommodate trending of all inputs and outputs with 100 samples per point.
 - .1 This shall include all points connected to subordinate TUCs if they do not have their own on-board trending capabilities.
 - .3 Point Types: Each DDC panel shall support the following types of point inputs and outputs if applicable:
 - .1 Analog inputs:
 - .1 4 - 20 Milliamps
 - .2 0 - 10 Volts DC
 - .3 120 Volts AC
 - .4 10,000 ohm thermistor
 - .5 100,000 ohm thermistor
 - .6 100 or 1000 ohm Pt
 - .7 1000 ohm Ni
 - .8 21 to 103 kPa (3 to 15 psig) 3 - 15 psig (- 103.4 kPa)(via external transducer)
 - .2 Digital inputs:
 - .1 Dry contact closure
 - .2 Pulse accumulator (i.e. electrical consumption)
 - .3 Actuators/Output Signals:
 - .1 Digital outputs (contact closure):
 - .1 Motor starters, sizes 1 to 4 (via external relays)
 - .2 Analog outputs:
 - .1 4 - 20 Milliamps
 - .2 0 - 10 Volts DC
 - .3 Triac 24 Volts AC
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- .4 21 to 103 kPa (3 to 15 psig) 3 - 15 psigwer (- 103.4 kPa) (via external transducer).
- .4 The DDC panel electronics shall be housed in a metal cabinet with keylock utilizing a master key.
- .5 Spare Points:
- .1 The system shall have spare points capacity for future use.
- .2 Housed in one specific DDC panel in each mechanical room the spares shall be comprised of not less than six analog and ten digital inputs as well as six analog and ten digital outputs.
- .3 These shall not require any vendor specific hardware or software to utilize.
- .6 Expandability:
- .1 The system architecture shall support a future system capacity of 5000 control points including points connected to SAPs and TUCs.
- .7 Serial Communication Ports:
- .1 SAPs shall provide at least two (2) serial data communication ports in addition to the network communication port, for simultaneous operation of multiple operator I/O devices such as industry standard printers, OWSs and Portable Operator's Terminals.
- .2 SAPs shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems, printers, or network terminals.
- .8 Hardware Override Switches:
- .1 The operator shall have the ability to manually override automatic or centrally executed commands at the SAP via local, point discrete, onboard hand/off/auto operator override switches for binary control points and analog control type points.
- .9 Integrated On-Line Diagnostics:
- .1 Each DDC panel shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all subsidiary equipment.
- .2 The DDC panel shall provide both local and remote annunciation of any detected component failures, or repeated failure to establish communication.
- .10 Surge and Transient Protection:
- .1 Isolation shall be provided at all network terminations, as well as all field point terminations to suppress induced voltage transients consistent with IEEE Standard 587-1980.
- .2 Isolation levels shall be sufficiently high as to allow all signal wiring to be run in the same conduit as line voltage wiring where acceptable by electrical code.
- .11 Power fail Restart:
- .1 In the event of the loss of normal power, there shall be an orderly shutdown of all SAPs to prevent the loss of database or operating system software.
- .1 Non-Volatile memory EPROM shall be incorporated for all critical controller configuration data, and battery back-up shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours.
- .2 Provide automatic power failure routine to accomplish orderly shutdown of the automation system when loss of power is detected.
- .1 Do not place any equipment in an unacceptable or dangerous condition as a result of power failure or restart procedures.
- .3 Restart the system automatically and in an orderly fashion upon power restoral.
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- .4 Restart equipment based on priority to minimize in-rush currents as large loads are reintroduced.
- .5 Restart only those systems or loads which were operating at the time of shutdown.
- .6 Alarm any equipment which fails to restart when requested.
- .7 Provide manual restart lockout capability.
- .12 Upon restoration of normal power, the DDC panel shall automatically resume full operation without manual intervention.
- .13 Should SAP memory be lost for any reason, the system shall generate an alarm. The user shall have the capability of reloading the SAP via an OWS which is either on-site or via modem.

2.7 SYSTEM SOFTWARE FEATURES

- .1 General:
 - .1 Provide all necessary software to form a complete operating system as described in this specification.
 - .2 The software shall become the property of the Building Owner, who shall have full control over its use (within the confines of the Project).
 - .1 Provide the user with all necessary access codes to all levels of software programming and control system access including custom DDC programming.
 - .3 Division 25 shall include for all necessary licensing, fees, cost, agreement requirements etc. so that the Owner has unrestricted use of the software.
 - .4 The software programs specified in this section shall be provided as an integral part of the DDC panel and shall not be dependent upon any higher-level computer for execution.
- .2 Communications Software Description:
 - .1 Provide all hardware and software to allow for local network access (multi-level password controlled) to all graphics, software, alarming, historical data, etc.
- .3 Control Software Description:
 - .1 Pre-Tested Control Algorithms: The DDC panels shall have the ability to perform the following pre-tested control algorithms:
 - .1 Two Position Control.
 - .2 Proportional, Integral, plus Derivative Control.
 - .3 Floating three position control (where specified).
 - .2 Equipment Cycling Protection:
 - .1 Control software shall include a provision for limiting the number of times each piece of equipment may be cycled within any one-hour period.
 - .3 Heavy Equipment Delays:
 - .1 The system shall provide protection against excessive demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads.
 - .4 Power Fail Motor Restart:
 - .1 Upon the resumption of normal power, the DDC panel shall analyze the status of all controlled equipment, compare it with normal occupancy scheduling, and turn equipment on or off as necessary to resume normal operation.
- .4 Energy Management Applications:

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- .1 SAPs shall have the ability to perform energy management routines, including but not limited to the following:
 - .1 Time of Day Scheduling
 - .2 Calendar Based Scheduling
 - .3 Holiday Scheduling
 - .4 Temporary Schedule Overrides
 - .5 Optimized Start
 - .6 Optimized Stop
 - .7 Night Setback Control
 - .8 Enthalpy Switchover (Economizer)
 - .9 Peak Demand Limiting
 - .10 Temperature Compensated Load Rolling
 - .11 Fan Speed/Volume Control
 - .12 Heating/Cooling Equipment Interlocks
 - .13 Relative Humidity Setpoint Reset
 - .14 Supply Air Temperature Setpoint Reset
 - .15 Hot Deck Temperature Setpoint Reset
 - .16 Heating Water Temperature Setpoint Reset
 - .17 Chilled and Condenser Water Temperature Setpoint Reset
 - .18 Boiler Sequencing
 - .19 Chiller/Cooling Tower Sequencing
 - .20 All programs shall be executed automatically without the need for operator intervention and shall be flexible enough to allow user customization.
 - .5 Custom Process Programming Capability:
 - .1 SAPs shall be able to execute custom, job-specific processes defined by the user, to automatically perform calculations and special control routines.
 - .2 Process Inputs and Variables:
 - .1 It shall be possible to use any of the following in a custom process:
 - .1 Any system-measured point data or status
 - .2 Any calculated data
 - .3 Any results from other processes
 - .4 User-Defined Constants
 - .5 Arithmetic functions (+, -, *, /, square root, exp, etc.)
 - .6 Boolean logic operators (and, or, exclusive or, etc.)
 - .7 On-delay/Off-delay/One-shot timers
 - .3 Process Triggers:
 - .1 Custom processes may be triggered based on any combination of the following:
 - .1 Time interval
 - .2 Time of day
 - .3 Date
 - .4 Other processes
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- .5 Time programming
 - .6 Events (e.g., point alarms)
 - .4 Dynamic Data Access:
 - .1 A single process shall be able to incorporate measured or calculated data from any and all other panels on the system including SAPs and TUCs
 - .1 In addition, a single process shall be able to issue commands to points in any and all other panels on the system including SAPs and TUCs.
 - .5 Advisory/Message Generation:
 - .1 Processes shall be able to generate operator messages and advisories to operator I/O devices.
 - .2 A process shall be able to directly send a message to a specified device, buffer the information in a follow-up file, or cause the execution of a dial-up connection to a remote device such as a printer or pager.
 - .6 All SAPs must be fully user custom programmable.
 - .1 Application specific controllers will not be accepted except for TUC applications as noted in the points list.
 - .6 Alarm Management:
 - .1 Provide alarm management to monitor, buffer, and direct alarm reports to operator devices and memory files.
 - .2 SAP shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic, and prevent alarms from being lost.
 - .3 At no time shall the DDC panel's ability to report alarms be affected by either operator activity at a PC Workstation or local I/O device, or communications with other panels on the network.
 - .7 Point Change Report Description:
 - .1 All alarm or point change reports shall include the point's English language description, and the time and date of occurrence.
 - .8 Prioritization:
 - .1 The user shall be able to define the specific system reaction for each point.
 - .2 Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms.
 - .3 A minimum of three priority levels shall be provided.
 - .4 Each DDC panel shall automatically inhibit the reporting of selected alarms during system shutdown and start-up.
 - .5 Users shall have the ability to manually inhibit alarm reporting for each point.
 - .6 The user shall also be able to define under which conditions point changes need to be acknowledged by an operator, and/or sent to follow-up files for retrieval and analysis at a later date.
 - .9 Report Routing:
 - .1 Alarm reports, messages, and files will be directed to a user-defined list of operator devices, or PCs used for archiving alarm information.
 - .2 Alarms shall also be automatically directed to a default device in the event a primary device is found to be off-line.
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- .10 Alarm Messages:
 - .1 In addition to the point's descriptor and the time and date, the user shall be able to print, display or store a 50-character alarm message to describe the alarm condition or direct operator response more fully. Each SAP shall be capable of storing a library of at least 250 Alarm Messages.
 - .11 Auto-Dial Alarm Management:
 - .1 In Dial-up applications, only critical alarms shall initiate a call to a remote operator device.
 - .2 In all other cases, call activity shall be minimized by timestamping and saving reports until an operator scheduled time, a manual request, or until the buffer space is full.
 - .3 The alarm buffer must store a minimum of 50 alarms.
 - .12 Historical Data and Trend Analysis:
 - .1 Trend analysis shall be time event and/or deviation based and must be capable of graphing at least 8 separate trends simultaneously.
 - .2 A variety of Historical data collection utilities shall be provided to automatically sample, store, and display system data in all of the following ways.
 - .13 Continuous Point Histories:
 - .1 SAPs shall store Point History Files for all analog and binary inputs and outputs (minimum of 100 samples per point).
 - .14 Dynamic Control Loop Performance Trends:
 - .1 SAPs shall also provide high resolution sampling capability with an operator-adjustable resolution of 10-300 seconds for verification of control loop performance.
 - .15 Extended Sample Period Trends:
 - .1 Measured and calculated analog and binary data shall also be assignable to user-definable trends for the purpose of collecting operator-specified performance data over extended periods of time.
 - .2 Sample intervals of 1 minute to 2 hours shall be provided.
 - .3 Each SAP shall have a dedicated buffer or capability of downloading to an on-line data storage and retrieval computer for trend data, and shall be capable of storing a minimum of 5000 data samples.
 - .16 Data Storage and Archiving:
 - .1 Trend data shall be stored at the SAP's, and uploaded to hard disk storage when archival is desired.
 - .2 Uploads shall occur based upon either user-defined interval, manual command, or when the trend buffers become full.
 - .3 All trend data shall be available in disk file form for use in 3rd Party personal computer applications.
 - .17 Runtime Totalization:
 - .1 SAPs shall have the ability to accumulate and store runtime hours for binary input and output points as specified in the Execution portion of this specification.
 - .2 The Totalization routine shall have a sampling resolution of one minute or less.
 - .3 The user shall have the ability to define a warning limit for Runtime Totalization. Unique, user-specified messages shall be generated when the limit is reached.
 - .18 Analog/Pulse Totalization:
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- .1 SAPs shall automatically sample, calculate and store consumption totals on a daily, weekly, or monthly basis for user-selected analog and binary pulse input-type points.
 - .2 Totalization shall provide calculation and storage of accumulations of up to 99,999.9 units (e.g. KWH, litres, KBTU, tons. etc.).
 - .3 The Totalization routine shall have a sampling resolution of one minute or less.
 - .4 The user shall have the ability to define a warning limit. Unique, user-specified messages shall be generated when the limit is reached.
 - .19 Event Totalization:
 - .1 SAPs shall have the ability to count events such as the number of times a pump or fan system is cycled on and off.
 - .2 Event totalization shall be performed on a daily, weekly, or monthly basis.
 - .3 The Event Totalization feature shall be able to store the records associated with a minimum of 9,999,999 events before reset.
 - .4 The user shall have the ability to define a warning limit. Unique, user-specified messages shall be generated when the limit is reached.

2.8 TERMINAL UNIT CONTROLLERS (TUCS)

- .1 Terminal Unit Controllers (TUCs) shall be used to control terminal equipment and other miscellaneous points as noted on the points list.
- .2 Each TUC shall operate as a standalone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each TUC shall be a microprocessor-based, multi-tasking, real-time digital control processor.
- .3 Each TUC shall have sufficient memory to support its own operating system and data bases including:
 - .1 Control Processes
 - .2 Energy Management Applications
 - .3 Portable Operators Terminal (POT)
- .4 The operator interface to any TUC point data or programs shall be through any OWS or any POT connected to any SAP or TUC in the network.
- .5 TUCs shall directly support the temporary use of a POT. The capabilities of the portable operator terminal shall include, at minimum, the following:
 - .1 Display temperatures
 - .2 Display status
 - .3 Display setpoints
 - .4 Display control parameters
 - .5 Override binary output control
 - .6 Override analog setpoints
 - .7 Modification of gain and offset constants
 - .8 Program parameter adjustments
 - .9 Trend log displays edit/create trend logs
 - .10 Display/Command any point connected to any TUC or SAP in the system.
- .6 Powerfail Protection:

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- .1 All system setpoints, proportional bands, control algorithms, and any other programmable parameters shall be stored such that a power failure of any duration does not necessitate reprogramming the controller. TUCs shall employ EEPROM or FLASH RAM for this functionality.
 - .7 Application Descriptions:
 - .1 VAV Reheat Coils, CV Reheat Coils, Perimeter Radiation controls only. Terminal Unit Controllers shall support, but not be limited to, the control of the terminal units to address current requirements as described in the Execution portion and points list of this specification.
 - .2 It is anticipated that TUCs will be application specific and thus not custom user programmable.
 - .1 The application software provided with the TUCs shall meet the requirements of the sequences of operation as specified herein. Include for reprogramming as required.
 - .3 For TUCs used in VAV applications, they shall have a built-in solid state flow transmitter for sensing air flow.
 - .1 Heated wire flow sensors will not be acceptable.
 - .2 It shall be the responsibility of this contractor to ensure that the flow transmitter is compatible with the velocity pressure probe supplied with the VAV box.

2.9 OPERATOR INTERFACE

- .1 Basic Interface Description
 - .1 Command Entry/Menu Selection Process:
 - .1 Operator Workstation interface software shall minimize operator training through the use of English language prompting, English language point identification, and industry standard PC application software. The operator interface shall minimize the use of a typewriter style keyboard through the use of a mouse or similar pointing device, and "point and click" approach to menu selection. Users shall be able to start and stop equipment or change setpoints from graphical displays through the use of a mouse or similar pointing device.
 - .2 Graphical and Text-Based Displays:
 - .1 At the option of the user, Operator Workstations shall provide consistent graphical or text-based displays of all system point and application data described in this specification.
 - .2 Point identification, engineering units, status indication, and application naming conventions shall be the same at all workstations.
 - .3 Multiple, Concurrent Displays:
 - .1 The Operator Interface shall provide the ability to simultaneously view several different types of system displays in overlapping windows to speed building analysis.
 - .2 For example, the interface shall provide the ability to simultaneously display a graphic depicting an air handling unit, while displaying the trend graph of several associated space temperatures to allow the user to analyze system performance. If the interface is unable to display several different types of displays at the same time, the controls contractor shall provide at least two operator stations.
 - .4 Password Protection:

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- .1 Multiple-level password access protection shall be provided to allow the user/manager to limit workstation control, display and data base manipulation capabilities as he deems appropriate for each user, based upon an assigned password.
 - .2 Passwords shall be exactly the same for all operator devices, including portable or panel-mounted network terminals.
 - .1 Any additions or changes made to password definition shall automatically cause passwords at all DDC panels on a network to be updated and downloaded to minimize the task of maintaining system security.
 - .2 Users shall not be required to update passwords for DDC panels individually.
 - .3 A minimum of four levels of access shall be supported.
 - .4 A minimum of 50 passwords shall be supported at each DDC panel.
 - .5 Operators will be able to perform only those commands available for their respective passwords.
 - .1 Menu selections displayed at any operator device, including portable or panel mounted devices, shall be limited to only those items defined for the access level of the password used to log-on.
 - .6 User-defineable, automatic log-off timers of from 1 to 60 minutes shall be provided to prevent operators from inadvertently leaving devices on-line.
 - .7 It shall be possible to limit which points in the system that a particular operator has access to.
 - .5 Operator Commands:
 - .1 The operator interface shall allow the operator to perform all commands required to operate or program the entire system.
 - .6 Logs and Summaries:
 - .1 Reports shall be generated automatically or manually, and directed to either CRT displays, printers, or disk files.
 - .1 As a minimum, the system shall allow the user to easily obtain the following types of reports:
 - .2 A general listing of all points in the network.
 - .3 Individual lists of all points currently in alarm, off-line, in override status, disabled, or locked out.
 - .4 List all weekly schedules.
 - .5 List all holiday programming.
 - .6 List of limits and dead bands.
 - .7 Summaries shall be provided for specific points, for a logical point group, for a user-selected group of groups, or for the entire facility without restriction due to the hardware configuration of the facility management system.
 - .1 Under no conditions shall the operator need to specify the address of hardware controller to obtain system information.
 - .2 Dynamic Color Graphic Displays:
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- .1 Color graphic floor plan displays, and system schematics for each piece of mechanical equipment, including air handling units, chilled water systems, and boiler systems, shall be provided as specified herein to optimize system performance analysis and speed alarm recognition.
 - .2 System Selection/Penetration:
 - .1 The operator interface shall allow users to access the various system schematics and floor plans via a graphical penetration scheme, menu selection, or text-based commands.
 - .3 Dynamic Data Displays:
 - .1 Dynamic temperature values, humidity values, flow values, and status indication shall be shown in their actual respective locations and shall automatically update to represent current conditions without operator intervention.
 - .4 Graphics Definition Package:
 - .1 Graphic generation software shall be provided to allow the user to add, modify, or delete system graphic displays.
 - .1 Libraries of pre-engineered screens and symbols depicting standard air handling unit components (e.g., fans, cooling coils, filters, dampers, etc.), complete mechanical systems (e.g. constant volume-terminal reheat, VAV, etc.) and electrical symbols shall be provided.
 - .2 The graphic development package shall use a mouse or similar pointing device in conjunction with a drawing program to allow the user to perform the following:
 - .1 Define symbols
 - .2 Position and size symbols
 - .3 Define background screens
 - .4 Define connecting lines and curves
 - .5 Locate, orient and size descriptive text
 - .6 Define and display colors for all elements
 - .7 Establish correlation between symbols or text and associated system points or other displays.
 - .2 Graphical displays can be created to represent any logical grouping of system points or calculated data based upon building function, mechanical system, building layout, or any other logical grouping of points which aids the operator in the analysis of the facility.
 - .1 To accomplish this, the user shall be able to build graphic displays that include point data from multiple DDC panels, including Terminal Unit Controllers used for DDC unitary or VAV terminal unit control.
 - .3 Pre-Constructed Graphics
 - .1 Provide a complete set of pre-constructed graphics for use with the system at time of hand-over.
 - .1 Provide dynamic graphics for all functions, including but not limited to the following,
 - .1 Domestic water and pretreatment water for the Reverse Osmosis water plant.
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- .2 Reverse Osmosis equipment monitoring.
- .4 System Configuration and Definition:
 - .1 All temperature and equipment control strategies and energy management routines shall be definable by the operator.
 - .1 System definition and modification procedures shall not interfere with normal system operation and control.
 - .2 The system shall be provided complete with all equipment and documentation necessary to allow an operator to independently perform the following functions:
 - .1 Add/Delete/Modify SAPs, Modify Operator Workstations, TUCs.
 - .2 Add/Delete/Modify points of any type, and all associated control loops, point parameters, and tuning constants.
 - .3 Add/Delete/Modify Totalization, Historical Data Trending for every point.
 - .4 Add/Delete/Modify custom control processes and all graphic displays, symbols, and cross-references to point data.
 - .5 Add/Delete/Modify dial-up telecommunication definition, operator passwords and Alarm Messages.
 - .2 System Definition/Control Sequence Documentation:
 - .1 All portions of system definition shall be self-documenting to provide hard copy printouts of all configuration and application data.
 - .3 Database Save/Restore/Back-Up:
 - .1 Back-up copies of all standalone panel databases shall be stored in at least one personal computer operator workstation.
 - .2 Continuous supervision of the integrity of all SAP data bases shall be provided.
 - .3 In the event that any SAP on the peer bus experiences a loss of its data base for any reason, the system shall automatically download a new copy of the respective data base to restore proper operation.
 - .4 Data base back-up / download shall occur over the peer bus without operator intervention.
 - .5 Users shall also have the ability to manually execute downloads of any or all portions of a SAP data base.

2.10 PERSONAL COMPUTER OPERATOR WORKSTATION DESCRIPTION:

- .1 Primary Personal Computer Operator Workstation shall be provided for command entry, information management, network alarm management, and database management functions.
 - .1 All real-time control functions shall be resident in the SAPs to facilitate greater fault tolerance and reliability.
 - .1 Workstation shall be general purpose, commercially available, desktop personal computer with sufficient memory and processor capacity to perform all functions described in this specification.
 - .2 Provide as a minimum, Intel i7 based PC with minimum of 32GB memory, 6GB video card, Windows 11 Pro 64-bit operating system.
 - .3 Unit shall have a CD/DVD RW drive, 3 x USB 3 ports, 2 x USB type C ports, HDMI, DVI port, Display Port, 10/100/1000 network port, 802.11 WIFI 6.

- .4 Sufficient proprietary bulk storage shall be provided to accommodate all fully configured point data bases, all application databases, all graphics data bases, all user-defined reports, and all historical data archival as described in this specification.
 - .1 Provide at minimum 1TB M.2 solid state drive and 2TB SATA 6 solid state drive.
- .5 The desktop LCD display monitor shall have a minimum 600 mm (24") diagonal screen measurement, and a minimum display resolution of no less than 1920x1080. The screen shall be non-reflective.
- .6 Standard ASCII keyboard with a 10-key numeric keypad and dedicated function keys.
- .7 Input Device: USB Keyboard
- .8 Input Device: USB optical mouse with scroll
- .9 Provide a printer appropriate for printing alarms, using current technology available at time.

PART 3 EXECUTION

3.1 PERSONAL COMPUTER OPERATOR WORKSTATION DESCRIPTION:

- .1 Provide connection to the existing primary Operator Work Station. Confirm exact location with the Hospital.
 - .1 Provide control over the complete communication system and monitor all connected SAP's throughout the system for change-of-state, change-of-value, or no response conditions.
 - .2 Centrally resident software shall be provided for the operator interface, temporary scheduling, control of holiday programming, definition process programming, automatic initialization routines, real-time logs, historical storage, reporting, trend logging and full on-line dynamic graphics.

END OF SECTION 25 10 00

PART 1 GENERAL

1.1 SECTION INCLUDES

- .1 This section provides requirements for BACnet systems and components.
- .2 Provide network devices to accommodate the connection of BACnet capable equipment.
- .3 Provide connections for BACnet capable equipment as indicated.
- .4 BACnet connections shall allow for monitoring and control of related equipment.
- .5 Provide system graphics as applicable to the connected equipment.
- .6 The Controls Contractor shall provide the following,
 - .1 Supply, installation and mounting of all hardware (unless specifically stated otherwise).
 - .2 Supply and mounting of sensor elements and associated hardware, wiring or piping connecting sensors to SAP's.
 - .3 Wiring connecting SAP's to transducers, fire alarm and smoke control.
 - .4 Supply and wiring connection of solid-state relays and relays to terminal connections at MCCs and to SAP's.
 - .5 Supply and installation of SAP's comprising of BC's, AAC's, and ASC's;
 - .6 Complete installation of all sensors associated control panels, relays, transducers, actuators, flow switches, gauges, air receivers, SAP computer board, associated power supplies, conduit, wiring, tubing, and all other control devices including isolation room panels, and all terminations.
 - .7 Participate and provide coordination required between the Owner, the Consultant, the Commissioning Agency, and other sub-contractors where controls are involved and.
 - .8 Provide verification and commissioning as follows:
 - .9 Perform end-to-end continuity checks on all wiring and control devices.
 - .10 Provide calibration and operational checks for all sensors, transducers, relays, actuators, control valves and dampers.
 - .11 Provide a point checkout sheet for verification of system. The Controls Contractor to initial each point as it is verified.
 - .12 The Controls Contractor will test the SAP computer hardware and operator consoles.

1.2 RELATED REQUIREMENTS

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted, and coordinated with all other parts.
- .2 Refer to and comply with the following sections:
 - .1 General Requirements - Division 01
 - .2 Common Work for Mechanical Systems – Division 20
 - .3 Fire Suppression Systems - Division 21
 - .4 Plumbing Systems - Division 22
 - .5 Heating, Ventilation and Air Conditioning Systems - Division 23
 - .6 Controls and Instrumentation - Division 25
 - .7 Electrical - Division 26/27

1.3 ABBREVIATIONS AND ACRONYMS

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- .1 BAS - Building Automation System
 - .2 SAP - Stand Alone Panel - generic term that applies to BC, AAC, ASC
 - .3 DI - Digital Input
 - .4 DO - Digital Output
 - .5 AI - Analog Input
 - .6 AO - Analog Output
 - .7 HVAC - Heating, Ventilation, Air Conditioning
 - .8 MCC - Motor Control Center
 - .9 DDC - Direct Digital Control
 - .10 LAN - Local Area Network
 - .11 OS - Operating System
 - .12 OT - Operator Terminal
 - .13 PC - Personal Computer
 - .14 OWS - BACnet Operator Work Station – same as B-OWS
 - .15 BC - BACnet Building Controller – same as B-BC
 - .16 AAC - BACnet Custom Application Controller - same as B-AAC
 - .17 ASC - BACnet Application Specific Controller - same as B-ASC
 - .18 SS - BACnet Smart Sensor – same as B-SSEthernet – BACnet TCP/IP Ethernet
 - .19 MS/TP - BACnet Master-Slave/Token Passing
 - .20 PTP - BACnet Point-to-Point Protocol

1.4 DEFINITIONS

- .1 Gateway - BACnet Gateway
- .2 Native - Native BACnet
- .3 Micropanel - Generic term that applies to AAC and ASC

1.5 SUBMITTALS

- .1 Action Submittals
- .2 Informational Submittals
- .3 LEED Submittals
- .4 Operation and Maintenance Materials
- .5 Record Documents

1.6 QUALITY ASSURANCE

- .1 Refer to Section 20 02 00 - General Provisions for Mechanical, Quality Assurance, for additional details.

1.7 APPLICABLE CODES AND STANDARDS

- .1 Canadian Standards Association - CSA C22.2no.205- M1983, Signal Equipment.
- .2 Institute of Electrical and Electronic Engineers - IEEE 472, IEEE 587.
- .3 National Institute of Standards and Technology - NISTIR 6392 GSA Guide to Specifying Interoperable Building Automation and Control Systems Using ANSI/ASHRAE Standard 135-1995, BACnet.

- .4 Native BACnet - Native BACnet means that no translation software will be used internal to the OWS, BC, AAC, and ASC to convert from a proprietary protocol to BACnet Standard Object Types, Standard Application Services and devices. Gateways are not native BACnet.
- .5 BACnet Gateways
 - .1 Any use of a proprietary protocol (non-BACnet) internal to a SAP, OWS, or communication bridge shall deem the SAP or OWS as a gateway not native BACnet.
 - .2 BACnet gateways shall be used only where identified in the specifications and nowhere else.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

- .1 A complete, fully tested, commissioned and operational Native BACnet Building Automation System (BAS) utilizing fully electronic Direct Digital Control (DDC) to meet the requirements described herein and in complete accordance with applicable codes and ordinances.
- .2 The system software and control devices shall be fully compatible with the existing ESC Automation/Delta System programs and hardware, latest BACnet versions.
- .3 Unless specified otherwise:
 - .1 Provide proportional plus integral electronic components.
 - .2 The design, installation, supervision and labor services, calibration, software programming and de-bugging, checkout and commissioning required for the BAS.
 - .3 Supply and installation of electronic packaged zone controllers for terminal unit control.
 - .4 Devices, components, wiring and materials as required for a fully operating control system.
 - .5 Include full graphics operating package with modification of existing site graphics and navigation sequences via customized software programming.
 - .6 Instruction to the Facility's maintenance and operating personnel.
 - .7 Complete system documentation including:
 - .1 As-built site diagrams showing location of wiring and panels and system architecture.
 - .2 Operating and Maintenance manuals.

2.2 CABLE

- .1 Primary Data transmission cable shall be CAT 6 Ethernet cable

2.3 ELECTRONIC TERMINAL EQUIPMENT (AAC) CONTROLLERS

- .1 Each zone controller will be microprocessor-based, multi-tasking, real-time digital control processor.
 - .1 The zone controllers will monitor space temperature sensors and control operation of terminal air valves, air valve reheat coils, fan coil units, and perimeter radiant panels in the corresponding zone.
- .2 Each zone controller will have sufficient memory to support its own operating system and data base including:
 - .1 Control functions
 - .2 Energy management applications

- .3 Interface with operator portable personal computer
- .4 Zone controller panels will have the following features:
- .5 Setpoint adjustments
- .6 Modify gain and offset constants
- .7 Program parameter adjustments
- .8 Trend log display edit/create trend logs through DDC system main panels
- .9 Zone controllers shall NOT be mounted in ceiling spaces.

2.4 ELECTRONIC AIR VALVE CONTROLS, SENSORS & ACTUATORS

- .1 Control sub-contractor shall include for the supply and installation of pressure sensors, operators and stand-alone controllers for the air valves.
- .2 Control components shall be pre-assembled for testing and performance verification prior to arrival on site.
- .3 Multipoint crossflow sensors shall be supplied by air valve manufacturer.
- .4 Flow transducer shall be a full differential pressure unit not hot wire or thermister type.
- .5 Electronic operators shall be provided for air valve dampers with piston or gear driven type damper operators.
- .6 Air valve damper motors shall be Belimo LM24-T floating control or approved equal.
- .7 Damper operators shall operate with floating point signal for full modulation.
- .8 Damper operators shall be rigidly attached to the support structure and linkage shall have no "slop".
- .9 These control components shall be field tested with air valve for testing and performance verification.
- .10 Submit written test data for the terminal unit controllers for each size of air valve and fan coil unit.
- .11 Supply air temperature measurement shall be provided on each air valve with reheat coils.

2.5 DDC SYSTEM FUNCTIONS

- .1 The DDC system shall utilize "BACnet open architecture" and have a proven Operator Control Language (OCL), which shall be capable of reading the value, and/or status of all control devices from any user defined combination of calculations and logical expressions.
- .2 All SAP's and BACnet Gateways shall conform to the BACnet Protocol Implementation Conformance Specification.
- .3 Other mandatory monitoring and control features of the DDC system are:
 - .1 Provide two level security system access with passwords.
 - .1 Level 1:
 - .1 To allow assignment of Level 1 and Level 2 passwords.
 - .2 Creation of new system operators, ability to create, delete and modify system components, modify selected system components, and alarm levels, and generally full system access.
 - .2 Level 2:
 - .1 To allow command and override of system components, alarm acknowledgment, monitor system, display information including alarm messages, graphics, points log, help menus.
 - .2 Operator defined digital and analog alarms and automatic alarm condition reporting.

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- .3 Auto lockout of alarms when alarmed system is shut down.
 - .4 Direct keyboard override of all digital and analog outputs, with an indication of the display of any point that is operating under keyboard override.
 - .5 Addition, deletion, definition and modification of points and point types from operator keyboard.
 - .6 Trend log graphing of user selected points and times.
 - .7 Run time totalization.
 - .1 The DDC system shall have the capability to be taken offline in the event of failure or for maintenance and returned to operation without the need for entering any portion of the software program manually.
 - .2 To accomplish this, an off-line disk storage device shall be utilized to provide software backup and reload.
 - .8 On-site backup and verification of the entire system, with full applications software, shall be less than TEN (10) seconds per SAP.
 - .9 The DDC system shall be provided with automatic protection from any power failure of up to seventy two (72) hours duration.
 - .10 This protection shall at a minimum include continuous real-time clock operation and automatic system restart upon power return.
 - .1 System shall be tested to confirm rated hours.
 - .11 Panel replacement shall be possible without any hardware modification. Describe replacement procedure in technical data submitted.
 - .12 Any panel malfunction shall not affect the operation of the multi-panel system.
 - .13 Indicate how points located on one panel can be accessed and utilized by another panel. Explain any limitations of the above.
 - .14 Each BC and AAC standard panel proposed shall have enough random access memory for all of the following:
 - .1 Trend Logs - two for each input and output point connected to the panel with 100 samples each.
 - .2 Controllers - two for each analog output point connected to the panel.
 - .3 Variables - three for each output point connected to the panel.
 - .1 Variables are "virtual points" (as opposed to physical points) but which have all the attributes of real or physical points.
 - .4 Operator Control Language (OCCL) - twenty syntactically correct lines each with at least 4 operators, for each output point connected to the panel, or TEN (10) syntactically correct lines, each with at least four operators, for each output point connected to the panel, if the OCL has the ability to call common routines or use wild card commands.
 - .5 Descriptor - one for each user definable point, real or virtual, in the panel.
 - .1 In addition, on multi-panel systems, every descriptor in the system must be accessible from a single I/O port.
 - .6 Time Schedules - one for every 3 output points connected to the panel.
 - .7 Totalizers - one for each digital point in the panel.
 - .15 Processing Speed
 - .1 Effective Panel Processing Speed
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- .1 Maximum permissible execution time is half a second.
 - .2 Execution time is defined as the time it takes the stand-alone panel CPU to execute all application software in the panel, from some point in the software back to the same point, assuming full memory usage, while simultaneously responding to operator or terminal display requests and carrying out normal inter-panel communications averaged over a one - minute period.
 - .3 This will be done by setting up a counter in each panel and monitoring the counting rate.
 - .2 Effective System Processing Speed
 - .1 This applies to multi-panel systems only.
 - .2 System processing speed is intended to address inter-panel communication and will be checked by evaluating system display response.
 - .3 This will be done by setting up a display of all panel counters and checking how frequently each counter updated on the refreshed display.
 - .3 Displays shall load real time current values, not stored values, within ten seconds.
 - .1 Every counter shall show an updated value on the display within sixty seconds at the previous update appearing.
 - .2 Provide confirmation that required system processing speed will be achieved.
 - .16 DDC System Inter-Panel Communication.
 - .1 Means shall be provided to ensure communication integrity. Provide detail of the system.
 - .2 To prevent damage to the system, each data highway line shall be provided with a means of isolation, either optically or by some other means.
 - .1 Provide detail of protection system in proposal.
 - .17 Sensors and Associated Equipment.
 - .1 BAS shall be supplied with all sensors, relays and associated equipment to fully connect the listed DDC points.
 - .1 Field point installation shall be performed in a neat and orderly fashion with all components marked or labeled to correspond with the making or labeling in the as built drawings.
 - .2 All sensors and controllers shall be of commercial grade and shall be installed according to the manufacturer's recommendations.
 - .1 Provide full details of all sensors and controllers proposed, including their range and accuracy.

2.6 SYSTEM STRUCTURE

- .1 The Building Automation System (BAS) architecture shall consist of the following installed in communication and main mechanical rooms:
 - .1 Stand-alone DDC system main panels
 - .2 Stand-alone DDC system terminal equipment (zone) controllers
 - .2 Provide plug-in access for remote or lap-top computer at each panel using the same software as resides on the central workstation.
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2.7 DDC SYSTEM PANELS

- .1 References:
 - .1 National Institute of Standards and Technology - NISTIR 6392 GSA Guide to Specifying Interoperable Building Automation and Control Systems Using ANSI/ASHRAE Standard 135-1995, BACnet.
- .2 DDC Panel Types:
 - .1 BC minimum capabilities equivalent to the BACnet Building Controller (B-BC).
 - .2 AAC Local Control Unit minimum capabilities equivalent to the BACnet Custom Application Specific Controller (B-AAC).
 - .3 ASC Terminal Control Unit minimum capabilities equivalent to the BACnet Application Specific (B-ASC).
 - .4 AAC Room Control Unit minimum capabilities equivalent to the BACnet Custom Application Specific Controller (B-AAC).
 - .5 SS Smart Sensor minimum capabilities equivalent to the BACnet Smart Sensor (B-SS).
 - .6 DDC Panel Applications – This section describes the mechanical systems that shall be connected to the different DDC panel types.
 - .7 BC main function is to provide direct control of all main central mechanical systems such as chillers, cooling towers, heat exchangers, domestic hot water, fan systems etc. The BC's shall directly reside on the primary Ethernet LAN.
 - .8 AAC function is to provide control for miscellaneous HVAC components in remote mechanical rooms such as rooftop units, fan coils, unit ventilators, VAV, etc. AAC's shall reside on the secondary RS485 MS/TP network.
 - .9 ASC level controllers are not acceptable unless specifically specified for a unique application.
- .3 All DDC panels shall meet the minimum requirements set out in this section.

2.8 BC BACNET OVERVIEW

- .1 A BC (B-BC) is a native BACnet, general purpose, field programmable controller capable of carrying out a variety of building automation and control tasks. It enables the specification of the following:
- .2 Data Sharing:
 - .1 Ability to provide the values of any of its BACnet objects.
 - .2 Ability to retrieve the values of BACnet objects from other devices.
 - .3 Ability to allow modification of all of its BACnet objects by another device.
- .3 Alarm and Event Management:
 - .1 Generation of alarm / event notifications and the ability to direct them to recipients.
 - .2 Maintain a list of unacknowledged alarms / events.
 - .3 Notification of other recipients that the acknowledgment has been received.
 - .4 Adjustment of alarm / event parameters.
- .4 Scheduling:
 - .1 Ability to schedule output actions, both in the local device and in other devices, both binary and analog, based on date and time.
- .5 Trending:

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- .1 Collection and delivery of (time, value) pairs.
 - .6 Device and Network Management:
 - .1 Ability to respond to information about its status.
 - .2 Ability to respond to requests for information about any of its objects.
 - .3 Ability to respond to communication control messages.
 - .4 Ability to synchronize its internal clock upon request.
 - .5 Ability to perform re-initialization upon request.
 - .6 Ability to upload its configuration and allow it to be subsequently restored.
 - .7 Ability to command half-routers to establish and terminate connections.
 - .7 Provide sufficient number of BC's to fully meet all requirements of this specification plus specified spare point capacity. An Ethernet gateway connecting the WAN to the building BC is NOT acceptable.
 - .8 BC to be stand-alone intelligent controller. BC panel to:
 - .1 Be microprocessor based, multi-tasking, multi-user, real-time digital control processors capable of supervising other lower level programmable controllers through secondary networks.
 - .2 Consist of modular hardware with plug-in processors, communication controllers, power supplies, I/O modules.
 - .3 Provide MS/TP BACnet LAN port for local AAC/ASC network.
 - .4 Provide on board LAN interface for ethernet BACnet peer-to-peer communication between BC's and at least 1 RS-232C serial data communication ports to support simultaneous operation of multiple operator I/O devices such as industry standard printers, lap-top work-stations, PC work-stations and BC-mounted or portable OT's. One RS-232C data port will support point-to-point PTP BACnet protocol.
 - .5 Allow temporary use of portable devices without interrupting normal operation of permanently connected modems, printers, OT's.
 - .6 Interface field sensors via local I/O terminations located on BC located in processor cabinet.
 - .7 In standalone mode execute programmable logic control (direct digital or closed loop process control) of associated HVAC equipment without interacting with other processors or OWS's.
 - .9 Dial-up Communications:
 - .1 Auto-dial/auto-answer communications to allow BC's to communicate with remote OW's on non-continuous basis via telephone lines. Or Internet IP communications link to communicate with network
 - .2 To analyze and set priorities for all alarms to minimize of calls. Non-critical alarms to be buffered in memory and reported as group or until operator manually requests upload of alarms.
 - .10 Spare Capacity:
 - .1 Provide 20% spare point capacity on panels with greater than 32 I/O and 10% spare capacity on panels with less than 32 I/O.
 - .11 Programming and Energy management routines:
 - .1 BC to provide for the following energy management routines:
 - .1 Time of day scheduling.
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- .2 Calendar based scheduling.
- .3 Holiday scheduling.
- .4 Temporary schedule overrides.
- .5 Optimal start.
- .6 Optimal stop.
- .7 Supply air reset
- .8 Duty cycling
- .9 Night setback
- .10 Chilled water and condenser water reset
- .11 Heating water reset
- .2 All programs to be executed automatically without need for operator intervention.
- .12 Programming languages:
 - .1 Shall meet requirements specified in Custom Programming Capability section of specification.
- .13 Priority Level:
 - .1 BC shall provide for 16 levels of priority from all outputs. The priority levels shall conform to the BACnet object specifications.
- .14 Trend Logging:
 - .1 All trend log information shall be stored at BC and not at OWS.

2.9 AAC BACNET OVERVIEW

- .1 An AAC (B-AAC) is a general purpose, field programmable controller capable of carrying out a variety of building automation and control tasks. It enables the specification of the following:
- .2 Data Sharing:
 - .1 Ability to provide the values of any of its BACnet objects.
 - .2 Ability to retrieve the values of BACnet objects from other devices.
 - .3 Ability to allow modification of all of its BACnet objects by another device.
- .3 Alarm and Event Management:
 - .1 Generation of alarm / event notifications and the ability to direct them to recipients.
 - .2 Maintain a list of unacknowledged alarms / events.
 - .3 Notifying other recipients that the acknowledgment has been received.
 - .4 Adjustment of alarm / event parameters.
- .4 Scheduling:
 - .1 Ability to schedule output actions, both in the local device and in other devices, both binary and analog, based on date and time.
- .5 Trending:
 - .1 Collection and delivery of (time, value) pairs.
- .6 Device and Network Management:
 - .1 Ability to respond to information about its status.
 - .2 Ability to respond to requests for information about any of its objects.
 - .3 Ability to respond to communication control messages.

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- .4 Ability to synchronize its internal clock upon request.
 - .5 Ability to perform re-initialization upon request.
 - .6 Ability to upload its configuration and allow it to be subsequently restored.
 - .7 Ability to command half-routers to establish and terminate connections.
 - .7 Provide sufficient number of AAC's to fully meet all requirements of this specification plus specified spare point capacity.
 - .8 AAC to be stand-alone intelligent controller. AAC panel to:
 - .1 Be microprocessor based, multi-tasking, multi-user, real-time digital control processors capable of supervising other lower level programmable controllers through secondary networks.
 - .2 Consist of modular hardware with plug-in processors, communication controllers, power supplies, I/O modules.
 - .3 Provide MS/TP BACnet LAN port for local ASC network.
 - .4 Provide on board LAN interface for MS/TP BACnet peer-to-peer communication between AAC's and at least 1 RS-232C serial data communication port to support operation of operator I/O devices such as industry standard printers, lap-top work-stations, PC work-stations and AAC-mounted or portable OT's. RS-232C data port, will support point to point PTP BACnet protocol.
 - .5 Allow temporary use of portable devices without interrupting normal operation of permanently connected modems, printers, OT's.
 - .6 Interface field sensors directly to I/O terminations located on AAC in processor cabinet.
 - .7 In standalone mode execute programmable logic control (direct digital or closed loop process control) of associated HVAC equipment without interacting with other processors or OWS's.
 - .9 Spare Capacity:
 - .1 Provide 10% spare point capacity for each AAC without additional cards, terminals or a minimum of one spare input and one spare output.
 - .2 If AAC is used for unitary equipment then no spare capacity is required unless identified on points list.
 - .10 Programming and Energy management routines:
 - .1 AAC to provide for the following energy management routines:
 - .1 Time of day scheduling.
 - .2 Calendar based scheduling.
 - .3 Holiday scheduling.
 - .4 Temporary schedule overrides.
 - .5 Optimal start.
 - .6 Optimal stop.
 - .7 Supply air reset.
 - .8 Duty cycling.
 - .9 Night setback.
 - .2 All programs to be executed automatically without need for operator intervention.
 - .11 Programming languages:
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- .1 Shall meet requirements specified in Custom Programming Capability section of specification.
- .12 Priority Level:
 - .1 AAC shall provide for 16 levels of priority from all outputs. The priority levels shall conform to the BACnet object specifications.
- .13 Trend Logging:
 - .1 All trend log information shall be stored at AAC and not at BC or OWS.

2.10 ASC BACNET OVERVIEW

- .1 ASC BACnet overview: An ASC (B-ASC) is a controller with limited resources relative to an AAC.
 - .1 It is intended for use in a specific application and supports limited programmability. It enables specification of the following:
- .2 Data Sharing:
 - .1 Ability to provide the values of any of its BACnet objects
 - .2 Ability to allow modification of some or all of its BACnet objects by another device
- .3 Alarm and Event Management:
 - .1 None
- .4 Scheduling
 - .1 None
- .5 Trending
 - .1 None
- .6 Device and Network Management
 - .1 Ability to respond to information about its status.
- .7 ASC to be stand-alone intelligent controller. ASC panel to:
 - .1 Be microprocessor based, real-time digital control processors.
 - .2 Consist of modular hardware with communication controllers, power supplies, I/O modules.
 - .3 Provide on board LAN interface for MS/TP BACnet peer-to-peer communication between ASC's and at least 1 RS-232C serial data communication port to support operation of operator I/O devices such as industry standard printers, lap-top work-stations, PC work-stations and ASC-mounted or portable OTs.
 - .4 Allow temporary use of portable devices without interrupting normal operation of permanently connected modems, printers, OTs.
 - .5 Interface field sensors directly to I/O terminations located on ASC in processor cabinet.
 - .6 In standalone mode execute programmable logic control (direct digital or closed loop process control) of associated terminal equipment without interacting with other processors or OWS's.
- .8 Spare Capacity:
 - .1 Provide 10% spare point capacity for each ASC without additional cards, terminals.
 - .2 If ASC is used for terminal equipment, then no spare capacity is required unless identified on points list.
- .9 Programming and Energy management routines:

- .1 ASC to provide for the following energy management routines:
 - .1 Temporary schedule overrides.
 - .2 Supply air reset
 - .3 Night setback
- .2 All programs to be executed automatically without need for operator intervention.
- .10 Programming languages:
 - .1 Firmware based application specific program utilizing full BACnet objects and functionality.
- .11 Priority Level:
 - .1 ASC shall provide for 1 levels of priority from all outputs.
- .12 Trend Logging
 - .1 All trend log information shall be stored at AAC or BC not ASC.

2.11 CUSTOM PROGRAMMING CAPABILITY

- .1 Programming languages:
- .2 All GCL General Control Language software to be programmed in general control type or high-level control language supporting full BACnet objects and functionality.

PART 3 EXECUTION

3.1 NOT APPLICABLE

END OF SECTION 25 20 00

PART 1 GENERAL

1.1 SECTION INCLUDES

- .1 This section provides guidance and requirements for devices and accessories for Building Automation Systems.
- .2 Provide all remote sensing points and instrumentation as required for the complete operational capability of the Control System.
- .3 All instruments of a particular category shall be of the same type and manufacture.

1.2 RELATED REQUIREMENTS

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted, and coordinated with all other parts.
- .2 In conjunction with Division 01, Division 20 General Mechanical Provisions shall govern all Division 25 Sections of the work.
- .3 Refer to Section 20 99 60 Mechanical Forms and submit all documentation therein that is applicable to Division 25.
- .4 Refer to and comply with the following sections:
 - .1 General Requirements - Division 01
 - .2 Common Work for Mechanical Systems – Division 20
 - .3 Plumbing Systems - Division 22
 - .4 Heating, Ventilation and Air Conditioning Systems - Division 23
 - .5 Controls and Instrumentation - Division 25
 - .6 Electrical - Division 26/27

1.3 SUBMITTALS

- .1 Action Submittals
- .2 Informational Submittals
- .3 LEED Submittals
- .4 Operation and Maintenance Materials
- .5 Record Documents

1.4 QUALITY ASSURANCE

- .1 Refer to Section 20 02 00 - General Provisions for Mechanical, Quality Assurance, for additional details.
 - .2 Provide all remote sensing points and instrumentation as required for the complete operational capability of the Control System.
 - .1 All sensors shall have the accuracies as stated hereinafter.
 - .1 Hysteresis, relaxation time, span, maximum / minimum limits, etc. shall also be accounted for in all application of sensors and controls.
 - .3 All instruments of a particular category shall be of the same type and manufacture.
 - .4 All external trim material shall be completely corrosion resistant with all internal parts assembled in watertight, shockproof, vibration proof, heat resistant assembly.
 - .5 Use standard conduit box termination with screwdriver connector block unless otherwise specifically stated.
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- .6 Operating conditions 0oC to 60oC with 10-90% RH (non-condensing) unless otherwise specifically stated.
 - .7 All instruments, transmitter's pressure switches, sensors, are expected to be reachable by ordinary means.
 - .1 All installed devices should incorporate future maintenance in mind.
 - .2 Mounting a device that has pipework in the way or makes it inaccessible is not permitted.
 - .8 Occupancy sensors, temperature, and humidity transmitters (sensors), CO2 detectors, must be verified, an initial calibration should not be required if factory calibrated.
 - .1 Refer to manufactures recommendation as a minimum.
 - .2 If the device is not within specification, it should be noted on the commissioning documents and corrected.
 - .3 If a reoccurrence or drift error occurs within the warranty period, it shall be replaced.
 - .9 All Sensors Gauges and Transmitters shall be installed to be operated within 75% of their capacity.

1.5 APPLICABLE CODES AND STANDARDS

- .1 This project is deemed to be a post-disaster design.
- .2 Refer to Section 20 05 01, Codes, Bylaws and Standards.
- .3 All installation, execution, and testing shall conform to the following standards as a minimum:
 - .1 Provincial Building Code
 - .2 Local Building By-Laws

PART 2 PRODUCTS

2.1 AIR VALVE CONTROLLERS

- .1 Microprocessor based terminal unit controllers (TUC's) (ASC – ASHRAE's standards for naming unitary controllers) and damper actuators for the air valves will be supplied by the Controls Contractor.
 - .1 The TUC's shall be provided in a pre-assembled control box for mounting on the air valve.
 - .2 The multi-point flow sensor shall be supplied and installed by the air valve manufacturer.
 - .2 The necessary interface requirements for the multi-point flow sensor shall be provided by the Controls Contractor (confirm exact requirements with the air valve manufacturer).
 - .3 Controller and actuator shall be factory field mounted on the air valve by the air valve manufacturer Controls Contractor.
 - .4 The Controls Contractor shall be responsible for ensuring that the controllers and damper actuators are suitable for the units and that the characteristics of the boxes listed herein are met.
 - .5 Controls shall be arranged for pressure independent, variable volume and constant volume operation.
 - .6 Controls shall be resettable to any air volume between zero and maximum rated volume.
 - .7 The Controls Contractor shall provide all necessary assistance to air valve manufacturer for factory / laboratory testing of air valves.
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- .1 One unit of each size air valve shall be factory tested under varying pressure and flow conditions.
- .8 Refer to Section 25 30 00 for TUC specifications.
- .9 Refer to Section 23 36 0023 36 00 for air valve specifications.

2.2 ALARM PANELS

- .1 Provide alarm panels in the following locations:
 - .1 Reverse Osmosis Equipment Room
 - .2 Level 0 Basement Mechanical Room
 - .3 Clinical Panel in Tech Workroom
 - .4 Local Alarm at Dialysis Clinic Nursing Stations
- .2 Alarm panels shall include:
 - .1 Test button to verify lights and alarm horn function.
 - .2 Pilot trouble light(s) and alarm horn to indicate any alarm condition (1 light for each alarm).
 - .3 Non-disabling silencing button on panel shall silence horn but alarm light(s) shall continue to burn until alarm condition has been corrected and reset button has been reset.
 - .1 On all subsequent alarms received the horn shall sound.
 - .4 System on-off switch with key.
 - .5 Panel to be suitably labelled.

2.3 CURRENT SENSING (CR)

- .1 Design: Nelsen-Kuljian; Greystone, Veris, RIB (Functional Devices).
- .2 Range: 0-120 amps.
- .3 Accuracy: +/-1%.
- .4 Split core type if required by owner
- .5 Interface care:
 - .1 +/-1% accuracy.
 - .2 Integral zero and span adjustment.
 - .3 1-5 VDC or 4-20 mA output for full range input.
 - .1 Two (2) end switches, open and closed

2.4 CONTROL VALVES

- .1 General
 - .1 Control valves to be supplied by this Division for installation by Division 22 or 23 as applicable.
 - .2 All characteristics of control valves shall be suited to the required application.
 - .1 Three-way mixing valves shall be linear for each port giving constant flow, and two-way valves shall have modified linear flow characteristics.
 - .3 All valves shall be plug type with stainless steel stems and EPT ring pads or teflon packing.
 - .1 12 mm (1/2") and 20 mm (3/4") control valves for radiant panels, reheat coils, unit heaters, cabinet unit heaters, small fan coil units, may be ball type.

- .4 Valve pressure / temperature rating - minimum ANSI Class 125.
- .5 Plugs shall be brass with molded composition discs.
- .6 Discs (renewable) shall be bronze for media 110C (140F) or less and stainless steel for media above 110C (140F) operating temperature.
- .7 Clearly identify the control valve coefficient (Cv) rating on valve bodies.
- .2 All primary building heating valves shall fail open to heating (valves on terminal units may fail either open or to the last operating position).
- .3 Cooling valves shall fail closed to cooling or to the last operating position.
- .4 Domestic hot water heating valves shall fail closed to heating.
- .5 Valve bodies for 12 mm (½") shall be threaded ends, cast brass with integral seat.
 - .1 Standard of Acceptance:
 - .1 Johnson Controls VG1000 series.
- .6 Valves 20 mm (¾") to 50 mm (2") shall have threaded ends, cast brass body, and cast brass cage with integral seat.
 - .1 Standard of Acceptance:
 - .1 Johnson Controls VG7000 series
- .7 Valve bodies for 65 mm (2½") and up shall be cast iron flanged.
 - .1 Standard of Acceptance:
 - .1 Johnson Controls VG2000 series
- .8 Control Valve Pressure Drops:
 - .1 Size control valves according to capacities and pressure drops as indicated in the schedules.
 - .1 Wide open pressure drop for valves 25 mm (1") and under shall not exceed 15 kPa (2 psig).
 - .2 Wide open pressure drop for valves over 25 mm (1") shall not exceed 35 kPa (5 psig).
 - .3 Any necessary variations shall be reviewed with the Consultant.

2.5 CONTROL VALVES - PRESSURE INDEPENDENT

- .1 Standard of Acceptance:
 - .1 Up to : Griswold PIC-V
 - .2 65 mm (2.5") and over: Griswold MVP
- .2 See Section 25 99 65 Equipment Manufactures for approved manufacturers.
- .3 See Section 23 21 13 23 21 13Hydronic Specialties for general valve requirements.
- .4 The modulating control valves shall be pressure independent and shall include a Pressure Compensating Cartridge, Actuated Ball Valve, and Manual Isolation Ball in a single valve housing.
- .5 Valve housing shall consist of forged brass, rated at no less than 2,482 kPa (360 psig) at 121C (250F)121oC.
- .6 Valve ball shall consist of chemically plated nickel brass or stainless steel.
- .7 Actuated stem shall be removable/replaceable without removing valve from line.
- .8 Manufacturer shall be able to provide ball insert to limit flow to maximum flow rate with ±5% accuracy.

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- .9 Valve shall have EPDM O-rings behind the seals to allow for a minimum close-off pressure of 689 kPa (100 psig) 100 psig (689 kPa) with 3.95 Nm (35 in-lbs) of torque for 12 mm to 75 mm (1/2" – 3") sizes.
 - .10 Valve shall have a fixed end or union end connection with factory installed air vent to allow for venting of the coil.
 - .11 Dual pressure/temperature test valves for verifying the pressure differential across the cartridge and flow limiting ball shall be standard.
 - .12 Pressure compensating cartridge shall automatically compensate for pressure changes in valve and shall maintain a constant pressure drop across the flow limiting actuated ball.
 - .1 The operating pressure range shall be available with the minimum range requiring 35 kPa (5 psig) 5 psig (35 kPa) to actuate the mechanism.
 - .2 Valve internal control mechanism includes a diaphragm and full travel linear coil spring.
 - .3 Valves shall include an accessible/ replaceable cartridge.
 - .13 A universal mounting plate shall allow installation of actuators meeting the system electrical requirements and valve torque requirements.
 - .1 The actuator and plate can be rotated after mounting.
 - .14 Valve shall include a 600 WOG manual isolation ball valve.
 - .15 Identification tags shall be available for all valves; tags shall be indelibly marked with Cv, model number and location; tags shall be 75 mm x 75 mm (3" x 3") aluminum.
 - .16 Provide 0-10 VDC control operators for terminal units.
 - .1 Floating point or tri-state operators will not be accepted.
 - .17 Valve operators shall be easily removable for service or replacement.
 - .18 Size valve operators to close valves against pump shut off head.
 - .19 All valve operators shall be suitable for continuous operation.
 - .20 Valves and actuators shall be suitable for operating conditions encountered and shall provide stable operation throughout the range of operating conditions.

2.6 CONTROL VALVE ACTUATORS

- .1 General:
 - .1 Valve operators shall allow smooth operation of the valve throughout its entire range and assure tight shut-off against system pressure.
 - .2 Valve actuator shall be easily removed from the valve body for replacement.
 - .2 Electric Two Position Valve Actuators (VTE):
 - .1 Two Position Control Valve Actuators (only to be used where specifically specified):
 - .3 Incremental Control Valve Actuators (only to be used where specifically specified) (VMI):
 - .1 The valve actuator shall modulate the control valve between the fully open and closed position based upon a 3-wire control signal (24 VAC).
 - .1 The actuator shall remain in position until the signal is applied.
 - .2 The valve shall maintain its shutoff force even if power is lost.
 - .3 The TUC shall calculate valve position based on the motor speed and duration of control signal.
 - .1 The valve shall be driven to a full position and the calculation reset once every 24 hours.
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- .4 Proportional Control Valve Actuators (VME):
 - .1 The valve actuator shall modulate the control valve between the fully open and closed position based upon a 0-10 VDC or 4-20 mA control signal.
 - .1 The actuator shall remain in its position until the applied signal changes.
 - .2 In the event of a control signal loss, the actuator shall move to the zero-voltage input position.
 - .2 The valve shall maintain its shutoff force even if power is lost.

2.7 CONTROL PANELS

- .1 General:
 - .1 Fabricate from prime and enamel coated steel suitable for flush mounting, recess mounting, or free standing with mounting legs, as applicable.
 - .2 Outdoor panels shall be weatherproof fiberglass type with a breather plug.
 - .3 All control panel enclosures shall be accessible with 1m clear working distance in front, with no obstructions.
 - .1 Ceiling mounted enclosures shall have accessible T-Bar removable panel and room to place a ladder below.
 - .4 Panels shall be identified with a panel legend, proper wire tagging, a panel identifier on the outside of the panel, and the panels are to be maximum 75% full when complete to allow room for future expansion.
 - .5 Panel doors shall be hinged and complete with locks.
 - .6 Construct so that instruments and gauges are flush mounted.
 - .7 Provide sub-panel, inside control panel, for mounting control components.
 - .8 Adhere Lamicoid nameplates on the control panels to clearly identify the service of each device.
 - .9 All DDC controllers which are networked together must be accompanied with a network map.
 - .10 Submit shop drawings of control panel for review.

2.8 DIFFERENTIAL PRESSURE TRANSMITTERS (DPT)

- .1 Provide differential pressure transmitters having the following minimum specifications:
 - .1 Internal materials to be suitable for continuous contact with the process material measured including compressed air, water, glycol or steam as applicable.
 - .2 Output signal of 4 - 20 mA into a maximum of 500-ohm load.
 - .3 Output variations of less than 0.2% full scale for supply voltage variations of +/- 10%.
 - .4 Combined non-linearity, repeatability and hysteresis effects not to exceed +/- 1% of full-scale output over entire range.
 - .5 Integral zero and span adjustment.
 - .6 Temperature effect of +/- 1.5% full scale at 50C (122F) or less.
 - .7 Output short circuit and open circuit protection.
 - .8 Over-pressure input protection to a minimum of twice rated input.

2.9 END SWITCHES (ESW)

- .1 End switches shall provide positive status indication of full open and full closed damper blade position.

- .1 Provide 2 switches per damper if necessary.

2.10 ELECTRIC RELAYS (ER)

- .1 Provide DPDT relays for control and status indication of alarms and/or electrical starters and equipment.
- .2 Relay coils shall be rated for 120V or 24V. Where other voltages occur provide transformer.
- .3 Contacts rated at 5 amps at 120V AC.
- .4 Relays to be plug in type with termination base.

2.11 ELECTRONIC AIR FLOW MEASURING STATIONS (FMS)

- .1 Air flow measuring stations are to be provided by the Sheet Metal Sub-Contractor c/w 4 – 20 mA electronic pressure transmitter for connection by the controls contractor.
- .2 Controls contractor to provide required external power supply to pressure transmitters.
- .3 Specify range of air flow to ensure station can read the velocity,
- .4 Note the required "straight lengths of ducting required for the station to read the flow accurately

2.12 ELECTRONIC AIR FLOW MEASURING STATIONS (FMS)

- .1 Air flow measuring stations for the VAV supply, return and exhaust fans shall be supplied and installed by this trade.
- .2 The electronic air flow measuring stations shall be as manufactured by Air Monitor Corporation or approved equal.
 - .1 The station shall consist of all necessary components to provide the required VAV control and interface with the BAS.
- .3 As a minimum the electronic air flow measuring stations shall consist of FI probes located in the bell mouth of the fans to be controlled and a Vectron DPT 2500 transmitter with digital readout.

2.13 ELECTRONIC WATER FLOW MEASURING STATIONS (WFS)

- .1 Water flow measuring stations are to be provided by the Mechanical Contractor(s) c/w electronic transducer for connection by the Controls subtrade.
- .2 Refer to Section 20 05 20 Flow Meters.

2.14 FLOW SWITCHES (FSW)

- .1 Standard of Acceptance:
 - .1 McDonnell Miller, Johnson Controls.
- .2 Minimum Requirements:
 - .1 Single pole double throw action (vapour proof on chilled water).
 - .2 Adjustable sensitivity.
 - .3 Extended trimmable paddles.
 - .4 Selected for minimum flow condition.
- .3 Notes:
 - .1 Install in upright position in horizontal run of pipe.
 - .2 Install a minimum of 5 pipe diameters downstream of any valves, elbows, orifices or any other obstructions.
 - .3 Adhere to manufacturer's installation recommendations.

2.15 HUMIDITY SENSORS (HS)

- .1 Provide humidity sensors as directed with the following minimum specifications:
 - .1 Range room type 30-80% RH.
 - .2 Range duct type 20-90% RH.
 - .3 Operating temperature range of 0C to 60C (32F to 140F).
 - .4 Absolute accuracy of +/- 3% RH.
 - .5 Stainless steel sheath construction complete with integral shroud to enable specified operation in air streams of up to 10 m/sec (2,000 ft/min).
 - .6 Sensor able to be cleansed of oil vapour, dust or other anticipated air borne contaminants by a simple field method such as solvent or mild detergent solution washing.
 - .7 Room humidity sensors shall be located at the inlet to an RA grille.
 - .8 Duct mounted sensors shall be located such that the sensing element is located in the air stream and the transmitter electronics are out of the air stream.

2.16 MIXING BOX CONTROLLERS

- .1 Microprocessor based terminal unit controllers (TUC's) and damper actuators for the mixing boxes to be supplied by the Controls Contractor.
 - .1 The TUC's shall be provided in a pre-assembled control box for field mounting on the mixing boxes.
 - .2 The multi-point flow sensors shall be supplied and installed by the mixing box manufacturer
- .2 The necessary interface requirements for the multi-point flow sensor shall be provided by the Controls Contractor (confirm exact requirements with the mixing box manufacturer).
- .3 The Controls Contractor shall be responsible for ensuring that the controllers and damper actuators are suitable for the units and that the characteristics of the boxes listed herein are met.
- .4 Controls arranged for pressure independent, variable volume and constant volume operation.
- .5 Resettable to any air volume between 50% and 120% of the nominal schedule volume or to zero.
- .6 External taps for balancing gauge.
- .7 Refer to Section 23 36 00 for mixing box specifications.

2.17 PROGRAMMABLE CONTROLLER NON DDC APPLICATION ONLY

- .1 Minimum Requirements:
 - .1 Seven-day programmable load controller with a minimum of four independent load circuits.
 - .2 Liquid crystal display to indicate time, day and function.
 - .3 Built-in battery to maintain program memory and clock accuracy for 72 hrs.
 - .4 Self-contained enclosure with clear plastic cover.
 - .5 Manual on/off/auto switches for each of the four circuits to allow manual override.
- .2 Standard of Acceptance: MaxiRex D4, Davis Controls Ltd.

2.18 PRESSURE SWITCHES (PSW)

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- .1 Provide pressure or differential pressure switches for ranges as indicated.
 - .2 Pressure sensing elements shall be Bourbon tube, bellows or diaphragm type.
 - .3 Adjustable setpoint and differential.
 - .4 Pressure switches shall be snap action type rated at 120 volts, 15 amps AC or 24 volts DC.
 - .5 Sensor assembly shall operate automatically and reset automatically when condition returns to normal.
 - .6 Sensor Ratings: sensors shall have the following pressure and accuracy ratings:
 - .1 Low and medium steam sensors shall be rated at 1,034 kPa (150 psig).
 - .2 Low pressure shall operate from 0 kPa to 207 kPa (0 psig to 30 psig) with an accuracy of plus or minus 3.5 kPa (0.5 psig).
 - .3 Medium pressure shall operate from 0 kPa to 700 kPa (0 psig to 100 psig) and with an accuracy of plus or minus 7 kPa (1 psig).
 - .4 High pressure steam sensors shall be rated at 2,068 kPa (300 psig), have a full operating range of 0 kPa to 2,068 kPa (0 psig to 300 psig) with an accuracy of plus or minus 14 kPa (2 psig).
 - .7 Pressure switches for pump operation shall have a range of 20 kPa to 350 kPa (3 psig to 50 psig) and adjustable differential from 1 kPa to 35 kPa (0.1 psig to 5 psig).
 - .8 Pressure switches for fan operation shall have a range of 0 kPa to 1,500 kPa (0 psig to 220 psig) and adjustable differential from 10 kPa to 50 kPa (1.5 psig to 7.5 psig).
 - .9 Sensors on steam lines and high temperature water shall be protected by pigtail siphon installed between the sensor and the fluid line.
 - .10 All sensors shall have an isolation valve and snubber installed between the sensor and pressure source.

2.19 ROOM HUMIDISTATS & THERMOSTATS

- .1 For non-DDC applications.
- .2 Minimum Requirements
 - .1 Adjustable sensitivity and set point.
 - .2 Electric.
 - .1 Low or line voltage as specified.
 - .3 Standard metal or Lexan covers.
 - .1 Visible thermometer (thermostats only) graduated in deg.C.
 - .2 Concealed set-point adjustment (or removable key adjustment).
 - .3 Lock key covers.
 - .4 Thermostats in the operating rooms to be adjustable by room occupants.
 - .5 Room thermostats sensors for all applications shall be equipped with an "occupied" switch or button to enable room occupants to override the "unoccupied" schedule for "after hours" operation.
- .3 Note:
 - .1 Provide a key for each instrument requiring a removable key up to a maximum of six.
 - .1 Obtain two signed receipts from the Owner certifying that the keys have been received.
 - .2 Hand one over to the Consultant.

2.20 STATIC PRESSURE TRANSMITTERS (SPT)

- .1 Output of 4 - 20 mA linear into maximum of 500-ohm load.
- .2 Calibrated span: not greater than twice the static pressure at maximum flow.
- .3 Accuracy: +/- 1% of span.
- .4 Repeatability: within 0.5% of output.
- .5 Linearity: 1.5% of span.
- .6 Deadband or Hysteresis: 0.1% of span.

2.21 TEMPERATURE SENSORS

- .1 For DDC applications.
- .2 General: Temperature sensors shall be thermistor, resistance or thermocouple type, however, thermocouples shall be restricted to temperature range 200C (392F) and above.
- .3 The following shall apply to thermistor, resistance or thermocouple temperature sensors as applicable.
 - .1 RTDs shall be 100 ohm or 1,000 ohms at 0C (32F) (+/- .2 ohm) nickel or platinum element with strain minimizing construction and 3 integral anchored leadwires coefficient of resistivity of 00.000385 ohms/ohm/deg.C (0.000693 ohms/ohm/deg.F). Thermistors shall be 3,000 or 10,000 ohms.
 - .2 Sensing element to be hermetically sealed.
 - .3 Stem and tip construction to be copper or 304 stainless steel as noted.
 - .4 Sensors to have a time constant response of less than 3 seconds to a temperature change of 10C (18F).
 - .5 Sensors shall operate over the following ranges with the accuracies over the noted range of the sensor.
 - .1 -50C to +50C (-58F to +122F), plus or minus 0.5C (1F).
 - .2 0C to 50C (32F to 122F), plus or minus 0.25C (0.5F).
 - .3 0C to 25C (32F to 77F), plus or minus 0.1C (0.2F).
 - .4 0C to 100C (32F to 212F), plus or minus 1C (2F).
 - .6 Immersion wells shall be of stainless-steel materials for steam and domestic hot water and brass for other applications.
 - .1 Heat transfer compound to be compatible with sensor.
- .4 Temperature sensors shall be of the following types:
 - .1 Room type (RTS)
 - .1 Suitable for wall mounting, with or without protective guard.
 - .2 Room temperature sensors in staff areas (non-student, non-public areas) – two-wire type with up/down temperature adjust, no display
 - .3 Room temperature sensors in student or public areas – no user interface input or display, flat stainless steel plate.
 - .4 Room temperature sensors shall be mounted 150 mm (6") below any other sensors to prevent false readings due to heat from these sensors.
 - .2 General purpose duct type (DTS)
 - .1 Suitable for insertion into air ducts at any angle, insertion length shall be suitable for application.

- .2 Copper sheathed construction.
- .3 Spring-loaded thermowell type (ITS)
 - .1 Spring loaded construction with compression fitting for 20 mm (3/4") NPT well mounting.
 - .2 Lengths shall be suitable for application.
 - .3 Stainless steel sheathed construction.
- .4 Averaging duct type (ATS)
 - .1 Continuous filament with immersion length of 6 mm (20') minimum.
 - .2 Probe to be bent, at field installation time, to a minimum radius of 100 mm (4") at any point along the probe length without degradation in performance.
 - .3 Copper sheathed construction.
 - .4 Multiple sensors mounted on a cable connected to provide an average temperature reading
- .5 Outside air type (OTS)
 - .1 Complete with non-corroding shield designed to minimize solar and wind effects, threaded fitting for mating to 12 mm (1/2") conduit, probe length of 1100 mm to 150 mm (4" to 6").

2.22 TEMPERATURE SWITCHES (TSW)

- .1 Provide high/low temperature switches for ranges as indicated on point schedule.
- .2 Temperature sensing element shall be liquid, vapour or bimetallic type.
- .3 Adjustable setpoint and differential.
- .4 Snap action type rated at 120 volts, or 24 V DC as required.
- .5 Sensors shall operate automatically and reset automatically. Sensors used for freeze detection or fire detection shall be manually reset type.
- .6 Temperature accuracy shall be +/-1C (2F).
- .7 Temperature switches shall be of the following types:
 - .1 Room type - suitable for wall mounting on standard electrical box with or without protective guard.
 - .2 General Purpose Duct type - suitable for insertion into air ducts, insertion length of 457 mm (18").
 - .3 Thermowell type - with compression fitting for 20 mm (3/4") well mounting, length of 100 mm (4").
 - .1 Immersion wells shall be brass (stainless steel for domestic water and steam).
 - .4 Freeze detection type - continuous element with insertion length of 6m (20 ft) minimum, suitable for duct mounting to detect the coldest temperature in any 300mm (12") section of its length.
 - .5 Strap-on type - with helical screw stainless steel clamps.

2.23 TIMECLOCKS

- .1 Minimum Requirements:
 - .1 150 mm (6") dia. dial, 7-day calendar type.
 - .2 Spring reserve (minimum of 10 hours) and manual reset.
- .2 Accessories:

- .1 Accessible manual-automatic bypass switch (one for each switching circuit).
- .2 Adjustable spring wound timer (0-12 hours) without "hold" (Intermatic F12H).
- .3 Standard of Acceptance: Intermatic, Paragon, Tork.

2.24 UNINTERRUPTIBLE POWER SUPPLY (UPS).

- .1 Under normal operating conditions power will be supplied from the local electricity distributor. B.C. Hydro.
 - .1 In the event of failure of this supply, the standby generator(s) will start and provide power to the essential distribution system.
 - .2 All equipment supplied under this Division is to be connected to the essential distribution system.
- .2 To allow for an extended delay which may be encountered getting the generator "online".
 - .1 Provide uninterruptible power for all AUTOMATION system and equipment required for MEMORY, PROCESSING, DATA ACQUISITION, and OPERATOR INTERFACE.
 - .2 The intent is that the automatic system must be aware of the length of time that the building systems are without power and adjust the chain of events accordingly once power is restored.
- .3 The automation system must be in full control of the building systems as soon as normal electrical power is restored.
 - .1 Delays for disk drive startup, and/or system "re-boot" are not acceptable.
- .4 Provide uninterruptible power capable of supporting this performance for a MINIMUM period twenty minutes for all B.A.S. equipment.
- .5 The uninterruptible power supply(ies) may be centrally located, or may be distributed as required throughout the building, and may take the form of individual battery/charger, and/or battery / charger / inverter combinations as required by the individual pieces of equipment.
- .6 Provided supplies must meet the following criteria:
 - .1 Total harmonic distortion less than 5%.
 - .2 Single frequency harmonic distortion less than 3%.
 - .3 Output frequency regulation better than 1%.
 - .4 Static output voltage regulation better than +/-2% over battery voltage range of 105 to 140 V.D.C.
 - .5 Dynamic output voltage regulation better than
 - .1 +/- 15% with a 50% load change, and
 - .2 +/- 30% with a 100% load change.
 - .6 Recovery rate faster than 3 Hertz after 100% load change.
 - .7 Slew rate less than 2 Hertz per second.
 - .8 Battery recharge time with full normal operating load, 8 hours from fully discharged state (105 V.D.C.) to full charge
 - .9 Overload capability
 - .1 105% continuous.
 - .2 125% 10 minutes.
 - .3 200% 1 minute.
 - .10 Power factor better than 0.8.
 - .11 Acoustical noise radiation at 1.2 m (4 ft.) less than 65 dBa for supplies up to 30 kva.

- .12 Batteries to be maintenance free gel/cell type.
- .13 Batteries to be warranted for three (3) years.
- .7 Provide the following monitoring features:
 - .1 D.C. voltmeter and ammeter.
 - .2 A.C. output voltmeter and ammeter.
 - .3 Audible and visible alarm indications on front panel.
 - .4 Common alarm output dry contacts for remote monitoring.
 - .5 Controls Contractor to wire from contacts to B.A.S.
- .8 Provide the following over current protection breakers:
 - .1 A.C. input.
 - .2 A.C. output.
 - .3 D.C. battery output.
 - .4 A.C. alternate line input.
- .9 Configure the power supply(ies) such that they can be removed for repair or maintenance without disrupting the memory or the operation of the automation system.
 - .1 Provide manual bypass switch to remove the supply from service.
- .10 For supplies having a capacity in excess of 3 kVA, provide a static transfer switch with manual lock-on feature to bypass supply for service.
 - .1 Provide for alternate source input which shall be connected to separate electrical panelboard.
 - .2 If primary input is connected to Essential panelboard, alternate input shall be connected to Normal panelboard.
- .11 Commercial quality electrical distribution panel and all wiring to B.A.S. head end computer, CRTs, printers and DDC panels shall be the responsibility of the Controls Contractor.
- .12 Standard of Acceptance:
 - .1 SAB NIFE Corporation.
 - .2 Liebert Corporation.
 - .3 Philtek Electronics Ltd.
 - .4 Power Inc. (PCI) Pulsesector.

2.25 VELOCITY PRESSURE TRANSMITTERS (VPT)

- .1 Output of 4 - 20 mA linear into maximum of 500-ohm load.
- .2 Calibrated span: not greater than twice the static pressure at maximum flow.
- .3 Calibrated accuracy: +/- 1.0% of span.
- .4 Repeatability: within 0.1% of output.
- .5 Linearity: 0.5% of span.
- .6 Deadband or Hysteresis: 0.1% of span.

2.26 VARIABLE SPEED DRIVE CONTROLLER

- .1 Refer to Section 20 05 04 Variable Speed Drives.

PART 3 EXECUTION

3.1 GENERAL

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- .1 All equipment shall be installed according to manufacturers' published instructions.
 - .2 Temperature, Humidity Sensors, Thermostats and Humidistats:
 - .1 All sensors shall be stabilized to such a level as to permit on-the-job installations that will require minimum field adjustments or calibration.
 - .2 Sensor assemblies shall be readily accessible and adaptable to each type of application in such a manner as to allow for quick, easy replacement and servicing without special tools or skills.
 - .3 Outdoor installation shall be weatherproof construction in NEMA 4 enclosures.
 - .1 Install space instruments at a height of 1.5 m (5 ft.) above the finished floor, unless otherwise indicated.
 - .4 Install corridor instruments at a height of 2.1 m (7 ft.) above the finished floor.
 - .5 Locate instruments in the same vertical centreline as light switches.
 - .6 Where instruments are indicated on an outside wall install on a stand-off wall bracket which provides an air space between the instrument and the wall; or on an insulating base (e.g. a cork pad).
 - .7 Install protective metal guards on instruments in areas where they may be subject to damage (loading areas, gymnasiums, workshops, public corridors, and storage areas).
 - .1 Fasten guards independent of instruments, to separate baseplates.
 - .2 Provide backing in wall for securing mounting bases.
 - .8 Sensors in ducts shall be mounted in locations to sense the correct temperature of the air only, and shall not be located in dead air spaces.
 - .1 The location shall be within the vibration and velocity limits of the sensor.
 - .2 Where an extended surface element is required to properly sense the average temperature it shall be securely mounted within the duct to measure the best average temperatures.
 - .3 Elements shall be thermally isolated from brackets and supports to respond to air temperature only.
 - .4 Sensor element to be supported separately and not connected to coils or filter racks.
 - .9 Wells shall be installed in the piping at elbows where piping is smaller than the length of the well to effect proper flow across the entire area of the well.
 - .1 Well shall not restrict flow area to less than 70 percent of line-size-pipe normal flow area.
 - .3 Temperature Transmitters, Humidity Transmitters, Controllers and relays to be installed in NEMA 1 enclosures.
 - .1 Panels to be either free standing or wall mounted ANSI 61 polyester powder coated steel cabinets with hinged and key locked front door.
 - .1 Arrange for conduit and tubing entry from top, bottom or either side.
 - .2 Panels shall be modular multiple panels being used if required for capacity in any particular location.
 - .3 All panels shall be lockable with same key.
 - .4 All wiring and tubing within panels to be located in trays or individually clipped to back of panel, and clearly identified.
 - .4 All field devices to be properly identified.
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- .5 Mount electrical instruments on standard electrical rough-in boxes fastened to structure.
- .6 Testing:
 - .1 All field devices shall be properly calibrated and tested for performance and accuracy.
 - .1 A report detailing test performed and results to be submitted to the consultant for approval.
 - .2 The consultant will verify results at random.
 - .3 Provide all testing equipment necessary.
 - .4 Provide manpower necessary to assist consultant's verification.

END OF SECTION 25 30 00

PART 1 GENERAL

1.1 SECTION INCLUDES

- .1 This section provides sequences of operation (written descriptions) for mechanical systems and equipment that will be controlled through the Building Automation System (BAS).
- .2 The Division 25 Controls Contractor is responsible for programming and implementing the control sequences provided in this specification section.
- .3 Refer to Section 25 05 00 Common Work for Control Systems

1.2 GENERAL REFERENCES

- .1 This Section of the Specification forms part of the Contract Documents and is to be read, interpreted, and coordinated with all other parts.
- .2 In conjunction with Division 01, Division 20 General Mechanical Provisions shall govern all Division 25 Sections of the work.
- .3 Refer to Section 20 99 60 Mechanical Forms and submit all documentation therein that is applicable to Division 25.
- .4 This Section of the specifications consists of systems descriptions where the control sequences of operations have been provided to guide the Mechanical Contractor, Controls Contractor, Commissioning Agency, and other team members.
- .5 This Section of the specifications provides control sequences intended to provide a guideline for the project design intent.
 - .1 In all cases the sequences require further development to meet the intent of the drawings and specification.
- .6 Refer to all other specification sections (including Divisions other than Division 25), the drawing packages (including layout drawings, schematics, drawing points lists etc. for additional information.

1.3 RELATED REQUIREMENTS

- .1 Refer to and comply with the following sections:
 - .1 General Requirements - Division 01
 - .2 Common Work for Mechanical Systems – Division 20
 - .3 Fire Suppression Systems - Division 21
 - .4 Plumbing Systems - Division 22
 - .5 Heating, Ventilation and Air Conditioning Systems - Division 23
 - .6 Controls and Instrumentation - Division 25
 - .7 Electrical - Division 26/27/28

1.4 SUSTAINABILITY

- .1 Refer to Division 01 for Sustainability Design Requirements and Section 20 02 00 - General Provisions for Mechanical, Sustainability

1.5 SUBMITTALS

- .1 Refer to Division 01 and Section 20 05 05 - Documentation and Submittals.
 - .2 Refer to Section 20 99 60 Mechanical Forms and submit all documentation therein that is applicable to this Specification Section.
 - .3 Shop Drawings
-

- .1 Submit shop drawings in accordance with Division 01 and Section 20 05 05 Documentation and Submittals.
- .2 Shop drawings are required for all materials and equipment.

1.6 HVAC CONTROL OBJECTIVES

- .1 Programming and installation of the control system shall be provided to meet the following objectives:
 - .1 General
 - .1 Setpoints shall be adjustable on operator workstations (OWS) or via login through web browser etc.
 - .1 All default set-points shall be tested, set, and recorded during testing and balancing.
 - .2 Work with testing and balancing Agency to assist with testing and balancing (TAB) of all controlled systems.
 - .1 Verify default set-points, emergency failure set-points and catastrophic mode setpoints.
 - .3 The Consultant, Commissioning Agency, and Controls Contractor shall optimize final control sequences to reflect the built condition.
 - .2 Temperature and Humidity
 - .1 Due to the nature of the project (Healthcare Facility) the temperature in all occupied spaces will be monitored and controlled.
 - .2 Humidity will be monitored in each regularly occupied space.
 - .1 Rooms that require direct humidity control (not via the general air handling system) will be indicated in this section or on the drawings.
 - .3 The humidification level is controlled (generally) from the supply air from the air handling units.
 - .4 Humidity alarms shall be monitored by the BMS and displayed at the room level.
 - .1 They shall not, however, be annunciated at the room level unless specifically requested in the specification or as indicated on the drawings.
 - .5 Unless otherwise specified the temperature ranges shall fall within the requirements of CSA Z317.2 Table 1 (HVAC Design Criteria) based on room type.
 - .1 Note that compounding room temperatures and air changes rates are defined in the NAPRA model standard for Hazardous or Non-Hazardous Sterile (or non-Sterile) compounding
 - .6 Unless otherwise specified the target humidity for most rooms shall be 40% RH (adjustable).
 - .1 In cold outside air temperatures, the relative humidity setpoint shall be reduced to minimize the building window RH according to a reset schedule according to outside air temperature.
 - .2 The building RH shall always be always maintained above 30% and below 60% to meet the requirements of CSA Z317.2 Table 1 (HVAC Design Criteria) based on room type.

- .3 Per CSA Z317.2 it is expected that the humidity (and temperature) may at times of the year may go outside of the required range.
 - .1 This shall be alarmed, recorded, and monitored through the BMS network.
- .3 Ventilation (air flow and air changes)
 - .1 The air supply quantity (l/s) and the total air changes per hour (ACPH) rates, for each space or room, shall be monitored tracked based on the space or room volume (adjusted for the final space or room configuration (ceiling height etc.) and supply and / or return air quantities.
 - .2 Control the system's minimum total air and minimum outdoor air supply to meet the demand of each room or space to meet the minimum ventilation requirements, under all operating conditions, based on CSA Z317.2 Table 1 and NAPRA model standards, ASHRAE 62 etc.
 - .1 Refer to drawings for additional information on space / room classifications.
 - .3 Airflow to each room shall be alarmed if the supply (return or exhaust) drops below CSA Z317.2 minimum requirements under normal conditions.
 - .1 Maximum supply air volumes are based on the larger of peak heating, peak cooling, CSA Z317.2 -19 values, ASHRAE 62 values, NAPRA values or other values as required to meet the design intent.
- .4 Energy and Sustainability Objectives
 - .1 Provide no more heating than is essential including minimizing reheat and turning air systems to minimum CSA airflow quantities whenever unoccupied or temperature and humidity ranges can be maintained.
 - .2 Provide temperature, humidity and pressure reset functions for air and water systems to reduce energy consumption.
 - .3 Shut systems down if all the spaces are scheduled to be unoccupied unless the temperature falls below the night setback temperature (while maintaining relative pressurization as required by Code) for Type III rooms only.
- .5 Room Temperature Setpoints
 - .1 All room temperature and humidity setpoints shall follow Table 1 from CSA Z317.2.

1.7 ALARMS AND SAFETIES

- .1 All temperature, humidity, and pressure sensors shall alarm their high or low alarm condition, as defined in the system database, at all Operator's Workstations (OWS), via browser or at location annunciator panels as indicated on the drawings and in the specifications.
- .2 Humidity shall not be alarmed under 30% RH or over 60% RH at annunciator panels unless specifically requested by Facilities or indicated on the drawings or in the specifications.
- .3 An alarm shall be generated through the BMS at any of the OWS's (including web browser login access, pager or text message as required by Facilities), when any motor status as sensed by a current sensing relay does not match the commanded value for that motor.

1.8 DUTY / STANDBY AND EQUIPMENT OPERATION

- .1 Where indicated, BMS shall automatically designate "duty" or "standby" status to pumps, fans or equipment based on totalized run time.

- .2 Duty designation shall be assigned to the pump, fan, or equipment with the least accumulated run time at the time of system start-up.
- .3 If duty pump, fan or equipment fails to start or is disabled the BMS shall start the standby pump, fan, or equipment.
- .4 Note that some equipment is configured in a duty / duty / standby configuration. For example, three (3) pumps sized at 50% each.

1.9 ADDITIONAL SEQUENCES

- .1 Refer to 25 09 35 – Compounding Pharmacy Airflow control for additional information regarding the pharmacy differential pressure monitoring and control systems.
- .2 Smoke Control Matrix – refer to section 25 90 30 Smoke Control for additional information.

PART 2 PRODUCTS

2.1 PRODUCTS

- .1 Refer to Sections 25 30 00 Controls Devices and 25 10 00 Building Automation System

PART 3 EXECUTION

3.1 PLUMBING SYSTEMS

- .1 The BMS shall monitor dry contact alarm outputs provided by the Plumbing Sections for recording and annunciation at the OWS(s).
 - .1 Wiring between the dry contacts and the BMS panels shall be by this contractor.
- .2 Automatic Trap Primers

END OF SECTION 25 90 10