DLR Group

Architecture
Engineering
Planning
Interiors

Lee's Summit Middle School #4

Lee's Summit R-7 School District
Lee's Summit, Missouri

Package 3 – Building & Site
Permit Set

Volume 3 of 4 – Division 21 through Division 23

DLR Group Project No. 13-20102-00

October 8, 2020

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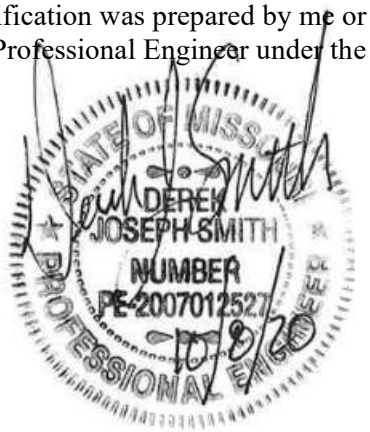
I hereby certify that this specification was prepared by me or under my direct supervision and that I am a duly Licensed Architect under the laws of the State of Missouri.

Scott Pashia License No. 7347

I hereby certify that this specification was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Missouri.

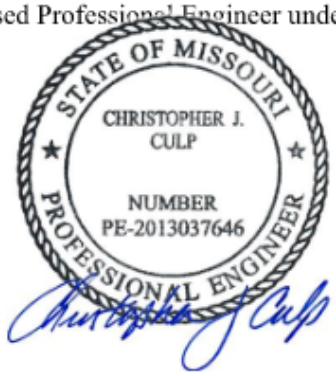


Derek Joseph Smith License No. 2007012527

I hereby certify that this specification was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Missouri.

Carl J. Holden License No. 2020016283 Oct 7 2020

I hereby certify that this specification was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Missouri.



Christopher J. Culp License No. 2013037646

Oct 7 2020

I hereby certify that this specification was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Missouri.

Curtis A. Olds License No. 2018036640

Oct 7 2020

I hereby certify that this specification was prepared by me or under my direct supervision and that I am a duly Licensed Landscape Architect under the laws of the State of Missouri.

David H. Contag License No. 000148

END OF SECTION 000105

SECTION 210010 - GENERAL FIRE SUPPRESSION REQUIRMENTS

PART 1 - GENERAL REQUIREMENTS

1.1 DESCRIPTION OF WORK

A. This Division requires the furnishing and installing of complete functioning systems, and each element thereof, as specified or indicated on the Drawings and Specifications or reasonably inferred; including every article, device or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the work include materials, labor, supervision, supplies, equipment, transportation, and utilities.

B. Division 21 of the Specifications and Drawings numbered with prefixes FP generally describe these systems, but the scope of the Fire Suppression work includes all such work indicated in the Contract Documents: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Fire Suppression, Mechanical, Plumbing, Fire Alarm and Electrical Drawings and Specifications; and Addenda.

C. The Drawings have been prepared diagrammatically intended to convey the scope of work, indicating the intended general location and arrangement of the equipment, piping, etc. without showing all the exact details as to elevations, offsets, pipe routing, and other installation requirements. The Contractor shall use the Drawings as a guide when laying out the work and shall verify that materials and equipment will fit into the designated spaces, and which, when installed per manufacturers requirements, will ensure a complete, coordinated, satisfactory and properly operating system.

D. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 7 Section "Penetration Firestopping" for material and methods for firestopping systems.

2. Division 21 Section 210500 "Common Work Results for Fire Suppression," for materials and methods for wall and floor penetrations.

3. Division 21 Section 210515 "Basic Fire Suppression Piping Material and Methods," for general piping and fitting materials and methods.

4. Division 21 Section 210553 "Identification for Fire Suppression Piping and Equipment" for labeling and identification of installed fire suppression equipment.

5. Division 21 Section 211100 "Fire Suppression Water Service Piping" for fire suppression piping starting 5 feet outside the building to within the building.

6. Division 21 Section 211313 "Water-based Fire Suppression Systems" for fire suppression sprinkler systems inside the building.

1.2 QUALITY ASSURANCE

A. All work under this division shall be executed in a thorough professional manner by competent and experienced workmen licensed to perform the Work specified.

B. All work shall be installed in strict conformance with manufacturer's requirements and recommendations. Equipment and materials shall be installed in a neat and professional manner and shall be aligned, leveled, and adjusted for satisfactory operation.

C. Material and equipment shall be new, shall be of the best quality and design, shall be current model of the manufacturer, shall be free from defects and imperfections and shall have markings or a nameplate identifying the manufacturer and providing sufficient reference to establish quality, size and capacity. Material and equipment of the same type shall be made by the same manufacturer whenever practicable.

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

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. Threaded joints shall conform to ASME B1.20.1, Pipe Threads, General Purpose and the Pipe Fitters Handbook.

G. Regulatory Requirements: Comply with all standards listed in Section 1.2 and all applicable local requirements.

H. All electrical equipment provided and the wiring and installation of electrical equipment shall be in accordance with the requirements of this Section, Division 26 and Division 28.

I. Through and Membrane Penetration Firestopping Systems Installer Qualifications: A firm experienced in installing penetration firestopping systems similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its penetration firestopping system products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.

1.3 CODES, REFERENCES AND STANDARDS

A. Execute Work in accordance with the National Fire Protection Association Standards and all Local, State, and National codes, ordinances and regulations in force governing the particular class of Work involved. Obtain timely inspections by the constituted authorities, and upon final completion of the Work obtain and deliver to the Owner executed final certificates of acceptance from the Authority Having Jurisdiction.

B. Any conflict between these Specifications and accompanying Drawings and the applicable Local, State and Federal codes, ordinances and regulations shall be reported to the Architect in sufficient time, prior to the submission of Bids, to prepare the Supplementary Drawings and Specification Addenda required to resolve the conflict.

C. The governing codes are minimum requirements. Where these Drawings and Specifications exceed the code requirements, these Drawings and Specification shall prevail.

D. All material, manufacturing methods, handling, dimensions, method or installation and test procedure shall conform to but not be limited to the following industry standards and codes.

1. NFPA (National Fire Protection Association) 13, "Installation of Sprinkler Systems", 2016 Edition.

2. NFPA 14, "Installation of Standpipes, Private Hydrants and Hose Systems", 2016 EditionNFPA 24, "Private Fire Service Mains and their Appurtenances", 2016 Edition.

3. NFPA 25, "Inspection, Testing and Maintenance of Water-Based Fire Protection Systems", 2017 Edition.

4. Underwriters Laboratories, "Fire Protection Equipment Directory", Latest Edition.

5. International Building Code (IBC), 2018 Edition with local amendments.

6. International Fire Code (IFC), 2018 Edition with local amendments.

E. Contractor shall comply with rules and regulations of public utilities and municipal departments affected by connections of services.

F. All Fire Suppression work shall be performed in compliance with applicable safety regulations, including OSHA regulations. Safety lights, guards, shoring and warning signs required for the performance of the Fire Suppression work shall be provided by the Contractor.

1.4 DEFINITIONS

A. General:

1. Furnish: The term "furnish" is used to mean "supply and deliver to the project site, ready for unloading, unpacking, assembly, installation and similar operations."

2. Install: The term "install" is used to describe operations at the project site including the actual "unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations."

3. Provide: The term "provide" means "to furnish and install, complete and ready for the intended use."

4. Furnished by Owner or Furnished by Others: The item will be furnished by the Owner or Others. It is to be installed and connected under the requirements of this Division, complete and ready for operation, including items incidental to the Work, including services necessary for proper installation and operation. The installation shall be included under the guarantee required by this Division.

5. Engineer: Where referenced in this Division, "Engineer" is the Engineer of Record and the Design Professional for the Work under this Division, and is a Consultant to, and an authorized representative of, the Architect, as defined in the General and/or Supplementary Conditions. When used in this Division, it means increased involvement by, and obligations to, the Engineer, in addition to involvement by, and obligations to, the "Architect".

6. AHJ: The local code and/or inspection agency (Authority) Having Jurisdiction over the Work.

7. NRTL: Nationally Recognized Testing Laboratory, as defined and listed by OSHA in 29 CFR 1910.7 (e.g., UL, ETL, CSA, etc.), and acceptable to the Authority having Jurisdiction

(AHJ) over this project. Nationally Recognized Testing Laboratories and standards listed are used only to represent the characteristics required and are not intended to restrict the use of other listed Manufacturers and models that meet the specified criteria.

8. Substitution: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor. Substitutions include Value Engineering proposals.

   a. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.

   b. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.

9. Value Engineering: A systematic method to improve the "value" of goods and services by using an examination of function. Value, as defined, is the ratio of function to cost. Value can therefore be increased by either improving the function or reducing the cost. The goal of VE is to achieve the desired function at the lowest overall cost consistent with required performance.

B. The terms "approved equal", "equivalent", or "equal" are used synonymously and shall mean "accepted by or acceptable to the Engineer as equivalent to the item or manufacturer specified". The term "approved" shall mean labeled, listed, or both, by an NRTL, and acceptable to the AHJ over this project.

C. Pipe sizes used in this Specification are Nominal Pipe Size (NPS).

D. Other definitions for fire protection systems are listed in NFPA Standards 13, and 24.

E. Working Plans, also referred to as Fire Protection Drawings as used in this Section means those documents (including drawings and calculations) prepared pursuant to the requirements contained in NFPA 13 for obtaining approval of the Authority Having Jurisdiction.

F. The following definitions apply to excavation operations:

1. Additional Excavation: Where excavation has reached required subgrade elevations, if unsuitable bearing materials are encountered, continue excavation until suitable bearing materials are reached. The Contract Sum may be adjusted by an appropriate Contract Modification.

2. Sub-base: as used in this Section refers to the compacted soil layer used in pavement systems between the subgrade and the pavement base course material.

3. Subgrade: as used in this Section refers to the compacted soil immediately below the slab or pavement system.

4. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction from the Architect.

1.5 COORDINATION

A. The Contractor shall visit the site and ascertain the conditions to be encountered while installing the Work under this Division, verify all dimensions and locations before purchasing equipment or

commencing work, and make due provision for same in the bid. Failure to comply with this requirement shall not be considered justification for omission, alteration, incorrect or faulty installation of Work under this Division or for additional compensation for Work covered by this Division.

B. The Contractor shall refer to Drawings of the other disciplines and to relevant equipment drawings and shop drawings to determine the extent of clear spaces. The Contractor shall make offsets required to clear equipment, beams and other structural members; and to facilitate concealing piping in the manner anticipated in the design.

C. The Contractor shall maintain a foreman on the jobsite at all times to coordinate his work with other contractors and subcontractors so that various components of the Fire Suppression systems will be installed at the proper time, will fit the available space, and will allow proper service access to the equipment. Carry on the work in such a manner that the work of the other contractors and trades will not be handicapped, hindered, or delayed at any time.

D. Work of this Division shall progress according to the "Construction Schedule" as established by the Prime Contractor and his subcontractors and as approved by the Architect/Engineer. Cooperate in establishing these schedules and perform the Work under this Division, in a timely manner in conformance with the construction schedule so as to ensure successful achievement of schedule dates.

E. The contractor shall coordinate work in this section with all related trades. Work and/or equipment provided in other sections and related to the fire protection system shall include, but not be limited to:

1. Sprinkler monitoring equipment (water flow switches, valve tampers, etc) shall be provided by the fire sprinkler installer, but wired and connected by Division 28.

F. System shall be complete and operational with power and control wiring provided to meet the design intent shown on the drawings and described within the specification sections.

1.6 MEASUREMENTS AND LAYOUTS

A. The drawings are schematic in nature, but show the various components of the systems approximately to scale and attempt to indicate how they are to be integrated with other parts of the building. Figured dimensions shall be taken in preference to scale dimensions. Determine exact locations by job measurements, by checking the requirements of other trades, and by reviewing the Contract Documents. The Contractor will be held responsible for errors which could have been avoided by proper checking and inspection.

1.7 SUBMITTALS

A. Refer to Division 01 and General Conditions for submittal requirements, in addition to requirements specified herein.

B. Submittals and shop drawings shall not contain the firm name, logo, seal, or signature of the Engineer. They shall not be copies of the work product of the Engineer. If the Contractor desires to use elements of such product, the license agreement for transfer of information obtained from the Engineer must be used.

C. Assemble and submit for review manufacturer product literature for material and equipment to be furnished and/or installed under this Division. Literature shall include shop drawings, manufacturer product data, performance sheets, samples, and other submittals required by this Division. Provide the

number of submittals required by Division 1; if hard-copy sets are provided, submit a minimum of seven (7) sets. General product catalog data not specifically noted to be part of the specified product will be rejected and returned without review.

D. Separate submittals according to individual specification sections. Only resubmit those sections requested for resubmittal.

E. Provide submittals in sufficient detail so as to demonstrate compliance with these Contract Documents and the design concept. Highlight, mark, list or indicate the materials, performance criteria and accessories that are being proposed. Illegible submittals will be rejected and returned without review.

F. Refer to individual Sections for additional submittal requirements.

G. Transmit submittals as early as required to support the project schedule. Allow two weeks for Engineer review time, plus to/from mailing time via the Architect, plus a duplication of this time for resubmittals, if required. Transmit submittals as soon as possible after Notice to Proceed and before Fire Suppression construction starts.

H. Before transmitting submittals and material lists, verify that the equipment submitted is mutually compatible with and suitable for the intended use. Verify that the equipment will fit the available space and maintain manufacturer recommended service clearances. If the size of equipment furnished makes necessary any change in location, or configuration, submit a shop drawing showing the proposed layout.

I. Submittals shall contain the following information:

1. The project name.

2. The applicable specification section and paragraph.

3. Equipment identification acronym as used on the drawings.

4. The submittal date.

5. The Contractor's stamp, which shall certify that the stamped drawings have been checked by the Contractor, comply with the Drawings and Specifications, and have been coordinated with other trades.

6. Submittals not so identified will be returned to the Contractor without action.

J. Refer to Division 1 for acceptance of electronic submittals for this project. For electronic submittals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 1. Contractor shall notify the Architect and Engineer that the submittals have been posted. If electronic submittal procedures are not defined in Division 1, Contractor shall include the website, user name and password information needed to access the submittals. For submittals sent by e-mail, Contractor shall copy the Architect and Engineer's designated representatives. Contractor shall allow for the Engineer review time as specified above in the construction schedule. Contractor shall submit only the documents required to purchase the materials and/or equipment in the submittal.

K. The checking and subsequent acceptance by the Engineer and/or Architect of submittals shall not relieve responsibility from the Contractor for (1) deviations from the Drawings and Specifications; (2) errors in dimensions, details, sizes of equipment, or quantities; (3) omissions of components or fittings; and (4) not coordinating items with actual building conditions and adjacent work. Contractor shall request and secure written acceptance from the Engineer and Architect prior to implementing any deviation.

L. Provide shop drawings prepared in accordance with referenced standards identified as "Working Plans", including hydraulic calculations where applicable. Shop drawings shall be signed and sealed by a Professional Engineer registered in the state in which the project is located where required by local authorities having jurisdiction, or NICET Level III or IV certified technician. Submit copies of the certification for the designer with submittal. Shop drawings consisting of the following shall be furnished at a minimum. Refer to NFPA 13 for additional requirements.

1. Scaled site plan indicating underground piping with sizes and hydrants utilized for flow test in relation to the building.

2. Layout drawings of complete fire sprinkler system indicating relationship to all other trades. This shall include all equipment, piping and a reflected ceiling plan indicating sprinkler locations.

3. Complete details and sections as required to clearly define and clarify the design indicated.

4. Shop drawings shall be to a standard scale and not less than 3/32" = 1'-0".

5. Shop drawings shall be produced using computer-aided design. Hand drawn documents will not be reviewed or approved.

6. Hydraulic calculations shall be based on a water flow test conducted at the site within twelve (12) months of the submittal of plans for approval. The contractor shall be responsible for obtaining the flow test if existing data is not available. Flow test information shall be documented on shop drawings with an accompanying site plan to scale. Contractor shall verify with AHJ any minimum safety factor requirements. Demand shall not be less than 10 percent below the supply at the demand point.

   a. Hydrant testing shall be in accordance with NFPA 13 and 291 requirements.

7. Available fire-hydrant flow test records indicate the following conditions:

   a. Date: 03/19/20

   b. Performed by: Ryan Ratcliffof City Of Lee's Summit Water Utility Operation Division

   c. Location of Residual Fire Hydrant: 040-091 FH

   d. Location of Flow Fire Hydrant: 040-090 FH

   e. Static Pressure at Residual Fire Hydrant: 76 PSI

   f. Measured Flow at Flow Fire Hydrant: 1650 GPM

   g. Residual Pressure at Residual Fire Hydrant: 70 PSI

M. Contractor shall prepare installation drawings (working shop drawings) based upon this design. Requests for deviations from the approved design shall be submitted in writing to the Engineer of Record for approval. Shop drawings showing deviations from the design without prior approval will not be approved.

N. Provide welders' qualification certificates.

O. Provide Test Reports and Certificates including:

1. "Contractor's Material & Test Certificate for Aboveground Piping"

2. "Contractor's Material & Test Certificate for Underground Piping" as described in NFPA

    a. Underground piping test certificate shall be obtained prior to connection of the aboveground system.

1.8 ELECTRONIC DRAWING FILES

A. In preparation of shop drawings or record drawings, Contractor may, at their option, obtain electronic drawing files in AutoCAD or DXF format from the Engineer for a shipping and handling fee of $200 for a drawing set up to 12 sheets and $15 per sheet for each additional sheet. Contact the Architect for Architect's written authorization. Contractor shall request and complete the Electronic File Release Agreement form from the Engineer. Send the form along with a check made payable to Henderson Engineers, Inc. Contractor shall indicate the desired shipping method and drawing format on the attached form. In addition to payment, Architect's written authorization and Engineer's release agreement form must be received before electronic drawing files will be sent.

1.9 SUBSTITUTIONS

A. Refer to Division 1 and General Conditions for substitutions in addition to requirements specified herein.

B. Materials, products, equipment, and systems described in the Bidding Documents establish a standard of required function, dimension, appearance and quality to be met by the proposed substitution.

C. The base bid shall include only the products from manufacturers specifically named in the drawings and specifications.

D. Request for Substitution:

1. Complete and send the Substitution Request Form attached at the end of this section for each material, product, equipment, or system that is proposed to be substituted.

2. The burden of proof of the merit of the proposed substitution is upon the proposer.

3. Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner the following:

    a. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.

    b. Proposed substitution is consistent with the Contract Documents and will produce indicated results, including functional clearances, maintenance service, and sourcing of replacement parts.

    c. Proposed substitution has received necessary approvals of authorities having jurisdiction.

    d. Same warranty will be furnished for proposed substitution as for specified Work.

    e. If accepted substitution fails to perform as required, Contractor shall replace substitute material or system with that originally specified and bear costs incurred thereby.

f. Coordination, installation and changes in the Work as necessary for accepted substitution will be complete in all respects.

E. Substitution Consideration:

1. No substitutions will be considered unless the Substitution Request Form is completed and attached with the appropriate substitution documentation.

2. No substitutions will be considered prior to receipt of Bids unless written request for approval to bid has been received by the Engineer at least ten (10) calendar days prior to the date for receipt of Bids.

3. If the proposed substitution is approved prior to receipt of Bids, such approval will be stated in an Addendum. Bidders shall not rely upon approvals made in any other manner. Verbal approval will not be given.

4. No substitutions will be considered after the Contract is awarded unless specifically provided in the Contract Documents.

1.10 OPERATION AND MAINTENANCE MANUALS

A. Refer to Division 1 and General Conditions for Operation and Maintenance Manuals in addition to requirements specified herein.

B. Submit manuals prior to requesting the final punch list and before all requests for Substantial Completion.

C. Instruct the Owner's permanent personnel in the proper operation of, startup and shutdown procedures and maintenance of the equipment and components of the systems installed under this Division.

D. Prior to Substantial Completion for the project, furnish to the Architect, for Engineer's review,and for Owner's use, four (4) copies of Operation and Maintenance Manuals in labeled, hard-back three-ring binders, with cover, binding label, tabbed dividers and plastic insert folders for Record Drawings. Include local contacts, complete with address and telephone number, for equipment, apparatus, and system components furnished and installed under this Division of the specifications.

E. Include the following sections with the appropriate information for each section:

1. Typewritten Index.

2. Qualifications. Provide designer and installer qualification.

3. Bill of Materials. Provide complete nomenclature, model number and vendor information for all parts.

4. Operating Instructions. Complete instructions detailing operation and maintenance of all equipment installed.

5. Product Data: Provide product cut-sheets for all equipment utilized and installed.

6. Guarantee. Copy of all guarantees and warranties issued.

7. Testing/Certification: Provide all completed testing and certification forms as required per NFPA 13 and 25.

8. Contact list with minimum three service representative phone numbers.

F. Refer to Division 1 for acceptance of electronic manuals for this project. For electronic manuals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 1. Contractor shall notify the Architect and Engineer that the manuals have been posted. If electronic manual procedures are not defined in Division 1, Contractor shall include the website, user name and password information needed to access the manuals. For manuals sent by e-mail, Contractor shall copy the Architect and Engineer's designated representatives.

1.11 SPARE PARTS

A. Provide to the Owner the spare parts specified in the individual sections in Division 21 specifications.

1.12 RECORD DRAWINGS

A. Refer to Division 01 and General Conditions for Record Drawings in addition to requirements specified herein.

B. A set of work prints of the Contract Documents shall be kept on the jobsite during construction for the purpose of noting changes. During the course of construction, the Contractor shall indicate on these Documents changes made from the original Contract Documents. Particular attention shall be paid to those items which need to be located for servicing. Underground utilities shall be located by dimension from column lines.

C. At the completion of the project, the Contractor shall obtain, at their expense, reproducible copies of the final drawings and incorporate changes noted on the jobsite work prints onto these drawings. These changes shall be done by a skilled drafter. Each sheet shall be marked "Record Drawing", along with the date. These drawings shall be delivered to the Architect/Engineer.

D. The fire shop drawings and all information contained therein shall be utilized as the basis for the Record Drawings.

1.13 TRAINING

A. Provide training as indicated in each specific section. Schedule training with the Owner at least 7 days in advance. Video tape the training sessions in a format as agreed to with the Owner. Provide three copies of each session to the Owner and obtain written receipt from the Owner.

1.14 PAINTING

A. Exposed ferrous surfaces, including pipe, pipe hangers, equipment stands and supports shall be painted by the Fire Suppression Contractor using materials and methods as specified under Division 9 of the Specifications; colors shall be as selected by the Architect.

B. Factory finishes, shop priming and special finishes are specified in the individual equipment specification sections.

C. Where factory finishes are provided and no additional field painting is specified, marred or damaged surfaces shall be touched up or refinished so as to leave a smooth, uniform finish.

1.15 DELIVERY, STORAGE AND HANDLING

A. Refer to Division 1 and General Conditions for Delivery, Storage and Handling in addition to requirements specified herein.

B. Equipment and material shall be delivered to the job site in their original containers with labels intact, fully identified with manufacturer's name, model, model number, type, size, capacity and Underwriter's Laboratories, Inc. labels and other pertinent information necessary to identify the item.

C. Deliver, receive, handle and store equipment and materials at the job site in the designated area and in such a manner as to prevent equipment and materials from damage and loss. Store equipment and materials delivered to the site on pallets and cover with waterproof, tear resistant tarp or plastic or as required to keep equipment and materials dry. Follow manufacturer's recommendations, and at all times, take every precaution to properly protect equipment and material from damage, to include the erection of temporary shelters to adequately protect equipment and material stored at the Site. Equipment and/or material which become rusted or damaged shall be replaced or restored by the Contractor to a condition acceptable to the Architect.

D. The Contractor shall be responsible for the safe storage of his own tools, material and equipment.

1.16 GUARANTEES AND WARRANTIES

A. Refer to Division 1 and General Conditions for Guarantees and Warranties in addition to requirements specified herein.

B. Furnish service and maintenance of fire protection system for one year from date of substantial completion.

C. Each system and element thereof shall be warranted against defects due to faulty workmanship, design or material for a period of 12 months from date of Substantial Completion, unless specific items are noted to carry a longer warranty in the Construction Documents or manufacturer's standard warranty. The Contractor shall remedy defects occurring within a period of one year from the date of Substantial Completion or as stated in the General Conditions.

D. The following additional items shall be guaranteed:

1. Piping shall be free from obstructions, holes or breaks of any nature.

2. Proper sloping of pipe to drain in each piping system per NFPA 13.

E. The above guarantees shall include labor (including travel expenses), troubleshooting and material; and repairs or replacements shall be made without additional cost to the Owner.

F. The remedial work shall be performed promptly, upon written notice from the Architect or Owner.

G. At the time of Substantial Completion, deliver to the Owner warranties with terms extending beyond the one year guarantee period, each warranty instrument being addressed and stating the commencement date and term.

1.17 PROJECT CONDITIONS

A. Environmental Conditions: Apply joint sealers under temperature and humidity conditions within the limits permitted by the joint sealer manufacturer. Do not apply joint sealers to wet substrates.

PART 2 - PRODUCTS AND MATERIALS

2.1 GENERAL

A. Electrical Contractors shall provide all motors, starters, disconnects, wire, conduit, etc. as specified in the Construction Documents. If, however, the Fire Suppression Contractor furnishes a piece of equipment requiring a different motor, starter, disconnect, wire size, etc. than what is shown and/or intended on the Construction Documents, the Fire Suppression Contractor shall coordinate the requirements with any other Contractor and shall be responsible for any additional cost incurred by any other Contractor that is associated with installing the different equipment and related accessories for proper working condition.

B. Refer to Division 26, "Common Work Results for Electrical" for specification of motor connections.

C. Refer to Division 26, "Enclosed Switches and Circuit Breakers" for specification of disconnect switches.

D. Refer to Division 28, "Fire Detection and Alarm" for specification of sprinkler monitoring equipment connections.

E. All fire protection equipment shall be UL listed for its intended use and in conformance with the applicable NFPA codes.

F. System Pressures: All system components shall be listed for the actual designed system pressures.

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

2.2 SOIL MATERIALS

A. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, crushed slag, or natural or crushed sand.

B. Drainage Fill: Washed, evenly graded mixture of crushed stone, or crushed or uncrushed gravel, with 100 percent passing a 1-1/2-inch sieve, and not more than 5 percent passing a No. 4 sieve.

C. Backfill and Fill Materials: Materials complying with ASTM D2487 soil classification groups GW, GP, GM, SM, SW, and SP; free of clay, rock, or gravel larger than 2 inches in any dimension; debris; waste; frozen materials; and vegetable and other deleterious matter.

PART 3 - EXECUTION

3.1 GENERAL

A. The Contractor shall install, and test all new equipment identified in this contract and revise existing equipment as noted.

B. Installation shall be in accordance with NFPA requirements and the Contractor shall have employed or enlist the design services of at least one minimum NICET Level II certified technician.

C. Installer: Company specializing in the products indicated in this section with minimum three years documented experience. Shall be bondable and licensed contractor and employ full-time factory-trained and certified installers and technicians. Installers shall provide with the fire sprinkler submittal proof of factory training for each installer.

D. The Contractor shall provide all required equipment, sprinklers and piping for a complete and operational fire protection system. All components shall be installed in accordance with the guidelines of these specifications and documents as well as the NFPA codes and standards listed in these specifications.

E. The General Contractor is the central authority governing the total responsibility of all trade contractors. Therefore, deviations and clarifications of this schedule are permitted provided the General Contractor assumes responsibility to coordinate the trade contractors different than as indicated herein. If deviations or clarifications to this schedule are implemented, submit a record copy to the Engineer.

3.2 PERMITS

A. Secure and pay for permits required in connection with the installation of the Fire Suppression Work. Arrange with the various utility companies for the installation and connection of required utilities for this facility and pay charges associated therewith including connection charges and inspection fees, except where these services or fees are designated to be provided by others.

3.3 PREPARATION

A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Section.

B. Report test results promptly and in writing.

3.4 EXCAVATION AND BACKFILLING

A. Perform excavation of every description, of whatever substance encountered and to the depth required in connection with the installation of the work under this Division. Excavation shall be in conformance with applicable Division and section of the General Specifications.

B. Roads, alleys, streets and sidewalks damaged during this work shall be restored to the satisfaction of Authorities Having Jurisdiction.

C. Trenches close to walks or columns shall not be excavated without prior consultation with the Architect.

D. The Contractor shall erect barricades around excavations, for safety, and shall place an adequate number of amber lights on or near the work and shall keep them burning from dusk to dawn. The Contractor shall be held responsible for any damage that any parties may sustain in consequence of neglecting the necessary precautions in prosecuting the work.

E. Slope sides of excavations to comply with local, state and federal codes and ordinances. Shoring and Bracing: Establish requirements for trench shoring and bracing to comply with local, state and federal codes and authorities. Maintain shoring and bracing in excavations regardless of time period excavations will be open.

1. Remove shoring and bracing when no longer required. Where sheeting is allowed to remain, cut top of sheeting at an elevation of 30 inches below finished grade elevation.

F. Install sediment and erosion control measures in accordance with local codes and ordinances.

G. Dewatering: Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area.

1. Do not allow water to accumulate in excavations. Remove water to prevent softening of bearing materials. Provide and maintain dewatering system components necessary to convey water away from excavations.

2. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey surface water to collecting or run-off areas. Do not use trench excavations as temporary drainage ditches. In no case shall sewers be used as drains for such water.

H. Material Storage: Stockpile satisfactory excavated materials where directed, until required for backfill or fill. Place, grade, and shape stockpiles for proper drainage.

1. Locate and retain soil materials away from edge of excavations. Do not store within drip-line of trees indicated to remain.

2. Remove and legally dispose of excess excavated materials and materials not acceptable for use as backfill or fill.

I. Excavation for Underground Tanks, Basins, and Fire Suppression Structures: Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10 foot; plus a sufficient distance to permit placing and removal of concrete formwork, installation of services, other construction, and for inspection.

1. Excavate, by hand, areas within drip-line of large trees. Protect the root system from damage and dry-out. Maintain moist conditions for root system and cover exposed roots with burlap. Paint root cuts of 1 inch in diameter and larger with emulsified asphalt tree paint.

2. Take care not to disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is placed.

J. Trenching: Excavate trenches for Fire Suppression installations as follows:

1. Excavate trenches to the uniform width, sufficiently wide to provide ample working room and a minimum of 6 to 9 inches clearance on both sides of pipe and equipment.

2. Excavate trenches to depth indicated or required for piping to establish indicated slope and invert elevations. Beyond building perimeter, excavate trenches to an elevation below frost line.

3. Limit the length of open trench to that in which pipe can be installed, tested, and the trench backfilled within the same day.

4. Where rock is encountered, carry excavation below required elevation and backfill with a layer of crushed stone or gravel prior to installation of pipe. Provide a minimum of 6 inches of stone or gravel cushion between rock bearing surface and pipe.

5. Excavate trenches for piping and equipment with bottoms of trench to accurate elevations for support of pipe and equipment on undisturbed soil.

   a. For pipes or equipment 6 inches or larger in nominal size, shape bottom of trench to fit bottom 1/4 of the circumference. Fill unevenness with tamped sand backfill. At each pipe joint over-excavate to relieve the bell or pipe joint of the pipe of loads, and to ensure continuous bearing of the pipe barrel on the bearing surface.

K. Cold Weather Protection: Protect excavation bottoms against freezing when atmospheric temperature is less than 35°F.

L. Backfilling and Filling: Place soil materials in layers to required subgrade elevations for each area classification listed below, using materials specified in Part 2 of this Section.

1. Under walks and pavements, use a combination of subbase materials and excavated or borrowed materials.

2. Under building slabs, use drainage fill materials.

3. Under piping and equipment, use subbase materials where required over rock bearing surface and for correction of unauthorized excavation.

4. For piping less than 30 inches below surface of roadways, provide 4-inch-thick concrete base slab support. After installation and testing of piping, provide a 4-inch thick concrete encasement (sides and top) prior to backfilling and placement of roadway subbase.

5. Other areas, use excavated or borrowed materials.

M. Backfill excavations as promptly as work permits, but not until completion of the following:

1. Inspection, testing, approval, and locations of underground utilities have been recorded.

2. Removal of concrete formwork.

3. Removal of shoring and bracing, and backfilling of voids.

4. Removal of trash and debris.

N. Placement and Compaction: Place backfill and fill materials in layers of not more than 8 inches in loose depth for material compacted by heavy equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

O. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification specified below. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.

P. Place backfill and fill materials evenly adjacent to structures, piping, and equipment to required elevations. Prevent displacement of piping and equipment by carrying material uniformly around them to approximately same elevation in each lift.

Q. Compaction: Control soil compaction during construction, providing minimum percentage of density specified for each area classification indicated below.

1. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density for soils which exhibit a well-defined moisture-density relationship (cohesive soils), determined in accordance with ASTM D 1557 and not less than the following percentages of relative density, determined in accordance with ASTM D 2049, for soils which will not exhibit a well-defined moisture-density relationship (cohesionless soils).

a. Areas under structures, building slabs, steps, and pavements: Compact top 12 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.

b. Areas under walkways: Compact top 6 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.

c. Other areas: Compact top 6 inches of subgrade and each layer of backfill or fill material to 85 percent maximum density for cohesive soils, and 90 percent relative density for cohesionless soils.

2. Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water. Apply water in minimum quantity necessary to achieve required moisture content and to prevent water appearing on surface during, or subsequent to, compaction operations.

R. Subsidence: Where subsidence occurs at Fire Suppression installation excavations during the period 12 months after Substantial Completion, remove surface treatment (i.e., pavement, lawn, or other finish), add backfill material, compact to specified conditions, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent areas.

3.5 CUTTING AND PATCHING

A. The Contractor shall do necessary cutting of walls, floors, ceilings and roofs.

B. No structural member shall be cut without permission from Architect and Structural Engineer.

C. Patch around openings to match adjacent construction.

D. After the final waterproofing membrane has been installed, roofs may be cut only with written permission by the Architect.

3.6 CLEANING

A. Dirt and refuse resulting from the performance of the work shall be removed from the premises as required to prevent accumulation. The Fire Suppression Contractor shall cooperate in maintaining reasonably clean premises at all times.

B. Immediately prior to the final inspection, the Fire Suppression Contractor shall clean material and equipment installed under the Fire Suppression Contract. Dirt, dust, plaster, stains, and foreign matter shall be removed from surfaces including components internal to equipment. Damaged finishes shall be touched-up and restored to their original condition.

3.7 SUBSTANTIAL COMPLETION REVIEW

A. Prior to requesting inspection for "CERTIFICATE OF SUBSTANTIAL COMPLETION", the Contractor shall complete the following items:

1. Submit complete Operation and Maintenance Manuals.

2. Submit complete Record Drawings.

3. Perform special inspections.

4. Start-up testing of systems.

5. Removal of temporary facilities from the site.

6. Comply with requirements for Substantial Completion in the "General Conditions".

B. The Contractor shall request in writing a review for Substantial Completion. The Contractor shall give the Architect/Engineer at least seven (7) days notice prior to the review.

C. The Contractor's written request shall state that the Contractor has complied with the requirements for Substantial Completion.

D. Upon receipt of a request for review, the Architect/Engineer will either proceed with the review or advise the Contractor of unfulfilled requirements.

E. If the Contractor requests a site visit for Substantial Completion review prior to completing the above mentioned items, they shall reimburse the Architect/Engineer for time and expenses incurred for the visit.

F. Upon completion of the review, the Architect/Engineer will prepare a "final list" of outstanding items to be completed or corrected for final acceptance.

G. Omissions on the "final list" shall not relieve the Contractor from the requirements of the Contract Documents.

H. Prior to requesting a final review, the Contractor shall submit a copy of the final list of items to be completed or corrected. He shall state in writing that each item has been completed, resolved for acceptance or the reason it has not been completed.

END OF SECTION

SUBSTITUTION REQUEST FORM

To Project Engineer: _____ Request # (GC Determined): _____

Project Name: _____

Project No/Phase: _____ Date: _____

Specification Title: _____

Section Number: _____ Page: _____ Article/Paragraph: _____

Proposed Substitution: _____

_____

Manufacturer: _____ Model No.: _____

Address: _____ Phone: _____

History: ☐ New product ☐ 1-4 years old ☐ 5-10 years old ☐ More than 10 years old

Differences between proposed substitution and specified Work: _____

_____

☐ Point-by-point comparative data attached – REQUIRED BY ENGINEER
Comparative data may include but not be limited to performance, certifications, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements. Include all information necessary for an evaluation.

Supporting Data Attached: ☐ Drawings ☐ Product Data ☐ Samples ☐ Tests ☐ Reports ☐ Other: _____

Reason for not providing specified item: _____

_____

Similar Installation:
Project: _____ Architect: _____

Address: _____ Owner: _____

_____ Date Installed: _____

Proposed substitution affects other parts of Work: ☐ No ☐ Yes; explain: _____

_____

_____

Substitution Certification Statement:

Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner that the:

A. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.
B. Proposed substitution is consistent with the Contract Documents and will produce indicated results.
C. Proposed substitution does not affect dimensions and functional clearances.
D. Proposed substitution has received necessary approvals of authorities having jurisdiction.
E. Same warranty will be furnished for proposed substitution as for specified Work.
F. Same maintenance service and source of replacement parts, as applicable, is available.
G. Proposed substitution will not adversely affect other trades or delay construction schedule.
H. Coordination, installation, and changes in the Work as necessary for accepted substitution will be complete in all respects.

Submitting Contractor	Date	Company

Manufacturer's Certification of Equal Quality:

I _____ represent the manufacturer of the Proposed Substitution item and hereby certify and warrant to Architect, Engineer, and Owner that the function and quality of the Proposed Substitution meets or exceeds the Specified Item.

Manufacturer's Representative	Date	Company

Engineer Review and Recommendation Section

Recommend Acceptance	☐ Yes	☐ No
Additional Comments:	☐ Attached	☐ None

Acceptance Section:

Contractor Acceptance Signature	Date	Company
Owner Acceptance Signature	Date	Company
Architect Acceptance Signature	Date	Company
Engineer Acceptance Signature	Date	Company

SECTION 210515 - BASIC FIRE SUPPRESSION PIPING MATERIALS AND METHODS

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section specifies piping materials and installation methods common to more than one Section of Division 21 and includes piping, joining materials, piping specialties and basic piping installation instructions.

B. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 21 Section 210010 "General Fire Suppression Requirements" for requirements for hydraulic calculations, fire flow test data, obtaining electronic drawings files, shop drawings and record drawings.

2. Division 21 Section 210500 "Common Work Results for Fire Suppression," for materials and methods for wall and floor penetrations.

3. Division 21 Section 210553 "Identification for Fire Suppression Piping and Equipment" for labeling and identification of installed fire suppression equipment.

4. Division 21 Section 211100 "Fire Suppression Water Service Piping" for fire suppression piping starting 5 feet outside the building to within the building.

5. Division 21 Section 211313 "Water-based Fire Suppression Systems" for fire-suppression sprinkler systems inside the building.

1.2 SUBMITTALS

A. Refer to Division 1 and Division 21 "General Fire Suppression Requirements" for administrative and procedural requirements for submittals.

B. Product Data: Submit product data on the following items:

1. Piping and Fittings

2. Escutcheons

3. Dielectric Unions and Fittings

4. Sleeves and Mechanical Sleeve Seals

5. Wall Pipes

1.3 QUALITY ASSURANCE

A. Welding procedures and testing shall comply with ANSI Standard B31.9 - Standard Code for Building Services Piping and The American Welding Society, Welding Handbook.

B. Soldering and Brazing procedures shall conform to ANSI B9.1 Standard Safety Code for Plumbing Refrigeration.

C. Threaded joints shall conform to ASME B1.20.1, Pipe Threads, General Purpose and the Pipe Fitters Handbook.

D. UL Compliance: Fire protection system materials and components shall be Underwriter's Laboratories listed and labeled, for fire service.

E. Pipe, piping specialties and fittings shall be manufactured in plants located in the United States.

PART 2 - PRODUCTS AND MATERIALS

2.1 GENERAL REQUIREMENTS

A. All fire suppression system materials and components essential to successful system operation shall be listed for their intended purpose.

B. General: Refer to the individual piping system specification sections in Division 21 for specifications on piping and fittings relative to that particular system.

2.2 STEEL PIPE AND FITTINGS

A. All piping 2-inch and smaller:

1. With the use of welded or roll grooved fittings: ASTM A135 or 795, Grade A, Schedule 10 or 40, seamless or ERW, black steel pipe.

2. With the use of threaded fittings: ASTM A135 or 795, Grade A, Schedule 40, seamless or ERW, black steel pipe. All 1-inch piping shall have threaded ends.

B. All piping 2-1/2" and larger: ASTM A135 or 795, Grade A, Schedule 10, ERW, black steel pipe, roll grooved ends.

C. All piping on the exterior of the building shall be externally galvanized or painted.

D. Acceptable alternatives to Schedule 40 and Schedule 10 pipe shall be manufactured to standards recognized by NFPA 13. Threaded pipe shall have a corrosion resistance rating (CRR) of 1.0 or greater. Crimp type couplings shall not be used. Threadable thinwall pipe with CRR less than 1.0 not permitted.

E. Cast-Iron Threaded Fittings: ANSI B16.4, Class 125, standard pattern, for threaded joints. Threads shall conform to ANSI B1.20.1.

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

G. Steel Couplings: ASTM A 865, threaded

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

I. Malleable-Iron Threaded Fittings: ANSI B16.3, Class 150, standard pattern, for threaded joints. Threads shall conform to ANSI B1.20.1.

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

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

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

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

N. Grooved-Joint, Steel-Pipe Appurtenances

1. Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.

2. 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.

3. Grooved mechanical couplings including gaskets used on dry-pipe systems shall be listed for dry-pipe service.

2.3 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L, water tube, drawn temper.

B. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.

C. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, pressure fittings.

D. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

E. 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.

2.4 JOINING MATERIALS

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

1. Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.

2. Class 250, Cast-Iron Flanges and Class 300, Steel Raised-Face Flanges: Ring-type gaskets.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

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

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

E. Plastic, Pipe-Flange Gasket, and Bolts and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

2.5 LISTED FIRE-PROTECTION VALVES

A. General Requirements:

1. Valves shall be UL listed

2. Minimum Pressure Rating for Standard-Pressure Piping: 175 psig.

B. Check Valves:

1. Description: Swing-check type, rubber-face checks unless otherwise indicated, and ends matching piping.

2. Standard: UL 312.

3. Pressure Rating: 250 psig minimum.

4. Type: Swing check.

5. Body Material: Cast iron.

6. End Connections: Flanged or grooved.

C. Iron OS&Y Gate Valves:

1. Description: Iron body and bonnet and bronze seating material.

2. Standard: UL 262.

3. Pressure Rating: 250 psig minimum.

4. Body Material: Cast or ductile iron.

5. End Connections: Flanged or grooved.

D. Indicating-Type Butterfly Valves:

1. Standard: UL 1091.

2. Pressure Rating: 175 psig minimum.

3. Valves NPS 2 and Smaller:

   a. Valve Type: Ball or butterfly.

   b. Body Material: Bronze.

   c. End Connections: Threaded or grooved.

4. Valves NPS 2-1/2 and Larger:

   a. Valve Type: Butterfly.

   b. Body Material: Cast or ductile iron.

   c. End Connections: Flanged or grooved.

5. Valve Operation: Integral, prewired supervisory switch and visual indicating device.

2.6 TRIM AND DRAIN VALVES

A. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing .

2. Pressure Rating: 175 psig minimum.

B. Automatic (Ball Drip) Drain Valves:

1. Standard: UL 1726.

2. Pressure Rating: 175 psig minimum.

3. Type: Automatic draining, ball check.

4. Size: NPS 3/4.

5. End Connections: Threaded.

2.7 AUTOMATIC AIR RELEASE VALVE

A. Standard: UL 2573

B. Pressure Rating: 175 psig minimum.

2.8 FIRE-DEPARTMENT CONNECTIONS

A. Storz-Type, Fire-Department Connection:

1. Pressure Rating: 175 psig minimum.

2. Body Material: Aluminum Alloy.

3. Inlets: NPS4. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.

4. Caps: Aluminum with gasket and chain.

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

6. Outlet: NPS 4

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

2.9 PIPING SPECIALTIES

A. Escutcheons: Inside diameter shall closely fit pipe outside diameter, or outside of pipe insulation where pipe is insulated. Outside diameter shall completely cover the opening in floors, walls, or ceilings.

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

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

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

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

B. Floor Plates: Inside diameter shall closely fit pipe outside diameter. Outside diameter shall completely cover the opening in floors, walls, or ceilings.

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

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

C. Unions: Malleable-iron, Class 150 for low pressure service and class 250 for high pressure service; hexagonal stock, with ball-and-socket joints, metal-to-metal bronze seating surfaces; female threaded ends.

D. Dielectric Unions and Fittings: Provide factory-fabricated dielectric unions and fittings with appropriate end connections for the pipe materials in which installed (screwed, soldered, or flanged), which effectively isolate dissimilar metals, prevent galvanic action, and stop corrosion.

E. Pressure Gauges

1. Standard: UL 393.

2. Dial Size: 3-1/2- to 4-1/2-inch diameter.

3. Pressure Gage Range: 0 to 300 psig.

4. Water System Piping Gage: Include "WATER" or "AIR/WATER" label on dial face.

5. Air System Piping Gage: Include "AIR" or "AIR/WATER" label on dial face.

2.10 PENETRATIONS

A. Sleeves:

1. Steel Sleeves: Schedule 40 galvanized, welded steel pipe, ASTM A-53 grade A or 12 gauge (0.1084 inches) welded galvanized steel formed to a true circle concentric to the pipe.

2. Sheet-Metal Sleeves: 10 gauge (0.1382 inches), galvanized steel, round tube closed with welded longitudinal joint.

3. Frames for rectangular openings attached to forms and of a maximum dimension established by the Architect. For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, provide 18 gauge (0.052 inches) welded galvanized steel. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, provide 10 gauge (0.1382 inches) welded galvanized steel. Notify the General Contractor or Architect before installing any box openings not shown on the Architectural or Structural Drawings.

4. Box Frames: Frames for rectangular openings shall be of welded 12 gauge steel attached to forms and of a maximum dimension established by the Architect. Contractor shall notify the General Contractor or Architect before installing any box openings not shown on the Architectural or Structural Drawings.

B. Wall Pipes

1. Cast-iron sleeve with integral clamping flange with clamping ring, bolts, and nuts for membrane flashing.

a. Underdeck Clamp: Clamping ring with setscrews.

C. Mechanical Sleeve Seals: Modular Plumbing type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

a. Pressure Plates: Carbon steel or stainless steel.

b. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, or Stainless steel of length required to secure pressure plates to sealing elements.

PART 3 - EXECUTION

3.1 PREPARATION

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

B. Remove scale, slag, dirt, and debris for both inside and outside of piping and fittings before assembly.

3.2 PIPING INSTALLATIONS

A. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated. Refer to individual system specifications for requirements for coordination drawing submittals.

B. Coordinate installation of horizontal piping with other components. Allow sufficient space above removable ceiling panels to allow for panel removal (minimum 6" clearance).

C. Install system such that all piping is rigidly secured and supported. All ductwork, lights, structural members and main runs of piping shall take precedence over sprinkler piping. Cutting of structural members for passage of sprinkler pipes or hangers shall not be permitted. All horizontal piping in ceiling space shall be at an elevation above the top of light fixtures and air outlets to allow for access to light fixtures and air outlets without removing horizontal piping. Route all sprinkler piping and provide all offsets, bends, and elbows around all mechanical, electrical, and structural members as required.

D. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated otherwise. In areas with ceilings, piping shall be routed concealed, above ceiling. In areas without ceilings, piping shall extend as high as possible.

E. Install piping free of sags and bends and with ample space between piping to permit proper insulation applications.

F. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated on the Drawings.

G. Locate groups of pipes parallel to each other, spaced to permit applying full insulation and servicing of valves.

H. Support piping from structure. Do not support piping from ceilings, equipment, ductwork, conduit and other non-structural elements.

I. Install sprinkler piping to provide for system drainage in accordance with NFPA 13. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple and cap.

J. Coordinate pipe routing near electrical equipment in accordance with NFPA 70.

K. Verify final equipment locations for roughing in.

L. Deviations from approved "Working Plans" for sprinkler piping require written approval of the Authority Having Jurisdiction. Written approval shall be on file with the Engineer prior to deviating from the approved "Working Plans."

M. Install escutcheons for exposed piping penetrations of walls, ceilings, and floors.

3.3 JOINT CONSTRUCTION

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

B. Use approved fittings to make all changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

C. Install unions in pipes NPS 2 and smaller, adjacent to each valve. Unions are not required on flanged devices or in piping installations using grooved mechanical couplings.

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

E. Install dielectric unions to connect piping materials of dissimilar metals in dry piping systems.

F. Non-ferrous Pipe Joints:

1. Brazed and Soldered Joints: For copper tube and fitting joints, braze joints in accordance with ANSI B31.9 - Standard Code for Building Services Piping.

2. Thoroughly clean tube surface and inside surface of the cup of the fittings, using very fine emery cloth, prior to making soldered or brazed joints. Wipe tube and fittings clean and apply flux. Flux shall not be used as the sole means for cleaning tube and fitting surfaces.

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

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

H. Threaded Joints: Conform to ANSI B1.20.1, tapered pipe threads for field cut threads and Pipe Fitter's Handbook. Join pipe, fittings, and valves as follows:

1. Note the internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.

2. Align threads at point of assembly.

3. Apply appropriate tape or thread compound to the external pipe threads.

4. Assemble joint to appropriate thread depth. When using a wrench on valves place the wrench on the valve end into which the pipe is being threaded.

5. Damaged Threads: Do not use pipe with threads that are corroded, or damaged. If a weld opens during cutting or threading operations, that portion of pipe shall not be used.

I. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9. Align flanged surfaces parallel. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly to appropriate torque specified by the bolt manufacturer.

J. Mechanical Grooved Joints: Roll grooves on pipe ends dimensionally compatible with the couplings. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.

K. Joints for other piping materials are specified within the respective piping system sections.

3.4 FIRE DEPARTMENT CONNECTION INSTALLATION

A. Install wall-type, fire department connection.

B. Install connections between 18- and 36-inches above finished grade and as indicated on the Drawings.

C. Grout or caulk pipe penetration in exterior wall.

D. Provide minimum 36-inch working clearance around connection for fire department access.

E. Install automatic (ball drip) drain valve at each check valve for fire department connection. <The drain line shall discharge to the exterior>.

3.5 ALARM DEVICE INSTALLATION

A. General: Comply with NFPA 24 for devices and methods of valve supervision.

B. Supervisory Switches: Supervise valves in open position unless noted otherwise.

1. Valves: Grind away portion of exposed valve stem. Bolt switch, with plunger in stem depression, to OS&Y gate-valve yoke.

2. Indicator Posts: Drill and thread hole in upper-barrel section at target plate. Install switch, with toggle against target plate, on barrel of indicator post.

C. Water-Flow Indicators: Install in fire suppression piping where indicated. Select indicator with saddle and vane matching pipe size. Drill hole in pipe, insert vane, and bolt saddle to pipe.

D. Connect alarm devices to building's fire-alarm system. Wiring and fire-alarm devices are specified in Division 28 Sections.

3.6 PIPING PROTECTION

A. Protect piping during construction period, to avoid clogging with dirt and debris, and to prevent damage from traffic and construction work.

B. Place plugs in ends of uncompleted piping at the end of each day or whenever work stops.

3.7 PENETRATIONS

A. Fire suppression penetrations occur when piping penetrate concrete slabs, concrete or masonry walls, or fire / smoke rated floor and wall assemblies.

B. Above Grade Concrete or Masonry Penetrations

1. Provide sleeves for pipes passing through above grade concrete or masonry walls, concrete floor or roof slabs. Sleeves are not required for core drilled holes in existing masonry walls, concrete floors or roofs. Provide sleeves as follows:

a. Provide schedule 40 galvanized steel pipe for sleeves smaller than 6 inches in diameter.

b. Provide galvanized sheet metal for sleeves 6 inches in diameter and larger, thickness shall be 10 gauge (0.1382 inches).

c. Provide welded galvanized sheet metal for rectangular sleeves with the following minimum metal thickness:

1) For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 18 gauge (0.052 inches).

2) For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 10 gauge (0.1382 inches).

d. Schedule 40 PVC pipe sleeves are acceptable for use in areas without return air plenums.

2. Seal elevated floor, exterior wall and roof penetrations watertight and weathertight with non-shrink, non-hardening commercial sealant. Pack with mineral wool and seal both ends with minimum of ½" of sealant.

C. Underground, Exterior-Wall Penetrations: Install cast-iron wall pipes for sleeves. Size sleeves to allow for 1-inch (or larger, if required by the mechanical sleeve manufacturer) annular clear space between pipe and sleeve. Provide mechanical sleeve seal.

1. Use type and number of sealing elements recommended by manufacturer 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.

2. Inspect installed sleeve and sleeve-seal installations for damage and faulty work. Verify watertight integrity of sleeves and seals installed below grade to seal against hydrostatic pressure.

D. Elevated Floor Penetrations of Waterproof Membrane:

1. Provide cast-iron wall pipes for sleeves, extend top of wall pipe minimum 1" above finish floor. Size wall pipe for minimum ½" annular space between pipe and wall pipe.

2. Extend pipe insulation for insulated pipe through wall pipe. The vapor barrier shall be maintained. Size wall pipe for a minimum of 1" annular clear space between inside of sleeve and outside of insulation.

3. Pack with mineral wool and seal both ends with minimum of ½" of waterproof sealant. Refer to Division 07 Section "Joint Sealants" for materials and installation.

4. Secure waterproof membrane flashing between clamping flange and clamping ring. Comply with requirements for flashing specified in Division 7 Section "Sheet Metal Flashing and Trim."

5. Extend bottom of wall pipe below floor slab as required and secure underdeck clamp to hold wall pipe rigidly in place.

E. Interior Foundation Penetrations: Provide sleeves for horizontal pipe passing through or under foundation. Sleeves shall be cast iron soil pipe two nominal pipe sizes larger than the pipe served.

F. Concrete Slab on Grade Penetrations:

1. Provide schedule 40 PVC pipe sleeves for vertical pressure pipe passing through concrete slab on grade. Sleeves shall be one nominal pipe size larger than the pipe served and two pipe sizes larger than pipe served for ductile iron pipes with restraining rods. Seal water-tight with silicone caulk.

2. Provide 1/2-inch thick cellular foam insulation around perimeter of non-pressure pipe passing thru concrete slab on grade. Insulation shall extend to 2-inch above and below the concrete slab.

G. Interior Penetrations of Non-Fire-Rated Walls: Seal annular space between sleeve and pipe or duct, using joint sealant appropriate for size, depth, and location of joint. Pack with mineral wool and seal both ends with minimum of 1/2-inch of sealant. Refer to Division 21 Section "Common Work Results for Fire Suppression" for materials and installation.

1. Extend pipe insulation for insulated pipe through sleeve. The vapor barrier shall be maintained. Size sleeve for a minimum of 1-inch annular clear space between inside of sleeve and outside of insulation.

H. Exterior Wall Penetrations: Seal annular space between sleeve and pipe or duct, using joint sealant appropriate for size, depth, and location of joint. Pack with mineral wool and seal both ends with minimum of 1/2-inch of waterproof sealant. Refer to Division 07 Section "Joint Sealants" for materials and installation.

1. Extend pipe insulation for insulated pipe through sleeve. The vapor barrier shall be maintained. Size sleeve for a minimum of 1-inch annular clear space between inside of sleeve and outside of insulation.

I. Fire / Smoke Rated Floor and Wall Assemblies: Seal around penetrations of fire rated assemblies to maintain fire resistance rating of assemblies. Coordinate fire ratings and locations with the architectural drawings. Install sealants in compliance with the manufacturer's UL listing. Refer to Division 21 Section "Common Work Results for Fire Suppression" for firestopping and materials.

3.8 ACOUSTICAL PENETRATIONS

A. General: There shall be no direct contact of piping with shaft walls, floor slabs and/or partition. All openings around pipes in the structure surrounding the Fire Suppression equipment and surrounding noise-critical spaces shall be sealed, packed with caulking for the full depth of the penetration, as described herein. This includes all slab penetrations and penetrations of noise critical walls.

B. Fire Sprinkler Piping

1. Where a pipe passes through a wall, ceiling or floor slab of a noise critical space, a steel sleeve shall be cast or grouted into the structure. The internal diameter of the sleeve shall be 2 inches larger than the external diameter of the pipe passing through it. After all of the piping is installed in that area, the Contractor shall check the clearance and correct it, if necessary, to within 1/2 inch. Pack the void full depth with packing material sealed at both ends, 1 inch deep, with non-hardening sealant backed by foam rod.

3.9 PIPE FIELD QUALITY CONTROL

A. Testing: Refer to individual piping system specification sections.

END OF SECTION

SECTION 210553 - IDENTIFICATION FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. Extent of Fire Suppression work to be identified as required by this Section is indicated on drawings and/or specified in other Division 21 Sections.

B. Types of identification devices specified in this Section include the following:

1. Equipment labels.

2. Valve tags.

3. Hydraulic placards.

C. Related Sections

1. Division 21 Section 210010 "General Fire Suppression Requirements" for requirements for hydraulic calculations, fire flow test data, obtaining electronic drawings files, shop drawings and record drawings.

2. Division 21 Section 210500 "Common Work Results for Fire Suppression," for materials and methods for wall and floor penetrations.

3. Division 21 Section 210515 "Basic Fire Suppression Piping Material and Methods," for general piping and fitting materials and methods.

4. Division 21 Section 211100 "Fire Suppression Water Service Piping," for fire suppression piping starting 5 feet outside the building to within the building.

5. Division 21 Section 211313 "Water-based Fire Suppression Systems" for fire-suppression sprinkler systems inside the building.

1.2 CODES AND STANDARDS:

A. ANSI Standards: Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

B. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data and installation instructions for each identification material and device required.

B. Maintenance Data: For each piping system to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: Brass, aluminum, or anodized aluminum, 0.032 inch thick, with predrilled holes for attachment hardware.

2. Background/Letter Color: Red/White or Bare Metal/Black.

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

4. 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.

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

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

B. Plastic Labels for Equipment:

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

2. Background/Letter Color: Red/White

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

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.

C. Label Content: Include equipment's Drawing designation or unique equipment number,

2.2 VALVE TAGS

A. 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: Brass, stainless steel, aluminum or anodized aluminum, 0.032 inch thick, with predrilled holes for attachment hardware.

2. Fasteners: Brass wire-link chain, beaded chain or S-hook.

3. Valve-Tag Color: Red.

4. Letter Color: White.

2.3 HYDRAULIC PLACARDS

A. Provide hydraulic calculation placard attached to each riser in accordance with NFPA 13. Placard shall include location of design area or areas, discharge densities over the design area or areas, required flow and pressures at the base of riser, occupancy classification and maximum permitted storage height and configuration, hose stream allowance included in addition to the sprinkler demand and name of installing contractor. Information shall be permanently and clearly displayed on placard.

PART 3 - EXECUTION

3.1 PREPARATION

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

3.2 EQUIPMENT IDENTIFICATION

A. General: Install metal or plastic equipment marker on or near each major item of fire protection equipment and each operational device, as specified herein if not otherwise specified for each item or device.

1. Backflow Preventers

3.3 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in fire suppression systems

3.4 LABEL INSTALLATION

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

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install or permanently fasten labels on each major piece of equipment.

D. Locate equipment labels where accessible and visible.

END OF SECTION

SECTION 211100 - FIRE SUPPRESSION WATER SERVICE PIPING

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. The extent of this fire suppression water service piping shall be as specified herein. Contractor shall be responsible for preparation of design drawings, fabrication and installation for complete fire suppression water service piping for the building.

B. This section specifies:

1. Materials and equipment for fire suppression water service piping and related components starting 5-feet outside the building and the following:

a. Service entrance piping through floor into the building.

C. This section includes:

1. Pipe and fittings

2. Valves

3. Backflow preventers

4. Alarm devices

5. Accessories

D. Provide facility fire suppression water service piping during construction in accordance with code.

E. Related Documents: Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 21 Specifications Sections, apply to this section.

F. Related Sections:

1. Division 31 Section "Earthwork," for trenching and backfilling materials and methods for underground piping installations.

2. Division 33 Section "Water Service Systems," for water service piping beginning from 5'-0" outside the building and extending to the water service line.

3. Division 21 Section 210010 "General Fire Suppression Requirements" for requirements for hydraulic calculations, fire flow test data, obtaining electronic drawings files, shop drawings and record drawings.

4. Division 21 Section 210500 "Common Work Results for Fire Suppression," for materials and methods for wall and floor penetrations.

5. Division 21 Section 210553 "Identification for Fire Suppression Piping and Equipment" for labeling and identification of installed fire suppression equipment.

6. Division 21 Section 211313 "Water-based Fire Suppression Systems" for fire suppression sprinkler systems inside the building.

1.2 SUBMITTALS

A. Submit shop drawings prepared in accordance with Division 21 Section 210010 "General Fire Suppression Requirements."

B. Detail precast concrete vault assemblies and indicate dimensions, method of field assembly, and components.

1.3 QUALITY ASSURANCE

A. Contractor shall be responsible for all permits and fees associated with preparation and approval of Drawings and the installation and approval of the Facility Fire Suppression Water Service Piping.

B. Regulatory Requirements:

1. Comply with requirements of utility company supplying water. Include tapping of water mains and backflow prevention.

2. Comply with standards of authorities having jurisdiction for fire suppression water service piping, including materials, hose threads, installation, and testing.

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

D. NFPA 24, "Private Fire Service Mains and their Appurtenances", 2013 Edition. Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire suppression water service piping.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Preparation for Transport: Prepare valves according to the following:

1. Ensure that valves are dry and internally protected against rust and corrosion.

2. Protect valves against damage to threaded ends and flange faces.

3. Set valves in best position for handling.

B. During Storage: Use precautions for valves, including fire hydrants, according to the following:

1. Do not remove end protectors unless necessary for inspection; then reinstall for storage.

2. Protect from weather. Store indoors and maintain temperature higher than ambient dew point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.

C. Handling: Use sling to handle valves if size requires handling by crane or lift. Rig valves to avoid damage to exposed parts. Do not use hand wheels or stems as lifting or rigging points.

D. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.

E. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.

F. Protect flanges, fittings, and specialties from moisture and dirt.

G. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

PART 2 - PRODUCTS AND MATERIALS

2.1 GENERAL

A. Refer to Division 21 Section 210515 "Basic Fire Suppression Piping Materials and Methods" for general piping fittings and piping specialty requirements.

2.2 DUCTILE-IRON PIPE AND FITTINGS.

A. Mechanical-Joint, Cement Lined Ductile-Iron Pipe: AWWA C151/C104, with mechanical-joint bell and plain spigot end.

B. Mechanical-Joint, Cement Lined Ductile-Iron Fittings: AWWA C110/C104, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.

1. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

C. Flanges: ASME B16.1, Class 125, cast iron.

D. Ductile-Iron Deflection Fittings:

1. Description: Compound, ductile-iron coupling fitting with sleeve and one or two flexing sections for up to 15-degree deflection, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.

2. Pressure Rating: 250 psig minimum.

2.3 SERVICE ENTRANCE ASSEMBLY

A. At Contractor's option, the service entrance is permitted to utilize a one-piece riser assembly to enter the building.

1. Assembly shall be Ames Fire and Waterworks Series IBR or approved equivalent. In-Building Riser shall be composed of a single extended 90 degree fitting of fabricated 304 stainless steel tubing, maximum working pressure 200 psi. The fitting shall have a grooved-end connection on

the outlet (building) side and a CIPS coupler on the inlet (underground) side. The grooved end shall include a coupler and cap to facilitate testing of the underground piping.

2.4 ENCASEMENT FOR PIPING

A. Standard: ASTM A 674 or AWWA C105.

B. Material: Linear low-density PE film of 0.008-inch (0.20-mm) or High-density, cross-laminated PE film of 0.004-inch (0.10-mm) minimum thickness.

C. Form: Sheet or tube.

2.5 CURB VALVES

A. Curb Valves: Comply with AWWA C800 for high pressure service line valves. Valve has bronze body, ground-key plug or ball, wide tee head, and inlet and outlet matching service piping material.

B. Service Boxes for Curb Valves: Similar to AWWA M44 requirements for cast-iron valve boxes. Include cast-iron telescoping top section of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over curb valve and with a barrel approximately 3 inches in diameter.

1. Shutoff Rods: Steel; with tee-handle with one pointed end, stem of length to operate deepest buried valve, and slotted end matching curb valve.

C. Meter Valves: Comply with AWWA C800 for high pressure service line valves. Include angle- or straight-through-pattern bronze body, ground-key plug or ball, and wide tee head, with inlet and outlet matching service piping material.

2.6 GATE VALVES

A. UL Listed Gate Valves:

1. UL listed, Iron, Non-rising Stem Gate Valves:

a. Description: Iron body and bonnet, bronze seating material, and inside screw.

b. Standards: UL 262 listing and "Approval Guide," published by FM Global, approval.

c. Pressure Rating: 175 psig minimum.

d. End Connections: Mechanical or push-on joint.

e. Indicator-Post Flange: Include on valves used with indicator posts.

2. UL-Listed, Iron, OS&Y, Gate Valves:

a. Description: Iron body and bonnet and bronze seating material.

b. Standards: UL 262 listing and "Approval Guide," published by FM Global, approval.

c. Pressure Rating: 175 psigminimum.

d. End Connections: Flanged or grooved.

2.7 GATE VALVE ACCESSORIES AND SPECIALTIES

A. Valve Boxes: Comply with AWWA M44 for cast-iron valve boxes. Include top section, adjustable extension of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over valve and with a barrel approximately 5-inches (125 mm) in diameter.

1. Operating Wrenches: Steel; with tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut.

2.8 CHECK VALVES

A. UL listed Check Valves:

1. Description: Swing-check type with pressure rating, rubber-face checks unless otherwise indicated, and ends matching piping.

2. Standards: UL 312 listing and "Approval Guide," published by FM Global, approval.

3. Pressure Rating: 175 psig minimum.

2.9 BACKFLOW PREVENTERS

A. Double Check Detector Backflow Preventer Assembly:

1. Standards: ASSE 1048 and UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, approval.

2. Operation: Continuous-pressure applications.

3. Body Material: Cast iron with interior lining complying with AWWA C550 or that is FDA approved; Steel with interior lining complying with AWWA C550 or that is FDA approved; or Stainless steel.

4. End Connections: Threaded, flanged or grooved.

5. Accessories:

a. Supervised butterfly or OS&Y gate valves. Backflow preventer and valves shall be listed as an assembly.

b. Bypass: With displacement-type water meter, shutoff valves, and reduced-pressure backflow preventer.

PART 3 - EXECUTION

3.1 PREPARATION FOUNDATION FOR BELOW GROUND WATER DISTRIBUTION PIPE AND FITTINGS

A. Grade trench bottoms to provide a smooth, firm, and stable foundation, free from rock, throughout the length of the pipe.

B. Remove unstable, soft, and unsuitable materials at the surface upon which pipes are to be laid and backfill with clean sand or pea gravel to indicated elevation.

C. Pipe Beds:

1. Ductile Iron Pipe: Shape bottom of trench to fit bottom of pipe for 90-degrees (bottom 1/4 of the circumference). Fill unevenness with tamped sand backfill. At each pipe joint dig bell holes to relieve the bell of the pipe of all loads, and to ensure continuous bearing of the pipe barrel on the foundation. Provide first layer of pea gravel backfill 6-inch above pipe, tamp backfill with mechanical tamper to 85% to 95% compaction. For piping with rock trench bottoms, provide sand pipe bed 6-inch underneath and around sides of pipe up to middle half of the pipe, including fittings.

D. Provide backfill above top of pipe bed as required for field conditions. Refer to Division 21 Section 210010 "General Fire Suppression Requirements" for materials and methods for backfill.

3.2 PIPE APPLICATIONS

A. Piping below grade: Provide cement lined ductile iron pipe and fittings with mechanical joints.

3.3 PIPING INSTALLATION

A. Comply with NFPA 24 for fire service main piping materials and installation.

B. Water main connection: Arrange with water utility company for tap of size and in location indicated in water main or tap water main according to the requirements of the water utility company.

C. Install ductile-iron, water service piping according to AWWA C600 and AWWA M41.

1. Install encasement for piping according to ASTM A 674 or AWWA C105.

D. Bury piping with depth of cover over top of piping at least 30-inches, with top at least 12-inches below level of maximum frost penetration, and according to the following:

1. Under Driveways: With at least 36-inches of cover over top.

2. Under Railroad Tracks: With at least 48-inches of cover over top.

E. Install piping by tunneling or jacking, or combination of both, under streets and other obstructions that cannot be disturbed.

F. Extend fire suppression water service piping and connect to water supply source and building fire suppression water service piping systems at locations and pipe sizes indicated.

1. Terminate fire suppression water service piping at building floor slab until building water piping systems are installed. Terminate piping with caps, plugs, or flanges as required for piping material. Make connections to building's fire suppression water service piping systems when those systems are installed.

G. Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports.

H. Comply with requirements in Section 211200 "Fire Suppression Standpipes," and Section 211313 "Water-Based Fire Suppression Systems," for fire suppression water piping inside the building.

I. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 210515 "Basic Fire Suppression Piping Materials and Methods."

J. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 210515 "Basic Fire Suppression Piping Materials and Methods."

K. Make connections between underground and aboveground piping using an approved transition piece strapped or fastened to prevent separation.

3.4 JOINT CONSTRUCTION

A. See Division 21 Section 210515 "Basic Fire Suppression Piping Materials and Methods" for general joint construction requirements.

B. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure rating same as or higher than systems pressure rating for aboveground applications unless otherwise indicated.

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

D. Ductile-Iron Piping, Gasketed-Joints for Fire Service Main Piping: UL 194.

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

3.5 ANCHORAGE INSTALLATION

A. Anchorage, General: Install water distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include the following:

1. Locking mechanical joints.

2. Bolted flanged joints.

B. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches in fire suppression water service piping according to NFPA 24 and the following:

1. Gasketed-Joint, Ductile-Iron, Water Service Piping: According to AWWA C600.

C. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

3.6 VALVE INSTALLATION

A. See Division 21 Section 210515 "Basic Fire Suppression Piping Materials and Methods" for general valve installation requirements.

B. UL-Listed Gate Valves: Comply with NFPA 24. Install each underground valve(s) in vaults with stem pointing up and with vertical cast-iron indicator post.

C. UL-Listed Valves Other Than Gate Valves: Comply with NFPA 24.

D. Support valves and piping, not direct buried, on concrete piers. Comply with requirements for concrete piers in Division 03.

3.7 ROUGHING-IN FOR WATER METERS

A. Rough-in piping and specialties for water meter installation according to utility company's written instructions.BACKFLOW PREVENTER INSTALLATIONS

B. Install backflow preventer at each fire protection entry in compliance with the plumbing code and Authority Having Jurisdiction. Install air gap fitting and pipe relief outlet drain without valves to nearest floor drain or exterior.

C. Install backflow preventers of type, size, and capacity indicated. Include valves and test cocks.

D. Do not install backflow preventers that have relief drain in vault or in other spaces subject to flooding.

E. Do not install bypass piping around backflow preventers.

F. Support NPS 2-1/2 and larger backflow preventers with pipe supports attached to the floor with anchor bolts where indicated on the drawings.

G. Test backflow preventer per requirements of plumbing or division of cross connection control official.

H. Reports: Prepare backflow preventer test reports signed by the plumbing or division of cross connection control official and turn over to the Architect upon completion of the project.

3.8 FIELD QUALITY CONTROL

A. Flush, test, and inspect in accordance with NFPA 24.

B. Leave uncovered and unconcealed all new, altered, extended, or replaced water distribution piping until it has been tested and approved. Expose all such work for testing that has been covered or concealed before it has been tested and approved.

C. Replace piping system components that do not pass the test procedures specified, and retest repaired portion of the system.

3.9 IDENTIFICATION

A. Install continuous underground warning tape during backfilling of trench for underground fire suppression water service piping. Locate below finished grade, directly over piping. Underground warning tapes are specified in Section 312000 "Earth Moving."

3.10 CLEANING

A. Clean fire suppression water service piping as follows:

1. Flush new piping systems and parts of existing systems that have been altered, extended, or repaired before use.

2. Use flushing procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in NFPA 24 for flushing of piping. Flush piping system with clean, potable water until dirty water does not appear at points of outlet.

B. Prepare reports of flushing activities.

END OF SECTION

SECTION 211313 - WATER BASED FIRE SUPPRESSION SYSTEMS

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. The extent of this fire sprinkler system shall be as specified herein. Contractor shall be responsible for preparation of design drawings, hydraulic calculations, fabrication and installation for complete fire sprinkler protection for the building.

B. Section Includes:

1. Pipes, fittings, and specialties.
2. Fire protection valves.
3. Sprinkler pipe fittings.
4. Sprinklers.
5. Alarm devices.

C. Related Sections:

1. Division 21 Section 210010 "General Fire Suppression Requirements" for requirements for hydraulic calculations, obtaining electronic drawings files, shop drawings and record drawings.
2. Division 21 Section 210500 "Common Work Results for Fire Suppression," for materials and methods for wall and floor penetrations.
3. Division 21 Section 210515 "Basic Fire Suppression Piping Material and Methods," for general piping and fitting materials and methods.
4. Division 21 Section 210553 "Identification for Fire Suppression Piping and Equipment" for labeling and identification of installed fire suppression equipment.
5. Division 21 Section 211100 "Fire Suppression Water Service Piping" for fire suppression piping starting 5 feet outside the building to within the building.

1.2 SYSTEM DESCRIPTION

A. Fire protection system in the location or portion of the building is a Wet Pipe Systems.

1. Wet Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to a water supply. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts a fusible link or destroys a frangible device. Hose connections are included if indicated.

B. Provide system(s) as specified herein and as shown on drawings. The sprinkler system shall be supplied by the underground or fire suppression standpipe system as shown on the Drawings.

C. Provide dry pipe fire protection system for non-heated spaces and other areas of building subject to freezing including the loading docks and canopies, mansards, and balconies. Portions of systems subject to freezing or temperatures below 40° F shall be protected against freezing as required by NFPA 13. The Contractor shall be responsible for repairs and for all costs incurred from damage caused by freezing of the fire protection system.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design fire suppression system, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Standard Pressure, Fire Suppression System Component: Listed for 175-psig minimum working pressure.

C. Performance Criteria

1. Protect entire area of work, unless noted otherwise, with a sprinkler system designed in accordance with NFPA 13 for Light Hazard requirements.

2. Protect mechanical and electrical areas/rooms with a sprinkler system designed in accordance with NFPA 13 for Ordinary Hazard Group 1 requirements.

3. Protect storage areas/rooms, unless noted otherwise, with a sprinkler system designed in accordance with NFPA 13 for Ordinary Hazard Group 2 requirement.

4. Other Occupancy Hazard Classifications.

a. Building Service Areas: Ordinary Hazard Group 1.

b. Libraries except Stack Areas: Light Hazard.

c. Machine Shops: Ordinary Hazard, Group 2.

d. Office and Public Areas: Light Hazard.

e. Wood Storage, Wood Shop: Ordinary Hazard, Group 2.

f. Kitchen Areas: Ordinary Hazard, Group1.

5. Design Criteria for Automatic-Sprinkler Piping Design:

a. Light Hazard Occupancy:

1) Minimum Design Density: 0.10 gpm over 1,500 sq.ft. area.

2) Maximum protection area per sprinkler: 225 sq.ft.

3) Minimum Combined Hose Stream Demand Requirement: 100 gpm for 30 minutes.

b. Ordinary Hazard Group 1 Occupancy:

1) Minimum Design Density: 0.15 gpm over 1,500 sq.ft. area.

2) Maximum area per sprinkler: 130 sq.ft..

3) Minimum Combined Hose Stream Demand: 250 gpm for 60 to 90 minutes.

c. Ordinary Hazard Group 2 Occupancy:

1) Minimum Design Density: 0.20 gpm over 1,500 sq.ft. area.

2) Maximum protection area per sprinkler: 130 sq.ft.

3) Minimum Combined Hose Stream Demand: 250 gpm for 60 to 90 minutes.

D. The criteria listed herein shall not preclude the use of extended coverage or special application fire sprinklers designed and installed in accordance with their listing and manufacturer's instructions.

E. The hydraulic area of operation may not be reduced as allowed by NFPA 13 for areas utilizing quick response sprinklers in unfinished shell spaces. For all other areas, the hydraulic area of operation shall not be reduced as allowed by NFPA 13 for areas utilizing quick response sprinklers unless specifically approved by the Engineer via a formally submitted RFI.

F. Sprinkler spacing shall conform to NFPA 13 and shall not exceed 256 SF per sprinkler in unfinished shell spaces.

G. The hydraulic area of operation shall be increased by 30% without revising the density for areas with sloped ceilings with a pitch exceeding 1 in 6 (16.7% slope) in accordance with NFPA 13.

H. The hydraulic area of operation shall be increased by 30% without revising the density for dry-pipe and double interlock preaction systems in accordance with NFPA 13.

1.4 SUBMITTALS

A. Submit shop drawings prepared in accordance with NFPA 13 as specified in Division 21 Section 210010 "General Fire Suppression Requirements."

1.5 QUALITY ASSURANCE

A. Contractor shall be responsible for all permits and fees associated with preparation and approval of Drawings and the installation and approval of a fire sprinkler system.

B. Tests and Inspections: Arrange, test, and pay for all tests required by code and authorities having jurisdiction.

1.6 COORDINATION

A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

1.7 EXTRA MATERIALS

A. Sprinkler Wrenches: Furnish to Owner, 2 sprinkler wrenches for each type of sprinkler installed.

B. Sprinklers: Furnish extra sprinklers of each style, type and finish included in the project as required by NFPA 13.

C. Sprinkler Cabinet and Wrench: Provide a finished steel cabinet(s), suitable for wall mounting, with hinged cover and space for the quantity of spare sprinklers provided plus sprinkler wrench(es).

D. Provide hydraulic calculation placard attached to each riser.

PART 2 - PRODUCTS AND MATERIALS

2.1 EQUIPMENT

A. All fire protection equipment shall be UL listed for its intended use and in conformance with the applicable NFPA documents.

2.2 PIPE AND FITTING MATERIALS

A. Refer to Division 21 Section 210515 "Basic Fire Suppression Piping Materials and Methods" for specifications on piping and fittings.

2.3 HANGERS

A. Shall be UL listed and shall meet requirements of NFPA 13 for type, dimension and location.

2.4 GENERAL DUTY VALVES

A. Refer to Division 21 Section 210515 "Basic Fire Suppression Piping Materials and Methods" for specifications on general duty valves.

2.5 SPECIALTY VALVES

A. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing.

2. Pressure Rating:

a. Standard Pressure Piping Specialty Valves: 175-psig minimum.

3. Body Material: Cast- or ductile- iron.

4. Size: Same as connected piping.

5. End Connections: Flanged or grooved.

B. Air Release Valve:

1. Provide for all wet pipe sprinkler systems utilizing metallic piping in accordance with one of the following options:

a. Manual ball valve with a minimum size of ½ inch (15 mm).

b. Listed automatic valve.

2.6 PIPE FITTINGS

A. Branch Outlet Fittings:

1. Standard: UL 213.

2. Pressure Rating: 175-psig minimum.

3. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.

4. Type: Mechanical-T and -cross fittings.

5. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.

6. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.

7. Branch Outlets: Grooved, welded or threaded.

B. Flow Detection and Test Assemblies:

1. Standard: UL's "Fire Protection Equipment Directory" listing.

2. Pressure Rating: 175-psig minimum.

3. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.

4. Size: Same as connected piping.

5. Inlet and Outlet: Grooved or threaded.

C. Sprinkler Inspector's Test Fittings:

1. Standard: UL's "Fire Protection Equipment Directory" listing.

2. Pressure Rating: 175-psig minimum.

3. Body Material: Cast- or ductile-iron housing with sight glass.

4. Size: Same as connected piping.

5. Inlet and Outlet: Threaded.

D. Flexible Piping Systems:

1. At Contractor's option, UL listed and FM approved flexible piping connections to sprinklers may be used for both acoustical panel and gypsum board ceilings when suitable for their intended use.

2. Description: Connections shall include a leak-tested sprinkler drop with a minimum internal corrugated hose diameter of 1 inch.

3. Flexible piping lengths shall not exceed 6 feet.

4. Installation shall not exceed the minimum bend radius and maximum allowable bends as specified by the manufacturer.

5. Change in direction shall be gradual enough to allow flexible piping to bend without crimping, distorting or reducing internal diameter.

2.7 AUTOMATIC SPRINKLERS

A. Sprinklers: type and style as indicated or required by application. Sprinkler operating temperatures to comply with NFPA 13. Sprinklers in Light Hazard areas shall be quick response type.

B. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing.

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

C. Automatic Sprinklers with Heat-Responsive Element:

1. Early-Suppression, Fast-Response Applications: UL 1767.

2. Nonresidential Applications: UL 199.

3. Characteristics: Nominal 1/2-inch orifice with discharge coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.

D. Use sprinkler types below for the following applications:

1. Rooms without Ceilings: Upright sprinklers.

2. Rooms with Suspended Ceilings: Concealed sprinklers.

3. Rooms with Gypsum Board Ceilings: Recessed sprinklers.

4. Wall Mounting: Sidewall sprinklers.

5. Spaces Subject to Freezing: Dry pendent or dry sidewall sprinklers as indicated on drawings.

E. Provide sprinkler types below with finishes indicated.

1. Finished Areas:

   a. Concealed Sprinklers: Rough brass, with cover plate factory painted to match ceiling. Coordinate ceiling color with architect.

   b. Upright, Pendent, and Sidewall Sprinklers: Bright chrome, with bright chrome escutcheon.

   c. Unfinished Areas: Rough bronze in unfinished spaces not exposed to view.

F. Coordinate sprinkler temperature ratings near heat-producing sources in accordance with NFPA 13.

G. Sprinklers shall be wax coated where exposed to acids, chemicals, or other corrosive fumes.

H. Sprinkler Guards: Provide sprinkler guard where sprinklers are less than 7-feet above finished floor; where subject to physical damage, and/or where indicated on drawings. Guard shall be UL 199 listed, wire cage type with fastening device for attaching to sprinkler.

I. Sprinkler Cabinet and Wrench: Provide a finished steel cabinet, suitable for wall mounting, with hinged cover and space for the appropriate quantity of spare sprinklers plus sprinkler wrench(es).

2.8 ALARM DEVICES

A. General: Alarm device types shall match piping and equipment connections.

B. Audible/Visual Alarm Notification Appliances (Horn/Strobe):

1. Standard: UL 1971 combination horn and strobe appliance.

2. Horn: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet from the horn.

3. Strobes: Xenon strobe lights complying with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch (25-mm) high letters on the lens.

4. Audible/visual notification appliance shall be exterior, weatherproof with weatherproof backbox.

C. Water Flow Indicators:

1. Standard: UL 346.

2. Water-Flow Detector: Electrically supervised.

3. 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.

4. Type: Paddle operated.

5. Pressure Rating: 250 psig.

6. Design Installation: Horizontal or vertical.

7. h

D. Valve Supervisory Switches:

1. Standard: UL 346.

2. Type: Electrically supervised.

3. Components: Single-pole, double-throw switch with normally closed contacts and tamperproof cover.

4. Design: Signals that controlled valve is in other than fully open position.

E. Indicator Post Supervisory Switches:

1. Standard: UL 346.

2. Type: Electrically supervised.

3. Components: Single-pole, double-throw switch with normally closed contacts and tamperproof cover.

4. Design: Signals that controlled indicator post valve is in other than fully open position.

5.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install in accordance with manufacturer's instructions.

3.2 PREPARATION

A. Perform fire hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.

3.3 WATER SUPPLY CONNECTION

A. Connect sprinkler piping to water service piping for service entrance to building. Do not connect to underground supply until provided with written documentation that piping has been flushed and pressure tested in accordance with NFPA 13. Comply with requirements for exterior piping in Division 21 Section 211100 "Fire Suppression Water Service Piping."

B. Connect sprinkler piping to building's interior water distribution piping. Comply with requirements in Division 22 Section 221116 "Domestic Water Piping" for interior piping.

C. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-service piping. Comply with requirements for backflow preventers in Division 21 Section 211100 "Fire Suppression Water Service Piping."

D. Wet pipe systems shall be equipped with a listed relief valve 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.

3.4 PIPE APPLICATIONS

A. Piping Below Grade: Refer to Division 21 Section 211100 "Fire Suppression Water Service Piping."

B. Piping Above Grade: Refer to Division 21 Section 210515 "Basis Fire Suppression Piping Materials and Methods."

3.5 PIPING INSTALLATIONS

A. Refer to Division 21 Section 210515"Basic Fire Suppression Piping Materials and Methods" for general fire suppression piping installation requirements.

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

C. Hangers and Supports: Comply with the requirements of NFPA 13. Hanger and support spacing and locations for piping joined with grooved mechanical couplings shall be in accordance with the grooved mechanical coupling manufacturer's written instructions, for rigid systems. Provide protection from damage where subject to earthquake if required by the applicable building code, designed in accordance with NFPA 13. Locate hangers at or directly adjacent to the joist panel points. Provide two nuts on threaded supports to securely fasten the support.

D. Install test connections sized and located in accordance with NFPA 13 complete with shutoff valve. Test connections may also serve as drain pipes.

E. Install pressure gauge on the riser or feed main at or near each test connection. Provide pressure gauge with a connection not less than 1/4 inch and having a soft metal seated globe valve, arranged for draining pipe between gauge and valve. Install gauges to permit removal, and install where they will not be subject to freezing.

F. Install automatic (ball drip) drain valves to drain piping between fire department connections and check valves. Drain to floor drain or outside building.

G. Fill wet-type sprinkler system piping with water.

H. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 21 Section 210515 "Basic Fire Suppression Piping Materials and Methods"

I. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 21 Section 210515 "Basic Fire Suppression Piping Materials and Methods."

3.6 PIPE JOINT CONSTRUCTION

A. Refer to Division 21 Section 210515 "Basic Fire Suppression Piping Materials and Methods" for general pipe joint construction requirements.

3.7 VALVE AND SPECIALTIES INSTALLATION

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

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

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

3.8 SPRINKLER INSTALLATIONS

A. Use proper tools to prevent damage during installations.

B. Install sprinklers in suspended ceilings in center or quarter point of acoustical ceiling panels, in a symmetrical pattern with lights and outlets.

C. Install sprinklers in a symmetrical pattern with lights and outlets in all other areas with ceilings.

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

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

F. Do not install more than one sprinkler on a one inch outlet unless hydraulic calculations are included to verify performance.

3.9 IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13 and Division 21 Section 210553 "Identification for Fire Suppression Piping and Equipment."

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

3.10 FIELD QUALITY CONTROL

A. Perform required tests and inspections.

B. Tests and Inspections:

1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.

2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.

4. Energize circuits to electrical equipment and devices.

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

6. Verify that equipment hose threads are same as local fire department equipment.

C. Replace piping system components that do not pass the test procedures specified, and retest repaired portion of the system.

3.11 CLEANING

A. Clean dirt and debris from sprinklers.

B. Remove and replace sprinklers with paint other than factory finish.

3.12 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain specialty valves.

3.13 COMMISSIONING

A. Sprinkler Systems: Test per NFPA 13, NFPA 25 and local authorities requirements. Submit Contractor's Material & Test Certificates for Above Ground Piping. Submit certificates of completion to Authority Having Jurisdiction and Owner.

1. After completion of all installation, tests, etc., and prior to the opening date, the Sprinkler Subcontractor shall instruct the building personnel in the operation of the sprinkler system. Special care shall be taken to make sure the building personnel:

a. Will immediately recognize whether the system control valves are in an 'Open' position or a 'Closed' position.

b. Will know how to drain the system.

c. Will know how to test the flow switches, tamper switches and alarm system.

d. Will know how to make complete weekly inspection.

e. Will know how to perform periodic maintenance of the Fire Sprinkler System.

B. Fire Alarm Equipment: Test per NFPA 25, NFPA 72 and local authorities requirements in the presence of the Owner. Submit certificates of completion to authority having jurisdiction and Owner.

END OF SECTION

SECTION 220010 - GENERAL PLUMBING REQUIREMENTS

PART 1 - GENERAL REQUIREMENTS

1.1 DESCRIPTION OF WORK

A. This Division requires the furnishing and installing of complete functioning systems, and each element thereof, as specified or indicated on the Drawings and Specifications or reasonably inferred; including every article, device or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the work include materials, labor, supervision, supplies, equipment, transportation, and utilities.

B. Division 22 of the Specifications and Drawings numbered with prefixes P, MP and EP generally describe these systems, but the scope of the Plumbing work includes all such work indicated in the Contract Documents: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Mechanical, Plumbing and Electrical Drawings and Specifications; and Addenda.

C. The Drawings have been prepared diagrammatically intended to convey the scope of work, indicating the intended general arrangement of the equipment, fixtures, piping, etc. without showing all the exact details as to elevations, offsets, control lines, and other installation requirements. The Contractor shall use the Drawings as a guide when laying out the work and shall verify that materials and equipment will fit into the designated spaces, and which, when installed per manufacturers requirements, will ensure a complete, coordinated, satisfactory and properly operating system.

1.2 QUALITY ASSURANCE

A. All work under this division shall be executed in a thorough professional manner by competent and experienced workmen licensed to perform the Work specified.

B. All work shall be installed in strict conformance with manufacturer's requirements and recommendations. Equipment and materials shall be installed in a neat and professional manner and shall be aligned, leveled, and adjusted for satisfactory operation.

C. Material and equipment shall be new, shall be of the best quality and design, shall be current model of the manufacturer, shall be free from defects and imperfections and shall have markings or a nameplate identifying the manufacturer and providing sufficient reference to establish quality, size and capacity. Material and equipment of the same type shall be made by the same manufacturer whenever practicable.

D. Unless specified otherwise, manufactured items shall have been installed and used, without modification, renovation, or repair for not less than one year prior to date of bidding for this project.

1.3 CODES, REFERENCES AND STANDARDS

A. Execute Work in accordance with the National Fire Protection Association and all Local, State, and National codes, ordinances and regulations in force governing the particular class of Work involved. Obtain timely inspections by the constituted authorities, and upon final completion of the Work obtain

and deliver to the Owner executed final certificates of acceptance from the Authority Having Jurisdiction.

B. Any conflict between these Specifications and accompanying Drawings and the applicable Local, State and Federal codes, ordinances and regulations shall be reported to the Architect in sufficient time, prior to the opening of Bids, to prepare the Supplementary Drawings and Specification Addenda required to resolve the conflict.

C. The governing codes are minimum requirements. Where these Drawings and Specifications exceed the code requirements, these Drawings and Specification shall prevail.

D. All material, manufacturing methods, handling, dimensions, method or installation and test procedure shall conform to but not be limited to the following industry standards and codes:

IBC	International Building Code – 2018
IMC	International Mechanical Code – 2018
IPC	International Plumbing Code – 2018
IFGC	International Fuel Gas Code – 2018
IECC	International Energy Conservation Code – 2012
ADA	American Disabilities Act
AIA	Guidelines for Design and Construction of Hospital and Healthcare Facilities
AMCA	Air Movement and Control Association, Inc.
ANSI	American National Standards Institute
ASHRAE	American Society of Heating Refrigerating and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASSE	American Society of Sanitary Engineering
ASTM	American Society of Testing Materials
AWS	American Welding Society
AWWA	American Water Works Association
CISPI	Cast Iron Soil Pipe Institute
MSS	Manufacturer's Standardization Society of the Valve and Fitting Industry
NBFU	National Board of Fire Underwriters
NEC	National Electrical Code
NFPA	National Fire Protection Association
NEMA	National Electrical Manufactures' Association
OSHA	Occupational Safety and Health Act
PDI	Plumbing and Drainage Institute
UL	Underwriter's Laboratories

E. Contractor shall comply with rules and regulations of public utilities and municipal departments affected by connections of services.

F. All Plumbing work shall be performed in compliance with applicable safety regulations, including OSHA regulations. Safety lights, guards, shoring and warning signs required for the performance of the Plumbing work shall be provided by the Contractor.

1.4 DEFINITIONS

A. General:

1. Furnish: The term "furnish" is used to mean "supply and deliver to the project site, ready for unloading, unpacking, assembly, installation and similar operations."

2. Install: The term "install" is used to describe operations at the project site including the actual "unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations."

3. Provide: The term "provide" means "to furnish and install, complete and ready for the intended use."

4. Furnished by Owner or Furnished by Others: The item will be furnished by the Owner or Others. It is to be installed and connected under the requirements of this Division, complete and ready for operation, including items incidental to the Work, including services necessary for proper installation and operation. The installation shall be included under the guarantee required by this Division.

5. Engineer: Where referenced in this Division, "Engineer" is the Engineer of Record and the Design Professional for the Work under this Division, and is a Consultant to, and an authorized representative of, the Architect, as defined in the General and/or Supplementary Conditions. When used in this Division, it means increased involvement by, and obligations to, the Engineer, in addition to involvement by, and obligations to, the "Architect".

6. AHJ: The local code and/or inspection agency (Authority) Having Jurisdiction over the Work.

7. NRTL: Nationally Recognized Testing Laboratory, as defined and listed by OSHA in 29 CFR 1910.7 (e.g., UL, ETL, CSA, etc.), and acceptable to the Authority having Jurisdiction (AHJ) over this project. Nationally Recognized Testing Laboratories and standards listed are used only to represent the characteristics required and are not intended to restrict the use of other listed Manufacturers and models that meet the specified criteria.

8. Substitution: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor. Substitutions include Value Engineering proposals.

    a. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.

    b. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.

9. Value Engineering: A systematic method to improve the "value" of goods and services by using an examination of function. Value, as defined, is the ratio of function to cost. Value can therefore be increased by either improving the function or reducing the cost. The goal of VE is to achieve the desired function at the lowest overall cost consistent with required performance.

B. The terms "approved equal", "equivalent", or "equal" are used synonymously and shall mean "accepted by or acceptable to the Engineer as equivalent to the item or manufacturer specified". The term "approved" shall mean labeled, listed, or both, by an NRTL, and acceptable to the AHJ over this project.

C. The following definitions apply to excavation operations:

1. Additional Excavation: Where excavation has reached required subgrade elevations, if unsuitable bearing materials are encountered, continue excavation until suitable bearing materials are reached. The Contract Sum may be adjusted by an appropriate Contract Modification.

2. Bedding: as used in this Section refers to the compacted sand or pea gravel installed in the bottom of a pipe trench to immediately support a pipe and cover a pipe.

3. Subbase: as used in this Section refers to the compacted soil layer used in pavement systems between the subgrade and the pavement base course material.

4. Subgrade: as used in this Section refers to the compacted soil immediately below the slab or pavement system.

5. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction from the Architect.

6. Building Fill: as used in this section refers to borrowed fill material of rock 1" and larger used to fill foundation excavations.

1.5 COORDINATION

A. The Contractor shall visit the site and ascertain the conditions to be encountered while installing the Work under this Division, verify all dimensions and locations before purchasing equipment or commencing work, and make due provision for same in the bid. Failure to comply with this requirement shall not be considered justification for omission, alteration, incorrect or faulty installation of Work under this Division or for additional compensation for Work covered by this Division.

B. The Contractor shall refer to Drawings of the other disciplines and to relevant equipment drawings and shop drawings to determine the extent of clear spaces. The Contractor shall make offsets required to clear equipment, beams and other structural members; and to facilitate concealing piping and ductwork in the manner anticipated in the design.

C. The contractor shall provide materials with trim which will fit properly the types of ceiling, wall, or floor finishes actually installed.

D. The Contractor shall maintain a foreman on the jobsite at all times to coordinate his work with other contractors and subcontractors so that various components of the Plumbing systems will be installed at the proper time, will fit the available space, and will allow proper service access to the equipment. Carry on the Work in such a manner that the Work of the other contractors and trades will not be handicapped, hindered, or delayed at any time.

E. Work of this Division shall progress according to the "Construction Schedule" as established by the Prime Contractor and his subcontractors and as approved by the Architect. Cooperate in establishing these schedules and perform the Work under this Division, in a timely manner in conformance with the construction schedule so as to ensure successful achievement of schedule dates.

1.6 MEASUREMENTS AND LAYOUTS

A. The drawings are schematic in nature, but show the various components of the systems approximately to scale and attempt to indicate how they are to be integrated with other parts of the building. Figured

dimensions shall be taken in preference to scale dimensions. Determine exact locations by job measurements, by checking the requirements of other trades, and by reviewing the Contract Documents. The Contractor will be held responsible for errors which could have been avoided by proper checking and inspection.

1.7 SUBMITTALS

A. Refer to Division 1 and General Conditions for submittal requirements in addition to requirements specified herein.

B. Submittals and shop drawings shall not contain the firm name, logo, seal, or signature of the Engineer. They shall not be copies of the work product of the Engineer. If the Contractor desires to use elements of such product, the license agreement for transfer of information obtained from the Engineer must be used.

C. Assemble and submit for review manufacturer product literature for material and equipment to be furnished and/or installed under this Division. Literature shall include shop drawings, manufacturer product data, performance sheets, samples and other submittals required by this Division as noted in Table 1 at the end of this Section. Provide the number of submittals required by Division 1; if hard-copy sets are provided, submit a minimum of seven (7) sets. General product catalog data not specifically noted to be part of the specified product will be rejected and returned without review.

D. Separate submittals according to individual specification sections. Only resubmit those sections requested for resubmittal.

E. Provide submittals in sufficient detail so as to demonstrate compliance with these Contract Documents and the design concept. Highlight, mark, list or indicate the materials, performance criteria and accessories that are being proposed. Illegible submittals will be rejected and returned without review.

F. Refer to individual Sections for additional submittal requirements.

G. Transmit submittals as early as required to support the project schedule. Allow two weeks for Engineer review time, plus to/from mailing time via the Architect, plus a duplication of this time for resubmittals, if required. Transmit submittals as soon as possible after Notice to Proceed and before Plumbing construction starts.

H. Before transmitting submittals and material lists, verify that the equipment submitted is mutually compatible with and suitable for the intended use. Verify that the equipment will fit the available space and maintain manufacturer recommended service clearances. If the size of equipment furnished makes necessary any change in location, or configuration, submit a shop drawing showing the proposed layout.

I. Submittals shall contain the following information:

1. The project name.

2. The applicable specification section and paragraph.

3. Equipment identification acronym as used on the drawings.

4. The submittal date.

5. The Contractor's stamp, which shall certify that the stamped drawings have been checked by the Contractor, comply with the Drawings and Specifications, and have been coordinated with other trades.

6. Submittals not so identified will be returned to the Contractor without action.

J. Refer to Division 1 for acceptance of electronic submittals for this project. For electronic submittals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 1. Contractor shall notify the Architect and Engineer that the submittals have been posted. If electronic submittal procedures are not defined in Division 1, Contractor shall include the website, user name and password information needed to access the submittals. For submittals sent by e-mail, Contractor shall copy the Architect and Engineer's designated representatives. Contractor shall allow for the Engineer review time as specified above in the construction schedule. Contractor shall submit only the documents required to purchase the materials and/or equipment in the submittal.

K. The checking and subsequent acceptance by the Engineer and/or Architect of submittals shall not relieve responsibility from the Contractor for (1) deviations from the Drawings and Specifications; (2) errors in dimensions, details, sizes of equipment, or quantities; (3) omissions of components or fittings; and (4) not coordinating items with actual building conditions and adjacent work. Contractor shall request and secure written acceptance from the Engineer and Architect prior to implementing any deviation.

L. Provide welders' qualification certificates.

1.8 ELECTRONIC DRAWING FILES

A. In preparation of shop drawings or record drawings, Contractor may, at their option, obtain electronic drawing files in AutoCAD or DXF format from the Engineer for a shipping and handling fee of $200 for a drawing set up to 12 sheets and $15 per sheet for each additional sheet. Contact the Architect for Architect's written authorization. Contractor shall request and complete the Electronic File Release Agreement form from the Engineer. Send the form along with a check made payable to Henderson Engineers, Inc. Contractor shall indicate the desired shipping method and drawing format on the attached form. In addition to payment, Architect's written authorization and Engineer's release agreement form must be received before electronic drawing files will be sent.

1.9 SUBSTITUTIONS

A. Refer to Division 01 and General Conditions for substitutions in addition to requirements specified herein.

B. Materials, products, equipment, and systems described in the Bidding Documents establish a standard of required function, dimension, appearance and quality to be met by the proposed substitution.

C. The base bid shall include only the products from manufacturers specifically named in the drawings and specifications.

D. Request for Substitution:

1. Complete and send the Substitution Request Form attached at the end of this section for each material, product, equipment, or system that is proposed to be substituted.

2. The burden of proof of the merit of the proposed substitution is upon the proposer.

3. Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner the following:

   a. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.

   b. Proposed substitution is consistent with the Contract Documents and will produce indicated results, including functional clearances, maintenance service, and sourcing of replacement parts.

   c. Proposed substitution has received necessary approvals of authorities having jurisdiction.

   d. Same warranty will be furnished for proposed substitution as for specified Work.

   e. If accepted substitution fails to perform as required, Contractor shall replace substitute material or system with that originally specified and bear costs incurred thereby.

   f. Coordination, installation and changes in the Work as necessary for accepted substitution will be complete in all respects.

E. Substitution Consideration:

1. No substitutions will be considered unless the Substitution Request Form is completed and attached with the appropriate substitution documentation.

2. No substitution will be considered prior to receipt of Bids unless written request for approval to bid has been received by the Engineer at least ten (10) calendar days prior to the date for receipt of Bids.

3. If the proposed substitution is approved prior to receipt of Bids, such approval will be stated in an Addendum. Bidders shall not rely upon approvals made in any other manner. Verbal approval will not be given.

4. No substitutions will be considered after the Contract is awarded unless specifically provided in the Contract Documents.

1.10 OPERATION AND MAINTENANCE MANUALS

A. Refer to Division 1 and General Conditions for Operation and Maintenance Manuals in addition to requirements specified herein.

B. Submit manuals prior to requesting the final punch list and before all requests for Substantial Completion.

C. Instruct the Owner's permanent personnel in the proper operation of, startup and shutdown procedures and maintenance of the equipment and components of the systems installed under this Division.

D. Prior to Substantial Completion of the project, furnish to the Architect, for Engineer's review, and for the Owner's use, four (4) copies of Operation and Maintenance Manuals in labeled, hard-back three-

ring binders, with cover, binding label, tabbed dividers and plastic insert folders for Record Drawings. Include local contacts, complete with address and telephone number, for equipment, apparatus, and system components furnished and installed under this Division of the specifications.

E. Each manual shall contain data listed in Table 5.

F. Refer to Division 1 for acceptance of electronic manuals for this project. For electronic manuals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 1. Contractor shall notify the Architect and Engineer that the manuals have been posted. If electronic manual procedures are not defined in Division 1, Contractor shall include the website, user name and password information needed to access the manuals. For manuals sent by e-mail, Contractor shall copy the Architect and Engineer's designated representatives.

1.11 SPARE PARTS

A. Provide to the Owner the spare parts specified in the individual sections in Division 22 of this specification. Refer to Table 2 at the end of this section for a list of specification sections in Division 22 that contain spare parts requirements.

B. Owner or Owner's representative shall initial and date each section line in Table 2 when the specified spare parts for that section are received and shall sign at the bottom when all spare parts have been received.

1.12 RECORD DRAWINGS

A. A set of work prints of the Contract Documents shall be kept on the jobsite during construction for the purpose of noting changes. During the course of construction, the Contractor shall indicate on these Documents changes made from the original Contract Documents. Particular attention shall be paid to those items which need to be located for servicing. Underground utilities shall be located by dimension, from column lines.

1.13 PAINTING

A. Exposed ferrous surfaces, including pipe, pipe hangers, equipment stands and supports [and exposed insulated piping] shall be painted by the Plumbing Contractor using materials and methods as specified under Division 9 of the Specifications; colors shall be as selected by the Architect.

B. Factory finishes, shop priming and special finishes are specified in the individual equipment specification sections.

C. Where factory finishes are provided and no additional field painting is specified, marred or damaged surfaces shall be touched up or refinished so as to leave a smooth, uniform finish.

1.14 DELIVERY, STORAGE AND HANDLING

A. Equipment and material shall be delivered to the job site in their original containers with labels intact, fully identified with manufacturer's name, model, model number, type, size, capacity and Underwriter's Laboratories, Inc. labels and other pertinent information necessary to identify the item.

B. Deliver, receive, handle and store equipment and materials at the job site in the designated area and in such a manner as to prevent equipment and materials from damage and loss. Store equipment and materials delivered to the site on pallets and cover with waterproof, tear resistant tarp or plastic or as required to keep equipment and materials dry. Follow manufacturer's recommendations, and at all times, take every precaution to properly protect equipment and material from damage, to include the erection of temporary shelters to adequately protect equipment and material stored at the Site. Equipment and/or material which become rusted or damaged shall be replaced or restored by the Contractor to a condition acceptable to the Architect.

C. The Contractor shall be responsible for the safe storage of his own tools, material and equipment.

1.15 GUARANTEES AND WARRANTIES

A. Each system and element thereof shall be warranted against defects due to faulty workmanship, design or material for a period of 12 months from date of Substantial Completion, unless specific items are noted to carry a longer warranty in the Construction Documents or manufacturer's standard warranty. The Contractor shall remedy defects occurring within a period of one year from the date of Substantial Completion or as stated in the General Conditions.

B. The following additional items shall be guaranteed:

1. Piping shall be free from obstructions, holes or breaks of any nature.

2. Insulation shall be effective.

3. Proper circulation of fluid in each piping system.

C. The above guarantees shall include both labor and material; and repairs or replacements shall be made without additional cost to the Owner.

D. The remedial work shall be performed promptly, upon written notice from the Architect or Owner.

E. At the time of Substantial Completion, deliver to the Owner warranties with terms extending beyond the one year guarantee period, each warranty instrument being addressed to the Owner and stating the commencement date and term. Refer to Table 3 at the end of this section for a list of specification sections in Division 22 that contain special warranties.

1.16 TEMPORARY FACILITIES

A. Temporary Utilities: The types of services required include, but are not limited to, water, sewerage, surface drainage and gas. When connecting to existing franchised utilities for required services, comply with service companies' recommendations on materials and methods, or engage service companies to install services. Locate and relocate services (as necessary) to minimize interference with construction operations.

1. Water: Premises are supplied with water services which may be used in this work: Contractor shall make his own arrangements for water services.

2. Provide the necessary backflow prevention devices where connecting to the potable water system. Protect water service from freezing by draining system or by providing adequate heat. Where non-potable water is used, mark each outlet with health hazard warning signs.

3. Sewer Sediment: Maintain sewers and temporary connecting sewers in a clean, nonclogged condition during construction period.

B. Construction Facilities: Provide facilities reasonably required to perform construction operations properly and adequately.

1. Enclosures: When temporary enclosures are required to ensure adequate workmanship, weather protection and ambient conditions required for the work, provide fire-retardant treated lumber and plywood; provide tarpaulins with UL label and flame spread of 15 or less; provide translucent type (nylon reinforced polyethylene) where daylighting of enclosed space would be beneficial for workmanship, and reduce use of temporary lighting.

1.17 PROJECT CONDITIONS

A.

B. Site Information: Subsurface conditions were investigated during the design of the Project. Reports of these investigations are available for information only; data in the reports are not intended as representations or warranties of accuracy or continuity of conditions. The Owner will not be responsible for interpretations or conclusions drawn from this information.

C. Use of explosives is not permitted.

D. Environmental Conditions: Apply joint sealers under temperature and humidity conditions within the limits permitted by the joint sealer manufacturer. Do not apply joint sealers to wet substrates.

PART 2 - PRODUCTS AND MATERIALS

2.1 SOIL MATERIALS

A. Provide clean sand, pea gravel or flowable fill material (per the geotechnical engineer's or structural engineer's recommendations).

B. Subbase Material: Where applicable, provide natural soils with 10% by volume of rocks less than 2" diameter or artificially crushed aggregate. Corrosive fill materials shall not be utilized. When CL clay, rock, or gravel is used, it shall not be larger than 2 inches in any dimension and be free of debris, waste, frozen materials, vegetable and other deleterious matter.

PART 3 - EXECUTION

3.1 PERMITS

A. Secure and pay for permits required in connection with the installation of the Plumbing Work. Arrange with the various utility companies for the installation and connection of required utilities for this facility and pay charges associated therewith including connection charges and inspection fees, except where these services or fees are designated to be provided by others.

3.2 EXCAVATION AND BACKFILLING

A. Refer to Division 01, Division 02, and Division 31, Geotechnical Soils Report and General Conditions for Excavation and Backfilling in addition to the requirements specified herein.

B. Perform excavation of every description, of whatever substance encountered and to the depth required in connection with the installation of the work under this Division. Excavation shall be in conformance with applicable Division and section of the General Specifications.

C. Roads, alleys, streets and sidewalks damaged during this work shall be restored to the satisfaction of Authorities Having Jurisdiction.

D. Trenches close to walks or columns shall not be excavated without prior consultation with the Architect.

E. Erect barricades around excavations. Provide an adequate number of amber lights on or near the work and keep them burning from dusk to dawn. The Contractor shall be held responsible for any damage that any parties may sustain due to neglecting the necessary precautions when performing the work.

F. Slope sides of excavations to comply with local, state and federal codes and ordinances. Shore and brace as required for stability of excavation.

G. Shoring and Bracing: Establish requirements for trench shoring and bracing to comply with local, state and federal codes and authorities. Maintain shoring and bracing in excavations regardless of time period excavations will be open.

1. Remove shoring and bracing when no longer required. Where sheeting is allowed to remain, cut top of sheeting at an elevation of 30 inches below finished grade elevation.

H. Install sediment and erosion control measures in accordance with local codes and ordinances.

I. Dewatering: Prevent surface water and subsurface or ground water from flowing into excavations and trenches.

1. Do not allow water to accumulate in excavations and trenches. Remove water to prevent softening of bearing materials. Provide and maintain dewatering system components necessary to convey water away from excavations.

2. Establish and maintain temporary drainage ditches and other diversions outside excavation and trench limits to convey surface water to collecting or run-off areas. Do not use trench excavations as temporary drainage ditches. In no case shall sewers be used as drains for such water.

J. Material Storage: Stockpile satisfactory excavated materials where directed, until required for backfill or fill. Place, grade, and shape stockpiles for proper drainage.

1. Locate and retain soil materials away from edge of excavations. Do not store within drip-line of trees indicated to remain.

2. Remove and legally dispose of excess excavated materials and materials not acceptable for use as backfill or fill.

K. Excavation for Underground Tanks, Basins, and Plumbing Structures: Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10 foot; plus a sufficient distance to permit placing and removal of concrete formwork, installation of services, other construction, and for inspection.

1. Excavate, by hand, areas within drip-line of large trees. Protect the root system from damage and dry-out. Maintain moist conditions for root system and cover exposed roots with burlap. Paint root cuts of 1 inch in diameter and larger with emulsified asphalt tree paint.

2. Take care not to disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is placed.

L. Trenching: Excavate trenches for Plumbing installations as follows:

1. Excavate trenches to the uniform width, sufficiently wide to provide ample working room and a minimum of 6 to 9 inches clearance on both sides of pipe and equipment.

2. Excavate trenches to depth indicated or required for piping to establish indicated slope and invert elevations. Beyond building perimeter, excavate trenches to an elevation below frost line.

3. Limit the length of open trench to that in which pipe can be installed, tested, and the trench backfilled within the same day.

4. Where rock is encountered, carry excavation below required elevation and backfill with a layer of crushed stone or gravel prior to installation of pipe. Provide a minimum of 6 inches of stone or gravel cushion between rock bearing surface and pipe.

5. Excavate trenches for piping and equipment with bottoms of trench to accurate elevations for support of pipe and equipment on undisturbed soil.

M. Cold Weather Protection: Protect excavation bottoms against freezing when atmospheric temperature is less than 35°F.

N. Bedding:

1. Fill bottom of pipe trench and fill unevenness with compacted bedding material to ensure continuous bearing of the pipe barrel on the bearing surface. Additional bedding installation requirements are in the following piping specifications. Compact bedding as described below:

2. Fill bottom of equipment trench and fill unevenness with compacted sand backfill to ensure continuous bearing of the equipment on the bearing surface. Compact bedding as described below.

O. Backfilling and Filling: Place soil materials in layers to required subgrade elevations for each area classification listed below, using materials specified in Part 2 of this Section.

1. Under walks and pavements, use a combination of subbase materials and excavated or borrowed materials.

2. Under building slabs, use drainage fill materials.

3. Under piping and equipment, use subbase materials where required over rock bearing surface and for correction of unauthorized excavation.

4. For piping less than 30 inches below surface of roadways, provide 4-inch-thick concrete base slab support after installation and testing of piping and prior to backfilling and placement of roadway subbase. Coordinate with AHJ for colored concrete requirements.

5. Other areas, use excavated or borrowed materials.

P. Backfill excavations as promptly as work permits, but not until completion of the following:

1. Inspection, testing, approval, and locations of underground utilities have been recorded.

2. Removal of concrete formwork.

3. Removal of shoring and bracing, and backfilling of voids.

4. Removal of trash and debris.

Q. Drainage Fill: Where building fill is used in lieu of natural soils, provide drainage fill as subbase material. Provide filter fabric material to line the trench to support the bedding material and subbase materials to ensure that backfill materials will not segregate within the trench nor create voids and sags within the pipe trench.

R. Placement and Compaction: Place subgrade backfill and fill materials in layers of not more than 8 inches in loose depth for material compacted by heavy equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

S. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification specified below. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.

T. Place backfill and fill materials evenly adjacent to structures, piping, and equipment to required elevations. Prevent displacement of piping and equipment by carrying material uniformly around them to approximately same elevation in each lift.

U. Compaction: Place bedding backfill materials in maximum layers of not more than 6 inches loose depth for material compacted by hand-operated tampers. Place subbase backfill materials in maximum layers of not more than 8 inches in loose depth for material compacted by heavy equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers. Control soil compaction during construction, providing minimum percentage of density specified for each area classification indicated below.

1. Use of pneumatic backhoe as compaction method is not allowed as an acceptable process for compaction of excavations or trenches.

2. For vertical and/or diagonal pipe installations greater than ½" rise/lf, thoroughly support pipes from permanent concrete structures or undisturbed earth at no less than 10-foot intervals, while placing backfill materials, so that pipes are not deflected, crushed, broken, or otherwise damaged by the backfill placement or settlement.

3. Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water. Apply water in minimum quantity necessary to achieve required moisture content and to prevent water appearing on surface during, or subsequent to, compaction operations. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification specified below. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.

4. Place backfill and/or drainage fill materials evenly adjacent to structures, piping, and equipment to required elevations. Coordinate with Architect and/or Civil Engineer backfill requirements prior to installation. Prevent displacement of pipes and equipment by carrying material uniformly around them to approximately same elevation in each layer or lift.

5. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density for soils which exhibit a well-defined moisture-density relationship (cohesive soils), determined in accordance with ASTM D 1557 or ASTM D 698 and not less than the following percentages of relative density, determined in accordance with ASTM D 4253, for soils which will not exhibit a well-defined moisture-density relationship (cohesionless soils).

    a. Areas Under Structures, Building Slabs and Steps, Pavements: Compact top 12 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.

    b. Areas Under Walkways: Compact top 6 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.

    c. Other Areas: Compact top 6 inches of subgrade and each layer of backfill or fill material to 85 percent maximum density for cohesive soils, and 90 percent relative density for cohesionless soils.

V. Subsidence: Where subsidence occurs at Plumbing installation excavations during the period 12 months after Substantial Completion, remove surface treatment (i.e., pavement, lawn, or other finish), add backfill material, compact to specified conditions, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent areas.

W. Additional Excavation: Where additional excavation may be required due to unsuitable bearing materials encountered, notify the architect immediately for resolution.

3.3 CLEANING

A. Dirt and refuse resulting from the performance of the work shall be removed from the premises as required to prevent accumulation. The Plumbing Contractor shall cooperate in maintaining reasonably clean premises at all times.

B. Immediately prior to the final inspection, the Plumbing Contractor shall clean material and equipment installed under the Plumbing Contract. Dirt, dust, plaster, stains, and foreign matter shall be removed from surfaces including components internal to equipment. Damaged finishes shall be touched-up and restored to their original condition.

3.4 SUBSTANTIAL COMPLETION REVIEW

A. Prior to requesting inspection for "CERTIFICATE OF SUBSTANTIAL COMPLETION", the Contractor shall complete the following items:

1. Submit complete Operation and Maintenance Manuals.

2. Submit complete Record Drawings.

3. Perform special inspections. Refer to Table 4 at the end of this section for a list of specification sections in Division 22 that contain special inspection requirements.

4. Start-up testing of systems.

5. Removal of temporary facilities from the site.

6. Comply with requirements for Substantial Completion in the "General Conditions".

B. The Contractor shall request in writing a review for Substantial Completion. The Contractor shall give the Architect/Engineer at least seven (7) days notice prior to the review.

C. The Contractor's written request shall state that the Contractor has complied with the requirements for Substantial Completion.

D. Upon receipt of a request for review, the Architect/Engineer will either proceed with the review or advise the Contractor of unfulfilled requirements.

E. If the Contractor requests a site visit for Substantial Completion review prior to completing the above mentioned items, He shall reimburse the Architect/Engineer for time and expenses incurred for the visit.

F. Upon completion of the review, the Architect/Engineer will prepare a "final list" of outstanding items to be completed or corrected for final acceptance.

G. Omissions on the "final list" shall not relieve the Contractor from the requirements of the Contract Documents.

H. Prior to requesting a final review, the Contractor shall submit a copy of the final list of items to be completed or corrected. He shall state in writing that each item has been completed, resolved for acceptance or the reason it has not been completed.

END OF SECTION 220010

TABLE 1: PLUMBING SPECIFICATION SHOP DRAWING SUBMITTAL REQUIREMENTS

SPECIFICATION NUMBER/TITLE		CODE DESIGNATION
220010	General Plumbing Requirements	NONE
220015	Coordination	NONE
220500	Common Work Results For Plumbing	A, B, G, M
220513	Common Motor Requirements For Plumbing Equipment	B
220515	Basic Piping Materials And Methods	B, G
220516	Expansion Fittings And Loops For Plumbing Piping	A, B, F
220519	Meters And Gauges For Plumbing Piping	B, H
220523	General-Duty Valves For Plumbing Piping	B
220529	Hangers And Supports For Plumbing Piping	B, F, G, H
220550	Vibration Isolation For Plumbing Piping & Equipment	A, B, C, F, I, J
220553	Identification For Plumbing Piping & Equipment	B, L, M
220700	Plumbing Insulation	B, M
221100	Water Distribution Piping & Specialties	B, G, H
221111	Mechanically Joined Plumbing Piping Systems	B, G, H
221112	GENERAL PLUMBING REQUIREMENTS & Specialties	B, G, H
221123	Domestic Water Pumps	A, B, C, E
221300	Sanitary Drainage & Vent Piping & Specialties	B
221400	Storm Drainage Piping & Specialties	B
221489	Sump Pumps	A, B, C, E
223300	Electric Domestic Water Heaters	B, C, E, F, H, K
223400	Fuel Fired Domestic Water Heaters	B, C, E, F, H, K
224000	Plumbing Fixtures	B, E, N
227000	Natural Gas Systems	A, B, C, D, F, G
227010	Mechanically Joined Natural Gas Piping Systems	B, F, H, N

CODED LEGEND

A	Shop Drawings
B	Product Data and equipment weights
C	Performance Data, Curves, Certificates and Test Data
D	Coordination Drawings
E	Wiring Diagrams and short circuit current ratings
F	Installation Instructions
G	Welder's Certificates
H	Certificates
I	Calculations
J	Special Inspections
K	Special Warranties
L	Material Samples
M	Schedules
N	Recommended Spare Parts List

TABLE 2: SPARE PARTS REQUIREMENTS FOR PLUMBING EQUIPMENT

SECTION NUMBER		RECEIVED/DATE/INITIAL
220553	Identification For Plumbing Piping & Equipment	_____
221100	Water Distribution Piping & Specialties	_____
221111	Mechanically Joined Plumbing Piping Systems	_____
221112	GENERAL PLUMBING REQUIREMENTS & Specialties	_____
224000	Plumbing Fixtures	_____
221123	Domestic Water Pumps	_____
221489	Sump Pumps	_____
227000	Natural Gas Systems	_____

_____
Owner's Signature

TABLE 3: SPECIAL WARRANTY REQUIREMENTS FOR PLUMBING EQUIPMENT

SECTION NUMBER		RECEIVED/DATE/INITIAL
223300	Electric Domestic Water Heaters	_____
223400	Fuel Fired Domestic Water Heaters	_____

TABLE 4: SPECIAL INSPECTION REQUIREMENTS FOR PLUMBING EQUIPMENT

SECTION NUMBER		COMPLETED/DATE/INITIAL
220550	Vibration Isolation For Plumbing Piping & Equipment	_____

TABLE 5: PLUMBING SPECIFICATION OPERATION AND MAINTENANCE SUBMITTAL REQUIREMENTS

SPECIFICATION NUMBER/TITLE		CODE DESIGNATION
220500	Common Work Results For Plumbing	B
220513	Common Motor Requirements For Plumbing Equipment	B
220515	Basic Piping Materials And Methods	B
220516	Expansion Fittings And Loops For Plumbing Piping	A, B
220519	Meters And Gauges For Plumbing Piping	B, G, I
220523	General-Duty Valves For Plumbing Piping	B, H, I
220529	Hangers And Supports For Plumbing Piping	B
220550	Vibration Isolation For Plumbing Piping & Equipment	A, B, C
220553	Identification For Plumbing Piping & Equipment	B
220700	Plumbing Insulation	B
221100	Water Distribution Piping & Specialties	A, B, F, H, I
221111	Mechanically Joined Plumbing Piping Systems	A, B, F, H, I
221112	GENERAL PLUMBING REQUIREMENTS & Specialties	A, B, F, H, I
221123	Domestic Water Pumps	B, C, D, E, G, H, I
221300	Sanitary Drainage & Vent Piping & Specialties	A, B, F
221400	Storm Drainage Piping & Specialties	A, B, F
221489	Sump Pumps	B, C, D, E, G, H, I223300
	Electric Domestic Water Heaters	B, C, D, E, G, H, I
223400	Fuel Fired Domestic Water Heaters	B, C, D, E, G, H, I
224000	Plumbing Fixtures	B, E, H, I
227000	Natural Gas Systems	A, B, C, H
227010	Mechanically Joined Natural Gas Piping Systems	B, F, H

CODED LEGEND

A	As-Built Drawings
B	Product Data
C	Performance Data, Capacities, Curves and Certificates
D	Wiring Diagrams
E	Operating Instructions
F	Test Reports
G	Warranties
H	Recommended Spare Parts List
I	Service and Maintenance Instructions

SUBSTITUTION REQUEST FORM

To Project Engineer: _____ Request # (GC Determined): _____

Project Name: _____

Project No/Phase: _____ Date: _____

Specification Title: _____

Section Number: _____ Page: _____ Article/Paragraph: _____

Proposed Substitution: _____

_____

Manufacturer: _____ Model No.: _____

Address: _____ Phone: _____

History: ☐ New product ☐ 1-4 years old ☐ 5-10 years old ☐ More than 10 years old

Differences between proposed substitution and specified Work: _____

_____

☐ Point-by-point comparative data attached – REQUIRED BY ENGINEER
Comparative data may include but not be limited to performance, certifications, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements. Include all information necessary for an evaluation.

Supporting Data Attached: ☐ Drawings ☐ Product Data ☐ Samples ☐ Tests ☐ Reports ☐ Other: _____

Reason for not providing specified item: _____

_____

Similar Installation:
Project: _____ Architect: _____

Address: _____ Owner: _____

_____ Date Installed: _____

Proposed substitution affects other parts of Work: ☐ No ☐ Yes; explain: _____

_____

_____

Substitution Certification Statement:

Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner that the:

A. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.
B. Proposed substitution is consistent with the Contract Documents and will produce indicated results.
C. Proposed substitution does not affect dimensions and functional clearances.
D. Proposed substitution has received necessary approvals of authorities having jurisdiction.
E. Same warranty will be furnished for proposed substitution as for specified Work.
F. Same maintenance service and source of replacement parts, as applicable, is available.
G. Proposed substitution will not adversely affect other trades or delay construction schedule.
H. Coordination, installation, and changes in the Work as necessary for accepted substitution will be complete in all respects.

Submitting Contractor	Date	Company

Manufacturer's Certification of Equal Quality:

I _____ represent the manufacturer of the Proposed Substitution item and hereby certify and warrant to Architect, Engineer, and Owner that the function and quality of the Proposed Substitution meets or exceeds the Specified Item.

Manufacturer's Representative	Date	Company

Engineer Review and Recommendation Section

Recommend Acceptance	☐ Yes	☐ No
Additional Comments:	☐ Attached	☐ None

Acceptance Section:

Contractor Acceptance Signature	Date	Company
Owner Acceptance Signature	Date	Company
Architect Acceptance Signature	Date	Company
Engineer Acceptance Signature	Date	Company

SECTION 220015 - COORDINATION

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section specifies the basic requirements for electrical components which are an integral part of packaged plumbing equipment. These components include, but are not limited to factory furnished motors, starters, and disconnect switches furnished as an integral part of packaged plumbing equipment.

B. Specific electrical requirements (i.e. horsepower and electrical characteristics) for plumbing equipment are scheduled on the Drawings.

C. System shall be complete and operational with power and control wiring provided to meet the design intent shown on the drawings and specified within the specification sections.

1.2 SUBMITTALS

A. No separate submittal is required. Submit product data for motors, starters, and other electrical components with submittal data required for the equipment for which it serves, as required by the individual equipment specification Sections.

1.3 QUALITY ASSURANCE

A. Electrical components and materials shall be UL labeled.

B. All electrical equipment provided and the wiring and installation of electrical equipment shall be in accordance with the requirements of this Section and Division 26.

PART 2 - PRODUCTS AND MATERIALS

2.1 GENERAL

A. The Contractors shall provide all motors, starters, disconnects, wire, conduit, etc. as specified in the Construction Documents. If, however, the Plumbing Contractor furnishes a piece of equipment requiring a different motor, starter, disconnect, wire size, etc. than what is shown and/or intended on the Construction Documents, the Plumbing Contractor shall coordinate the requirements with any other Contractor and shall be responsible for any additional cost incurred by any other Contractor that is associated with installing the different equipment and related accessories for proper working condition.

B. Refer to Division 26, "Common Work Results for Electrical" for specification of motor connections

C. Refer to Division 26, "Enclosed Switches and Circuit Breakers" for specification of disconnect switches.

PART 3 - EXECUTION

3.1 CONTRACTOR COORDINATION

A. Unless otherwise indicated, all motors, equipment, controls, etc. shall be furnished, set in place and wired in accordance with Table 1. Any items not listed but shown on the drawings shall be considered part of the Contract Documents and brought to the attention of the Architect.

B. The General Contractor is the central authority governing the total responsibility of all trade contractors. Therefore, deviations and clarifications of this schedule are permitted provided the General Contractor assumes responsibility to coordinate the trade contractors different than as indicated herein. If deviations or clarifications to this schedule are implemented, submit a record copy to the Engineer.

TABLE 1: ELECTRICAL REQUIREMENTS FOR PLUMBING EQUIPMENT

ITEM	FURN BY	SET BY	POWER WIRING	CONTROL WIRING
Equipment motors	DIV 22	DIV 22	DIV 26	---
Factory furnished motor starters, contactors and disconnects	DIV 22	DIV 26	DIV 26	DIV 23
Loose motor starters, disconnect switches, thermal overloads and heaters.	DIV 26	DIV 26	DIV 26	DIV 23
Factory assembled control panels	DIV 22	DIV 26	DIV 26	DIV 23
Manual operating multi-speed switches	DIV 22	DIV 26	DIV 26	DIV 23
Control relays and transformers	DIV 22	DIV 22	DIV 26	DIV 23
Thermostats (line voltage)	DIV 22	DIV 22	DIV 26	---
Time switches DIV 22	DIV 22	DIV 26	DIV 23	
Remote pressure switches (booster pumps)DIV 22	DIV 22 ---		DIV 23	
Variable speed drives	DIV 22	DIV 22	DIV 26	DIV 23
Motor and solenoid operated valves	DIV 22	DIV 22	DIV 23	DIV 23

DIV 22 = Plumbing Contractor
DIV 26 = Electrical Contractor
DIV 23 = Building Automation System Contractor, refer to Division 23 Section "Direct-Digital Control for HVAC".

END OF SECTION 220015

SECTION 220500 - COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section includes limited scope general construction materials and methods for application with Plumbing installations as follows:

1. Access panels and doors in walls, ceilings, and floors for access to Plumbing materials and equipment.

2. Plumbing equipment nameplate data.

3. Concrete for bases and housekeeping pads.

4. Non-shrink grout for equipment installations.

5. Sleeves for Plumbing penetrations.

6. Miscellaneous metals for support of Plumbing materials and equipment.

7. Wood grounds, nailers, blocking, fasteners, and anchorage for support of Plumbing materials and equipment.

8. Joint sealers for sealing around Plumbing materials and equipment.

B. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 7 Section "Penetration Firestopping" for material and methods for firestopping systems.

2. Division 22 Section "Basic piping Materials and Methods" for materials and methods for mechanical sleeve seals.

3. Division 22 Section "Sanitary Drainage and Vent Piping and Specialties" for indirect drain piping and installation requirements.

4. Division 23 Section "Direct Digital Controls for HVAC" for integration with building automation system of leak detection system "Water Present" alarm.

5. Division 26 Section "Common Work Results for Electrical" required electrical devices.

6. Division 26 Sections "Enclosed Switches and Circuit Breakers" for field-installed disconnects.

1.2 SUBMITTALS

A. General: Submit the following in accordance with Division 1 and Division 22 Section "General Plumbing Requirements".

1. Product data for the following products:

a. Access panels and doors.

b. Through and membrane-penetration firestopping systems.

c. Joint sealers.

2. Shop drawings detailing fabrication and installation for metal fabrications, and wood supports and anchorage for Plumbing materials and equipment.

3. Welder certificates, signed by Contractor, certifying that welders comply with requirements specified under "Quality Assurance" article of this Section.

4. Schedules indicating proposed methods and sequence of operations for selective demolition prior to commencement of Work. Include coordination for shut-off of utility services and details for dust and noise control.

a. Coordinate sequencing with construction phasing and Owner occupancy specified in Division 1 Section "Summary of Work."

5. Through and Membrane Penetration Firestopping Systems Product Schedule: Submit a schedule for each piping system penetration that includes UL listing, location, wall or floor rating and installation drawing for each penetration fire stop system.

a. Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping condition, submit illustration, with modifications marked, approved by penetration firestopping manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

1.3 QUALITY ASSURANCE

A. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel."

1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

B. Fire-Resistance Ratings: Where a fire-resistance classification is indicated, provide access door assembly with panel door, frame, hinge, and latch from manufacturer listed in the UL "Building Materials Directory" for rating shown.

1. Provide UL Label on each fire-rated access door.

C. Through and Membrane Penetration Systems Installer Qualifications: A firm experienced in installing penetration firestopping systems similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its penetration firestopping system products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.

1.4 NOISE CRITICAL SPACES

A. Many areas of the building, referred to as "noise-critical spaces", require special attention (special acoustical provisions and restrictions). The table below designates the noise-critical spaces; noise levels due to equipment, ductwork, grilles, registers, terminal devices, diffusers, etc., shall permit attaining sound pressure levels in all 8 octave bands in occupied spaces conforming to RC levels per ASHRAE handbook as indicated.

Space	RC Levels
Choir Risers	25
Stage	25
Sound/Lighting Control Rooms	25
A/V Spaces	25
Music Teaching Studios	25
Teleconference Rooms	25
Meeting/Banquet Rooms	30
Conference Rooms	30

PART 2 - PRODUCTS AND MATERIALS

2.1 ACCESS TO EQUIPMENT

A. Manufacturer:

1. Bar-Co., Inc.
2. Elmdor Stoneman.
3. JL Industries
4. Jay R. Smith Mfg. Co.
5. Karp Associates, Inc.
6. Milcor
7. Nystrom Building Products
8. Wade
9. Zurn

B. Access Doors:

1. Provide access doors for all concealed equipment, except where above lay-in ceilings. Refer to Section "Identification for Plumbing Piping" for labeling of access doors.

2. Access doors shall be adequately sized for the devices served with a minimum size of 18 inches x 18 inches, furnished by the respective Contractor or Subcontractor and installed by the General Contractor.

3. Access doors must be of the proper construction for type of construction where installed.

4. The exact location of all access doors shall be verified with the Architect prior to installation.

5. Steel Access Doors and Frames: Factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation. Joints and seams shall be continuously welded steel, with welds ground smooth and flush with adjacent surfaces.

6. Frames: 16-gauge steel, with a 1-inch-wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile, or wood paneling.

    a. For installation in masonry, concrete, ceramic tile, or wood paneling: 1-inch-wide exposed perimeter flange and adjustable metal masonry anchors.

    b. For installation in gypsum wallboard or plaster: perforated flanges with wallboard bead.

    c. For installation in full-bed plaster applications: galvanized, expanded metal lath and exposed casing bead, welded to perimeter of frame.

7. Flush Panel Doors: 14-gauge sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees; factory-applied prime paint.

    a. Fire-Rated Units: Insulated flush panel doors, with continuous piano hinge and self-closing mechanism.

8. Locking Devices: Flush, screwdriver-operated cam locks.

9. Locking Devices: Where indicated on the drawings or where access panels are installed in locations accessible to the public, provide 5-pin or 5-disc type cylinder locks, individually keyed; provide 2 keys.

2.2 PLUMBING EQUIPMENT NAMEPLATE DATA

A. For each piece of power operated Plumbing equipment, provide a permanent operational data nameplate indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliance's, and similar essential data. Locate nameplates in an accessible location.

2.3 CONCRETE EQUIPMENT BASES/HOUSEKEEPING PADS

A. Provide concrete equipment bases and housekeeping pads for various pieces of floor mounted Plumbing equipment.. Concrete equipment bases/housekeeping pads shall generally conform to the shape of the piece of equipment it serves with a minimum 4" margin around the equipment and supports.

B. Form concrete equipment bases and housekeeping pads using framing lumber or steel channel with form release agent. Chamfer top edges and corners. Trowel tops and sides of each base/pad to a smooth finish, equal to that of the floors.

C. Concrete equipment bases and housekeeping pads shall be made of a minimum 28 day, 4000 psi concrete conforming to American Concrete Institute Standard Building Code for Reinforced Concrete (ACI 318-99) and the latest applicable recommendations of the ACI standard practice manual. Concrete shall be composed of cement conforming to ASTM C 150 Type I, aggregate conforming to ASTM C33, and potable water. All exposed exterior concrete shall contain 5 to 7 percent air entrainment.

D. Unless otherwise specified or shown on the structural drawings, reinforce equipment bases and housekeeping pads with No. 4 reinforcing bars conforming to ASTM A 615 or 6x6 – W2.9 x W2.9 welded wire mesh conforming to ASTM A185. Reinforcing bars shall be placed 24" on center with a minimum of two bars each direction.

E. Provide galvanized anchor bolts for all equipment placed on concrete equipment bases and housekeeping pads or on concrete slabs. Anchor bolts size, number and placement shall be as recommended by the Manufacturer of the equipment.

F. Concrete equipment bases and housekeeping pads shall have minimum heights in accordance with the following table:

Equipment	Minimum Height
Water Heaters, Water Softeners and Equipment Less than or equal to 20 tons and Other Equipment Not Listed – Note 1	3-1/2"

NOTES:

1. Height of equipment bases applies to equipment installed on slab-on-grade. For equipment installed on floors above grade and/or roof, reference the drawings.

2.4 GROUT

A. Provide nonshrink, nonmetallic grout conforming to ASTM C 1107, Grade B, in premixed and factory-packaged containers.

B. Grout shall have post-hardening, volume-adjusting, dry, non-staining, non-corrosive, non-gaseous, hydraulic-cement characteristics and shall be as recommended by manufacturer for interior and exterior applications.

C. Grout shall have 5,000 psi, 28-day compressive strength design mix.

2.5 PENETRATIONS

A. Sleeves:

1. Steel Sleeves: Schedule 40 galvanized, welded steel pipe, ASTM A-53 grade A or 12 gauge (0.1084 inches) welded galvanized steel formed to a true circle concentric to the pipe.

2. Sheet-Metal Sleeves: 10 gauge (0.1382 inches), galvanized steel, round tube closed with welded longitudinal joint.

B. Frames for rectangular openings attached to forms and of a maximum dimension established by the Architect. For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, provide 18 gauge (0.052 inches) welded galvanized steel. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, provide 10 gauge (0.1382 inches) welded galvanized steel. Notify the General Contractor or Architect before installing any box openings not shown on the Architectural or Structural Drawings.

C. Box Frames: Frames for rectangular openings shall be of welded 12 gauge steel attached to forms and of a maximum dimension established by the Architect. Contractor shall notify the General Contractor or Architect before installing any box openings not shown on the Architectural or Structural Drawings.

2.6 DRIP PANS

A. Drip pans for pipes in protected areas shall be 20 gauge galvanized steel with 2" lapped and soldered joints. Drip pan shall have a depth of 2" and a width of 6" in addition to the diameter of the associated pipe. Provide 3/4" galvanized pipe with male NPT outlet at low point of drip pan.

B. Drip pan supports shall be ¼" X 2" galvanized bar stock welded to the drip pan without holes.

2.7 LEAK DETECTION SYSTEM

A. Leak detection system with Rope style leak sensor and controller capable of connecting to a building automation system with audible and visual alarms for leak detection and cable failure in all drip pans unless otherwise noted on drawings. Provide with factory 24V DC power supply with power plug, sensing cables, and accessories.

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

a. RLE Technologies #LD1000

2.8 MISCELLANEOUS METALS

A. Steel plates, shapes, bars, and bar grating: ASTM A 36.

B. Cold-Formed Steel Tubing: ASTM A 500.

C. Hot-Rolled Steel Tubing: ASTM A 501.

D. Steel Pipe: ASTM A 53, Schedule 40, welded.

E. Fasteners: Zinc-coated, type, grade, and class as required.

2.9 MISCELLANEOUS LUMBER

A. Framing Materials: Standard Grade, light-framing-size lumber of any species. Number 3 Common or Standard Grade boards complying with WCLIB or AWPA rules, or Number 3 boards complying with SPIB rules. Lumber shall be preservative treated in accordance with AWPB LP-2, and kiln dried to a moisture content of not more than 19 percent.

B. Construction Panels: Plywood panels; APA C-D PLUGGED INT, with exterior glue; thickness as indicated, or if not indicated, not less that 15/32 inches.

2.10 JOINT SEALERS

A. General: Joint sealers, joint fillers, and other related materials compatible with each other and with joint substrates under conditions of service and application.

B. Colors: As selected by the Architect from manufacturer's standard colors.

C. Elastomeric Joint Sealers: Provide the following types:

1. One-part, nonacid-curing, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for masonry, glass, aluminum, and other substrates recommended by the sealant manufacturer. Provide one of the following:

a. "Dow Corning 790," Dow Corning Corp.

b. "Silglaze II SCS 2801," General Electric Co.

c. "Silpruf SCS 2000," General Electric Co.

d. "864," Pecora Corp.

e. "Rhodia 5C," Rhone-Poulenc, Inc.

f. "Spectrem 1," Tremco, Inc.

g. "Spectrem 2," Tremco, Inc.

h. "Dow Corning 795," Dow Corning Corp.

i. "Rhodia 7B," Rhone-Poulenc, Inc.

j. "Rhodia 7S," Rhone-Poulenc, Inc.

k. "Omniseal," Sonneborn Building Products Div.

2. One-part, mildew-resistant, silicone sealant complying with ASTM C 920, Type S, Grade NS, Class 25, for uses in non-traffic areas for glass, aluminum, metal or porcelain plumbing fixtures and nonporous joint substrates; formulated with fungicide; intended for sealing interior joints with nonporous substrates; and subject to in-service exposure to conditions of high humidity and temperature extremes. Provide one of the following:

   a. "Dow Corning 786," Dow Corning Corp.

   b. "Sanitary 1700," General Electric Co.

   c. "898 Silicone Sanitary Sealant," Pecora Corp.

D. Acrylic-Emulsion Sealants: One-part, nonsag, mildew-resistant, paintable complying with ASTM C 834 recommended for exposed applications on interior and protected exterior locations involving joint movement of not more than plus or minus 5 percent. Provide one of the following:

1. Products: Subject to compliance with requirements, provide one of the following:

   a. "Chem-Calk 600," Bostik Construction Products Div.

   b. "AC-20," Pecora Corp.

   c. "Sonolac," Sonneborn Building Products Div.

   d. "Tremflex 834," Tremco, Inc.

2.11 ACOUSTICAL SEALANTS

A. General: Penetrations by pipes through surfaces that are around and between noise critical spaces shall be sleeved, packed and sealed airtight with foam rod, non-hardening sealant and/or packing material as described herein.

B. Foam Rod: Foam backer rod shall be closed cell polyethylene suitable for use as a backing for non-hardening sealant.

C. Non-Hardening Sealant: Sealant for penetrations shall be non-hardening polysulphide type. Permanently flexible, approved firestop putty may be used in lieu of the sealant on foam rod in noise critical walls that are also fire rated.

D. Packing Material: Mineral fiber; non-combustible; resistant to water, mildew and vermin. Expanding resilient foams manufactured for this purpose are an acceptable alternative only if the material density is at least 15 pcf (40 kg/m3).

2.12 FIRESTOPPING

A. Sealants and accessories shall have fire-resistance ratings indicated, as established by testing identical assemblies in accordance with UL 2079 or ASTM E 814, or other NRTL acceptable to AHJ. Manufactured by:

1. Hilti
2. RectorSeal
3. Specified Technologies Inc.,
4. United States Gypsum Company
5. 3M Corp.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install access doors and sealants in accordance with manufacturer's installation instructions.

3.2 INSTALLATION OF ACCESS DOORS

A. Set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.

B. Adjust hardware and panels after installation for proper operation.

3.3 ERECTION OF METAL SUPPORTS AND ANCHORAGE

A. Cut, fit, and place miscellaneous metal fabrications accurately in location, alignment, and elevation to support and anchor Plumbing materials and equipment.

B. Field Welding: Comply with AWS "Structural Welding Code."

3.4 ERECTION OF WOOD SUPPORTS AND ANCHORAGE

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorage accurately in location, alignment, and elevation to support and anchor Plumbing materials and equipment.

B. Select fastener sizes that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.5 PREPARATION FOR JOINT SEALERS

A. Surface Cleaning for Joint Sealers: Clean surfaces of joints immediately before applying joint sealers to comply with recommendations of joint sealer manufacturer.

B. Apply joint sealer primer to substrates as recommended by joint sealer manufacturer. Protect adjacent areas from spillage and migration of primers, using masking tape. Remove tape immediately after tooling without disturbing joint seal.

3.6 APPLICATION OF JOINT SEALERS

A. General: Comply with joint sealer manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.

1. Comply with recommendations of ASTM C 962 for use of elastomeric joint sealants.

2. Comply with recommendations of ASTM C 790 for use of acrylic-emulsion joint sealants.

B. Tooling: Immediately after sealant application and prior to time shinning or curing begins, tool sealants to form smooth, uniform beads; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

3.7 PENETRATIONS:

A. New Construction:

1. Coordinate with Divisions 03 and 04 for installation of sleeves and sleeve seals integrally in cast-in-place, precast, and masonry walls and horizontal slabs where indicated on the Drawings or as required to support piping or ductwork penetrations.

B. Construction in Existing Facilities:

1. Saw cut or core drill existing walls and slabs to install sleeves and sleeve seals in existing facilities. Do not cut or drill any walls or slabs without first coordinating with, and receiving approval from, the Architect, Owner, or both. Seal sleeves and sleeve seals into concrete walls or slabs with a waterproof non-shrink grout acceptable to the Architect.

C. Provide sleeves and/or box frames for openings in all concrete and masonry construction and fire or smoke partitions, for all mechanical work that passes through such construction; Coordinate with other trades and Divisions to dimension and lay out all such openings.

D. The General Contractor will provide only those openings specifically indicated on the Architectural or Structural Drawings as being provided under the General Contractor's work.

E. The cutting of new or existing construction shall not be permitted except by written approval of the Architect.

F. Floor sleeves shall be fitted with means for attachment to forms and shall be of length to extend at least two inches above the floor level.

G. Cut sleeves to length for mounting flush with both surfaces of walls.

H. Extend sleeves installed in floors 2 inches above finished floor level.

I. Seal space outside of sleeves with grout for penetrations of concrete and masonry.

J. Seal space outside of sleeves with approved joint compound for penetrations of gypsum board assemblies.

K. All openings sleeved through underground exterior walls shall be sealed with mechanical sleeve seals as specified in Division 22 Section "Basic Piping Materials and Methods".

3.8 DRIP PANS

A. Provide drip pans in locations indicated on drawings.

B. Provide drip pans for piping directly above a two hour rated ceiling of an elevator machine room.

C. Provide drip pans, only with written approval obtained prior to installation, installed beneath piping above electrical rooms, telecom rooms, data rooms, servers or any other protected area not clearly indicated by drawings.

D. Provide drip pan supports every 4'-0". Provide ¼" galvanized threaded rods through bar stock on each side of the drip pan and attached with 2 nuts per rod. Attach rods to structure with MSS SP-58 compliant components.

E. Connect ¾" type "L" copper indirect drain line to drip pan outlet. Route and discharge to receptor with air gap outside of the protected area.

F. Install leak detection rope in a zig-zag pattern covering entire length and width of the drip pan. Secure rope to pan per manufacturers recommendations.

G. Mount leak detection controller on wall adjacent to exit of the room above which the drip pan is located unless otherwise indicated on drawings indicated on drawings.

H. Coordinate disconnect and power supply for leak detection system and 120V dedicated receptacle adjacent to controller with Division 26. Power wiring and receptacles are specified in Division 26 Section "Common Work Results for Electrical" Disconnects are specified in Division 26 Section "Enclosed Switches and Circuit Breakers"

I. Coordinate interlock of "Water Present" alarm and "Cable Fault alarm with Building Automation System. Refer to Division 23 Section "Direct Digital Controls for HVAC" for integration with building automation system and low voltage power wiring.

3.9 LEAK DETECTION SYSTEM FOR WATER HEATERS

A. Provide leak detection rope all around perimeter of water heater drip pan. Secure rope to pan per manufacturers recommendations.

B. Mount leak detection system controller where indicated on drawings.

C. Interlock control panel with building automation system for alarm signal for "Leak at Water Heaters" and "Cable Fault" alarm. Upon receiving leak alarm signal from control panel, building automation

system shall energize motorized ball valve "MBV" to close. Motorized ball valve "MBV" is indicated and specified on the drawings. Refer to Division 23 Section "Direct Digital Controls for HVAC" for integration with building automation system and low voltage power wiring.

3.10 ACOUSTICAL PENETRATIONS

A. General: There shall be no direct contact of piping with shaft walls, floor slabs and/or partition. All openings around pipes in the structure surrounding the plumbing equipment and surrounding noise-critical spaces shall be sealed, packed with caulking for the full depth of the penetration, as described herein. This includes all slab penetrations and penetrations of noise critical walls.

B. Domestic Water, Sewer, Drain and Vent Piping

1. Where a pipe passes through a wall, ceiling or floor slab of a noise critical space, a steel sleeve shall be cast or grouted into the structure. The internal diameter of the sleeve shall be 2 inches larger than the external diameter of the pipe passing through it. After all of the piping is installed in that area, the Contractor shall check the clearance and correct it, if necessary, to within 1/2 inch. Pack the void full depth with packing material sealed at both ends, 1 inch deep, with non-hardening sealant backed by foam rod.

C. Compressed Air Piping

1. Compressed air pipes may be sleeved and sealed as described above, or may be grouted and caulked into the structure as follows: before grout has set, rake a groove around the pipe on each side of the wall or slab; groove shall be 1/2 inch wide and 1/2 inch deep. After grout has set, fill groove full depth with sealant.

END OF SECTION 220500

SECTION 220513 - COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section includes the following:

1. Single phase electric motors.

2. Three phase electric motors.

1.2 SUBMITTALS

A. General: Submit the following in accordance with conditions of contract and Division 1 specification Sections.

1. Product Data: Show nameplate data and ratings; characteristics; mounting arrangements; size and location of winding termination lugs, conduit entry, and grounding lug; and coatings.

1.3 QUALITY ASSURANCE

A. All motors shall be UL listed.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

A. Century

B. General Electric

C. Westinghouse

D. Baldor

E. Gould

2.2 GENERAL CONSTRUCTION AND REQUIREMENTS

A. Motors Less Than 250 Watts, for Intermittent Service: Provide equipment manufacturer's standard. Motor's need not conform to these specifications.

B. Electrical Service: All motors shall be supplied in accordance with the following voltage and phase unless noted otherwise on the Drawings.

1. Motors 3/4 HP and Larger: 480 volts, three phase, 60 Hz.

2. Motors 1/2 HP and Smaller: 120 volts, single phase, 60 Hz.

C. Type:

1. Open drip-proof except where noted otherwise.

2. Motors: Design for continuous operation in 40 degrees C environment.

3. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.

4. Motors with frame sizes 254T and larger: Energy Efficient Type.

D. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.

E. Wiring Terminations:

1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.

2. For fractional horsepower motors, provide flexible conduit connection in end frame. Maximum length of flexible conduit shall be five feet.

2.3 SINGLE PHASE POWER - PERMANENT-SPLIT CAPACITOR MOTORS

A. Starting Torque: Exceeding one fourth of full load torque.

B. Starting Current: Up to six times full load current.

C. Multiple Speed: Through tapped windings.

D. Open Drip-proof or Enclosed Air Over Enclosure: Class A (50 degrees C temperature rise) insulation, minimum 1.0 Service Factor, prelubricated sleeve or ball bearings, automatic reset overload protector.

2.4 THREE PHASE POWER - SQUIRREL CAGE MOTORS

A. Starting Torque: Between 1 and 1-1/2 times full load torque.

B. Starting Current: Six times full load current.

C. Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics.

D. Design, Construction, Testing, and Performance: Conform to NEMA MG 1 for Design B motors.

E. Insulation System: NEMA Class B or better.

F. Drip-proof Enclosure: NEMA Service Factor.

G. All motors controlled by variable frequency controllers shall have a 1.15 Service Factor.

H. Testing Procedure: In accordance with IEEE 112. Load test motors to determine free from electrical or mechanical defects in compliance with performance data.

I. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.

J. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors imbedded in motor windings and epoxy encapsulated solid state control relay for wiring into motor starter; refer to Division 16 - Motor Controlling Equipment.

K. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum AFBMA 9, L-10 life of 20,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

L. Sound Power Levels: To NEMA MG 1.

M. Variable Frequency Drive Motors: Motors controlled by variable frequency drives shall be rated for voltage peaks and minimum rise times in accordance with NEMA MG1, Part 31.

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

2. Inverter-Duty Motors: Class B temperature rise; Class F insulation.

3. Grounding: Provide shaft grounding system equal to AEGIS SGR Bearing Protection Ring, Inpro/Seal Current Diverter Ring (CDR) or approved equal. Install system in accordance with manufacturer's recommendations.

N. Nominal Efficiency: Motors shall have minimum efficiency meeting the requirements of the Energy Policy Act of 1992 and as scheduled at full load and rated voltage when tested in accordance with IEEE 112.

O. Nominal Power Factor: As scheduled at full load and rated voltage when tested in accordance with IEEE 112.

2.5 CAPACITORS

A. Furnish capacitors for power factor correction as specified herein on motors furnished under Division 22 that are not connected to variable frequency drives. KVAR size shall be as required to correct motor power factor to 90 percent or better and shall be installed on all motors 1 horsepower and larger, that have an uncorrected power factor of less than 85 percent at rated load.

B. Features:

1. Individual unit cells.

2. All welded steel housing.

3. Each capacitor internally fused.

4. Non-flammable synthetic liquid impregnated.

5. Craft tissue insulation.

6. Aluminum foil electrodes.

PART 3 - EXECUTION

3.1 APPLICATION

A. Single phase motors for pumps and air compressors: Capacitor start type.

B.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install securely on firm foundation.

C. Check line voltage and phase and ensure agreement with nameplate.

3.3 NEMA OPEN MOTOR SERVICE FACTOR SCHEDULE

HP	3600 RPM	1800 RPM	1200 RPM	900 RPM
1/6-1/3	1.35	1.35	1.35	1.35
1/2	1.25	1.25	1.25	1.15
3/4	1.25	1.25	1.15	1.15
1	1.25	1.15	1.15	1.15
1.5-150	1.15	1.15	1.15	1.15

3.4 PERFORMANCE SCHEDULE: THREE PHASE - OPEN DRIP-PROOF

HP	RPM(Sync)	NEMA Frame	Minimum Percent Efficiency	Minimum Power Factor
1	1800	143T	82.5	84
1-1/2	1800	145T	84	85
2	1800	145T	84	85
3	1800	182T	86.5	86
5	1800	184T	87.5	87
7-1/2	1800	213T	88.5	86
1-1/2	3600	143T	82.5	85
2	3600	145T	84	87
3	3600	145T	84	85
5	3600	182T	85.5	86
7-1/2	3600	184T	87.5	88
10	3600	213T	88.5	86

END OF SECTION 220513

SECTION 220515 - BASIC PIPING MATERIALS AND METHODS

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section specifies piping materials and installation methods common to more than one Section of Division 22 and includes joining materials, piping specialties and basic piping installation instructions.

B. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 22 Section "Common Work Results for Plumbing," for materials and methods for sleeve materials.

1.2 DEFINITIONS

A. Lead Free: Refers to the wetted surface of pipe, fittings and fixtures in potable water systems that have a weighted average lead content ≤0.25% per Safe Drinking Water Act as amended January 4th 2011 Section 1417.

1.3 SUBMITTALS

A. Refer to Division 1 and Division 22 Section "General Plumbing Requirements" for administrative and procedural requirements for submittals.

B. Product Data: Submit product data on the following items:

1. Escutcheons
2. Dielectric Unions
3. Dielectric Waterway Fittings
4. Dielectric Flanges and Flange Kits
5. Strainers
6. Flexible Connectors

C. Quality Control Submittals:

1. Submit welders' certificates specified in Quality Assurance below.

D. Submit certification that specialties and fittings for domestic water distribution comply with NSF 61 Annex G and / or NSF 372.

E. Submit a schedule of dissimilar metal joints and dielectric waterway fittings, unions, flanges or flange kits. Include joint type materials, connection method and proposed dielectric waterway fittings, unions and flanges to isolate dissimilar metals. Include minimum and maximum torque requirements for flange connections to valves. Refer to the individual piping system specification sections in Division 22 for specifications for piping materials and fittings relative to that particular system and additional requirements.

F. Submit certification that fittings and specialties are manufactured in plants located in the United States or certified that they comply with applicable ANSI and ASTM standards.

1.4 QUALITY ASSURANCE

A. Welder's Qualifications: All welders shall be qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications.

B. Welding procedures and testing shall comply with ANSI Standard B31.9 - Standard Code for Building Services Piping and The American Welding Society, Welding Handbook.

C. Soldering and Brazing procedures shall conform to ANSI B9.1 Standard Safety Code for Plumbing Refrigeration.

D. Pipe specialties and fittings shall be manufactured in plants located in the United States or certified to meet the specified ASTM and ANSI standards.

E. Comply with NSF 61 Annex G and / or NSF 372 for wetted surfaces of specialties and fittings containing no more than 0.25% lead by weight for domestic water distribution.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide piping materials and specialties from one of the following:

1. Pipe Escutcheons:

a. AWI Manufacturing.

b. Keeney Manufacturing Company

c. Wal-Rich Corp.

d. Jones Stephens Corp.

2. Dielectric Waterway Fittings:

a. .

b. Grinnell Mechanical Products; Tyco Fire Products LP

c. Precision Plumbing Products, Inc.

3. Dielectric Unions:

a. JOMAR International

b. Smith Cooper International

c. Watts Regulator Co.

d. Zurn Industries

4. Dielectric Flanges and Flange Kits:

a. Calpico, Inc.

b. FMC Technologies

c. Pipeline Seal & Insulator, Inc.

d. Tampa Rubber and Gasket Co., inc.

e. Watts Industries Inc.; Water Products Div.

f. Zurn Industries, Inc.; Wilkins Div.

5. Strainers:

a. Armstrong Machine Works.

b. Hoffman Specialty ITT; Fluid Handling Div.

c. MEPCO

d. Metraflex Co.

e. Mueller Steam Specialties.

f. Nicholson Steam

g. RP&C Valve, Division of Conbraco Ind.

h. Spirax Sarco.

i. Watts Regulator Co.

6. Metal Flexible Connectors:

a. United Flexible, Inc.

b. Hyspan

c. Mason Industries, Inc.

d. Mercer Rubber Co.

e. Metraflex Co.

f. Proco Products, Inc.

g. Resistoflex

h. Tyler Pipe; Gustin-Bacon Div.

2.2 PIPE AND FITTINGS

A. Refer to the individual piping system specification sections in Division 22 for specifications on piping and fittings relative to that particular system.

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

2.3 JOINING MATERIALS

A. Refer to individual Division 22 Piping Sections for special joining materials not listed below.

B. Welding Materials: AWS D10.12; Comply with Section II, Part C, ASME Boiler and Pressure Vessel Code for welding materials appropriate for the wall thickness and chemical analysis of the pipe being welded.

C. Brazing Materials: AWS A5.8; Comply with SFA-5.8, Section II, ASME Boiler and Pressure Vessel Code for brazing filler metal materials appropriate for the materials being joined.

D. Soldering Materials: ASTM B32; Refer to individual piping system specifications for solder appropriate for each respective system.

E. Gaskets for Flanged Joints: ASME B16.21; Gasket material shall be full-faced for cast-iron flanges and raised-face for steel flanges. Select materials to suit the service of the piping system in which installed and which conform to their respective ANSI Standard (A21.11, B16.20, or B16.21). Provide materials that will not be detrimentally affected by the chemical and thermal conditions of the fluid being carried.

2.4 PIPING SPECIALTIES

A. Escutcheons: Chrome-plated, stamped steel, hinged, split-ring escutcheon, with set screw. Inside diameter shall closely fit pipe outside diameter, or outside of pipe insulation where pipe is insulated. Outside diameter shall completely cover the opening in floors, walls, or ceilings.

B. Unions:

1. Malleable-iron, Class 150 for low pressure service and class 300 for high pressure service; hexagonal stock, with ball-and-socket joints, metal-to-metal bronze seating surfaces; female threaded ends.

2. Bronze, Class 125, with lead free cast bronze body meeting ASTM B584, for low pressure service and class 250 for high pressure service; hexagonal stock, with ball-and-socket joints, metal-to-metal bronze seating surfaces; solder or female threaded ends.

C. Dielectric Unions: Factory-fabricated with lead free cast bronze body meeting ASTM B584 and galvanized steel body with plastic dielectric gasket, class 125 for low pressure service and class 250 for high pressure service, and appropriate end connections for the pipe materials in which installed (screwed or soldered) to effectively isolate dissimilar metals, prevent galvanic action, and stop corrosion.

D. Dielectric Waterway Fittings: Electroplated steel or brass nipple, with an inert and non-corrosive, thermoplastic lining.

E. Dielectric Flanges and Flange Kits:

1. Full faced gasket with same outside diameter and bolt hole arrangement as the flange. Pressure rating of 200psi for low pressure service and 400 psi for high pressure service at a continuous operating temperature of 180F.

2. Steel washers, thermoplastic washers and bolt isolation sleeves or thermoplastic combination washers and bolt sleeves.

3. Lead free cast bronze meeting ASTM B584, class 125 solder type or cast iron class 125 threaded type for low pressure service and bronze class 250 solder type or cast iron class 250 threaded type for high pressure service.

F. Y-Type Strainers: Provide strainers full line size of connecting piping, with ends matching piping system materials. Screens for 4" and smaller shall be Type 304 stainless steel mesh with 0.062" perforations and screens for 5" and larger shall be Type 304 stainless steel, with 0.125" perforations.

1. For low pressure applications, cast iron strainers shall have 125 psi working pressure rating and cast bronze strainers shall have 150 psi working pressure rating. For high pressure applications, cast iron strainers shall have 250 psi working pressure rating and cast bronze strainers shall have 300 psi working pressure rating.

2. Solder Ends, 2" and Smaller: Lead free cast bronze body meeting ASTM B584, screwed screen retainer with centered blowdown fitted with pipe plug.

3. Threaded Ends, 2" and Smaller: Cast-iron body, screwed screen retainer with centered blowdown fitted with pipe plug.

4. Threaded Ends, 2-1/2" and Larger: Cast-iron body, bolted screen retainer with off-center blowdown fitted with pipe plug.

5. Flanged Ends, 2-1/2" and Larger: Cast-iron body, bolted screen retainer with off-center blowdown fitted with pipe plug.

G. Sleeves:

1. Sleeve: Refer to Division 22 Section "Common Work Results for Plumbing" for sleeve materials.

H. Mechanical Sleeve Seals: Modular Plumbing type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure

plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

I. Flexible Connectors: Fabricated from materials suitable for system fluid and that will provide flexible pipe connections.

1. Stainless-Steel-Hose, Flexible Connectors: For 2" and smaller, corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include ANSI 150# 304 stainless-steel nipples with screwed connections, welded to hose.

2. Bronze Hose, Flexible Connectors: For 2" and smaller, corrugated bronze inner tubing covered with bronze wire braid. Include ANSI 150# brass nipples with screwed connections, braised to hose.

3. Stainless-Steel-Hose, Flexible Connectors: For 2-1/2" and larger, corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include ANSI 150# 304 stainless-steel nipples or flanges, welded to hose.

2.5 WALL PIPES

A. Cast-iron sleeve with integral clamping flange with clamping ring, bolts, and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with setscrews.

2.6 WALL SLEEVES

1. Steel sleeve of schedule 40 pipe meeting ASTM A53B with 2" wide metal plate meeting ASTM A36 welded all around. Hot dip galvanized inside and out.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install in accordance with manufacturer's installation instructions.

3.2 PREPARATION

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

B. Remove scale, slag, dirt, and debris for both inside and outside of piping and fittings before assembly.

3.3 INSTALLATIONS

A. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into

consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated. Refer to individual system specifications for requirements for coordination drawing submittals.

B. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated otherwise.

C. Install piping free of sags and bends and with ample space between piping to permit proper insulation applications.

D. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated on the Drawings.

E. Install horizontal piping as high as possible allowing for specified slope and coordination with other components. Install vertical piping tight to columns or walls. Provide space to permit insulation applications, with 1" clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.

F. Locate groups of pipes parallel to each other, spaced to permit applying full insulation and servicing of valves.

G. Support piping from structure. Do not support piping from ceilings, equipment, ductwork, conduit and other non-structural elements.

H. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, 3/4" ball valve, and short 3/4" threaded nipple and cap.

I. Verify final equipment locations for roughing in.

3.4 PIPING PROTECTION

A. Protect piping during construction period, to avoid clogging with dirt and debris, and to prevent damage from traffic and construction work.

B. Place plugs in ends of uncompleted piping at end of day or whenever work stops.

3.5 PENETRATIONS

A. Plumbing penetrations occur when piping penetrate concrete slabs, concrete or masonry walls, or fire / smoke rated floor and wall assemblies.

B. Above Grade Concrete or Masonry Penetrations

1. Provide sleeves for pipes passing through above grade concrete or masonry walls, concrete floor or roof slabs. Sleeves are not required for core drilled holes in existing masonry walls, concrete floors or roofs. Provide sleeves as follows:

a. Provide schedule 40 galvanized steel pipe for sleeves smaller than 6 inches in diameter.

b. Provide galvanized sheet metal for sleeves 6 inches in diameter and larger, thickness shall be 10 gauge (0.1382 inches).

c. Provide welded galvanized sheet metal for rectangular sleeves with the following minimum metal thickness:

1) For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 18 gauge (0.052 inches).

2) For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 10 gauge (0.1382 inches).

d. Schedule 40 PVC pipe sleeves are acceptable for use in areas without return air plenums.

2. Extend pipe insulation for insulated pipe through floor, wall and roof penetrations, including fire rated walls and floors. The vapor barrier shall be maintained. Size sleeve for a minimum of 1" annular clear space between inside of sleeve and outside of insulation.

3. Seal elevated floor, exterior wall and roof penetrations watertight and weathertight with non-shrink, non-hardening commercial sealant. Pack with mineral wool and seal both ends with minimum of ½" of sealant.

C. Underground, Exterior-Wall Penetrations: Provide galvanized steel wall sleeve. Wall sleeve is not required for existing concrete walls with core drilled penetrations. Size wall sleeves to allow for 1-inch or larger, if required by the mechanical sleeve seal manufacturer) annular clear space between pipe and sleeve. Provide mechanical sleeve seal.

1. Use type and number of sealing elements recommended by manufacturer 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.

2. Verify sleeve and mechanical sleeve seal installations for damage and faulty work. Verify watertight integrity of sleeves and mechanical sleeve seals installed below grade to seal against hydrostatic water pressure. If sleeve and or sleeve seal are not watertight, provide new wall sleeve and mechanical sleeve seal.

D. Elevated Floor Penetrations of Waterproof Membrane:

1. Provide cast-iron wall pipes for sleeves, extend top of wall pipe minimum 1" above finish floor. Size wall pipe for minimum ½" annular space between pipe and wall pipe.

2. Extend pipe insulation for insulated pipe through wall pipe. The vapor barrier shall be maintained. Size wall pipe for a minimum of 1" annular clear space between inside of sleeve and outside of insulation.

3. Pack with mineral wool and seal both ends with minimum of ½" of waterproof sealant. Refer to Division 07 Section "Joint Sealants" for materials and installation.

4. Secure waterproof membrane flashing between clamping flange and clamping ring. Comply with requirements for flashing specified in Division 7 Section "Sheet Metal Flashing and Trim."

5. Extend bottom of wall pipe below floor slab as required and secure underdeck clamp to hold wall pipe rigidly in place.

E. Interior Foundation Penetrations: Provide sleeves for horizontal pipe passing through or under foundation. Sleeves shall be cast iron soil pipe two nominal pipe sizes larger than the pipe served.

F. Concrete Slab on Grade Penetrations:

1. Provide schedule 40 PVC pipe sleeves for vertical pressure pipe passing through concrete slab on grade. Sleeves shall be one nominal pipe size larger than the pipe served and two pipe sizes larger than pipe served for ductile iron pipes with restraining rods. Seal water-tight with silicone caulk.

2. Provide ½" thick cellular foam insulation around perimeter of non-pressure pipe passing thru concrete slab on grade. Insulation shall extend to 2" above and below the concrete slab.

G. Interior Penetrations of Non-Fire-Rated Walls: Seal annular space between sleeve and pipe or duct, using joint sealant appropriate for size, depth, and location of joint. Pack with mineral wool and seal both ends with minimum of ½" of sealant. Refer to Division 07 Section "Joint Sealants" for materials and installation.

1. Extend pipe insulation for insulated pipe through sleeve. The vapor barrier shall be maintained. Size sleeve for a minimum of 1" annular clear space between inside of sleeve and outside of insulation.

H. Exterior Wall Penetrations: Seal annular space between sleeve and pipe or duct, using joint sealant appropriate for size, depth, and location of joint. Pack with mineral wool and seal both ends with minimum of ½" of waterproof sealant. Refer to Division 07 Section "Joint Sealants" for materials and installation.

1. Extend pipe insulation for insulated pipe through sleeve. The vapor barrier shall be maintained. Size sleeve for a minimum of 1" annular clear space between inside of sleeve and outside of insulation.

I. Fire / Smoke Rated Floor and Wall Assemblies: Seal around penetrations of fire rated assemblies to maintain fire resistance rating of fire-rated assemblies. Coordinate fire ratings and locations with the architectural drawings. Install sealants in compliance with the manufacturer's UL listing. Refer to Division 22 Section "Common Work Results for Plumbing" for firestoppings and materials.

J. Acoustical Barrier Penetrations: Where a pipe passes through a wall, ceiling or floor slab of a noise critical space, a steel sleeve shall be cast or grouted into the structure. Refer to Section "Basic Mechanical Materials and Methods" for noise critical spaces. The internal diameter of the sleeve shall be a minimum of 2 inches larger than the external diameter of the pipe. After the piping is installed, the Contractor shall check the clearance and correct it to within 1/2-inch. Contractor shall pack the void full depth with glass/mineral fiber insulation and seal at both ends, 1-inch deep, with sealant backed by foam rod.

1. Penetration of sound isolating ceilings by sprinkler pipes and heads shall be sleeved and sealed and shall have no rigid connections between them.

3.6 FITTINGS AND SPECIALTIES

A. Use fittings for all changes in direction and all branch connections.

B. Remake leaking joints using new materials.

C. Install components with pressure rating equal to or greater than system operating pressure.

D. Install strainers on the supply side of each control valve, pressure reducing or regulating valve, solenoid valve, mixing valve, backflow preventer and elsewhere as indicated.

E. Install unions at the final connection to each piece of equipment adjacent to each isolation valve or valve assembly for connections 2" and smaller. Install unions where indicated elsewhere on the drawings.

F. Install flanges at the final connection to each piece of equipment, adjacent to each isolation valve or valve assembly in piping 2-1/2" and larger. Install flanges at each valve 2-1/2" and larger.

G. Install dielectric unions for piping 2" and smaller or dielectric flanges for piping 2-1/2" and larger to connect piping materials of dissimilar metals in dry piping systems (gas, compressed air, vacuum) for copper or brass connected to carbon steel, cast or ductile iron.

H. Install dielectric unions for piping 2" and smaller or dielectric flanges for piping 2-1/2" and larger to connect piping materials of dissimilar metals in wet piping systems (water) (except do not install dielectric unions in concealed spaces, instead, install dielectric waterway fittings) for copper or brass connected to carbon steel, cast or ductile iron.

I. Install dielectric waterway fittings for piping 2" and smaller for copper or brass pipe connections to carbon steel equipment connections.

J. Install dielectric flanges for piping 2-1/2" and larger for copper or brass pipe connections to carbon steel equipment connections, steel, ductile iron or cast iron valves and fittings.

K. Dielectric Flange Installation:

1. Provide brass nipples between the equipment connection and dielectric flange for screwed connections. Provide an iron flange for the equipment side and a bronze flange for the copper or brass piping side of the joint.

2. Provide a bronze flange for the copper or brass piping connection to a cast iron, ductile iron or steel flange.

3. Provide full face gasket with pressure rating equal to system served.

4. At each bolt provide, steel washers, thermoplastic washers and bolt isolation sleeves or thermoplastic combination washers and bolt sleeves.

3.7 JOINTS

A. Steel Pipe Joints:

1. Pipe 2" and Smaller: Thread pipe with tapered pipe threads in accordance with ANSI B2.1. Cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Apply pipe joint lubricant or sealant suitable for the service for which the pipe is intended on the male threads at each joint and tighten joint to leave not more than 3 threads exposed.

2. Pipe Larger Than 2":

   a. Weld pipe joints (except for exterior water service pipe) in accordance with ASME Code for Pressure Piping, B31.

   b. Weld pipe joints of exterior water service pipe in accordance with AWWA C206.

   c. Install flanges on all valves, apparatus, and equipment. Weld pipe flanges to pipe ends in accordance with ASME B31.9 Code for Building Services Piping. Clean flange faces and install gaskets. Tighten bolts to torque specified by manufacturer of flange and flange bolts, to provide uniform compression of gaskets.

B. Non-ferrous Pipe Joints:

1. Brazed And Soldered Joints: For copper tube and fitting joints, braze joints in accordance with ANSI B31.9 - Standard Code for Building Services Piping and ANSI B9.1 - Standard Safety Code for Plumbing Refrigeration.

2. Thoroughly clean tube surface and inside surface of the cup of the fittings, using very fine emory cloth, prior to making soldered or brazed joints. Wipe tube and fittings clean and apply flux. Flux shall not be used as the sole means for cleaning tube and fitting surfaces.

C. Joints for other piping materials are specified within the respective piping system Sections.

3.8 FLEXIBLE CONNECTORS

A. Install flexible connectors for piping system connections on equipment side of shutoff valves for all Plumbing equipment, pumps, and where indicated on Drawings.

1. Install stainless steel connectors for domestic water copper equipment connections 2" and smaller.

2. Install bronze connectors for non-domestic water copper equipment connections 2" and smaller.

3. Install flanged stainless steel connectors for flanged equipment connections 2-1/2" and larger.

B. Install connectors according to manufacturer's recommendations.

3.9 PIPE FIELD QUALITY CONTROL

A. Testing: Refer to individual piping system specification sections.

B. Inspection Report Form: Refer to the inspection report form at the end of this section for inspection data to be completed for each piping system. Submit completed forms to the Owner and Engineer.

END OF SECTION 220515

PLUMBING & PLUMBING PIPING SYSTEMS
INSPECTION REPORT FORM

Project Name:
Project No: _____ Contractor Project No. _____
General Contractor: _____
Inspection Date: _____Temperature: _____

System Inspected

Building: _____
Location/Description: _____
Service: _____

Inspection Results

Time of Inspection: _____
Approval to Insulate: Y N Approval to Cover in Wall: Y N
Approval to backfill Y N

Signatures

Witness: _____ Representing: _____
Witness: _____ Representing: _____
Witness: _____ Representing: _____

Remarks
_____
_____
_____
Contractor Supervisor's signature: _____

SECTION 220516 - EXPANSION FITTINGS AND LOOPS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section includes the following:

1. Packless expansion joints

1.2 DEFINITIONS

A. Pipe sizes used in this Specification are nominal pipe size (NPS).

B. Lead Free: Refers to the wetted surface of pipe, fittings and fixtures in potable water systems that have a weighted average lead content ≤0.25% per Safe Drinking Water Act as amended January 4th 2011 Section 1417.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 01 Specification Sections.

1. Product data for each type of pipe expansion joints specified. Submit expansion compensation schedule showing manufacturer's figure number, size, location, connections, material and displacement for each required expansion joint.

2. Assembly-type shop drawings for each type of expansion compensation product, indicating dimensions, weights, required clearances, and methods of assembly of components. Detail fabrication of pipe anchors, hangers, special pipe support assemblies and their attachment to the building structure.

3. Shop drawings for field-fabricated expansion loops indicating location, dimensions, pipe sizes, calculations for compression or tension required, and location. Detail fabrication of pipe anchors, hangers, special pipe support assemblies and their attachment to the building structure.

4. Maintenance data for expansion joints for inclusion in Operating and Maintenance Manuals specified in Division 1 and Division 22 Section "General Plumbing Requirements."

5. Submit certification that expansion joints for domestic water distribution for drinking or cooking comply with NSF 61 Annex G and / or NSF 372.

6. Submit American Gas Association certification for expansion joints used for natural gas distribution systems.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with the provisions of the following codes:

1. ASME B31.9 "Building Services Piping" for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label.

2. ASME Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications" for Qualifications for Welding Processes and Operators.

B. Comply with NSF 61 Annex G and / or NSF 372 for wetted surfaces of specialties and fittings containing no more than 0.25% lead by weight for domestic water distribution for drinking or cooking.

C. Expansion joints shall be manufactured in plants located in the United States or certified to meet the specified ASTM and ANSI standards.

1.5

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

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

1. Packless Expansion Compensators:

a. Adsco Manufacturing Corp.

b. Anamet, Inc.

c. Flexonics Inc., Metal Hose and Expansion Joint Div.

d. Hyspan Precision Products, Inc.

e. Keflex HVAC Products, Flex-Weld, Inc.

a. Metraflex Co.

f. Flexicraft

2.2 PIPE EXPANSION JOINTS, GENERAL

A. Pipe expansion joints shall provide 200 percent absorption capacity of piping expansion between anchors.

2.3 PACKLESS EXPANSION JOINTS

A. Expansion Compensators for domestic distribution water systems: Flexible loops shall consist of two 90 degree elbow and one 180 degree return assembly, such that the piping does not change direction and maintains course along a single axis. Provide with support nut at the bottom of the 180 degree return assembly for proper positioning, drain plug, lead free internal bronze flexible braid with brass shroud and copper elbows. Provide copper sweat ends for 2" and smaller and lead free bronze 150# flanges for 2-1/2" and larger. Units shall be cold working pressure 175 psi. Expansion compensators shall have internal guides and antitorque device.

B. Expansion Compensators for natural gas distribution systems: Flexible loops shall consist of two 90 degree elbow and one 180 degree return assembly, such that the piping does not change direction and maintains course along a single axis. Provide with support nut at the bottom of the 180 degree return assembly for proper positioning, drain plug, internal 304 stainless steel braid and steel elbows. Provide screwed ends for 2" and smaller and steel 150# flanges for 2-1/2" and larger. Units shall be cold working pressure 175 psi. Expansion compensators shall have internal guides and antitorque device and bear the AGA stamp.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install expansion joints and expansion loops where indicated and required for adequate expansion of installed piping system.

3.2 EXPANSION JOINTS

A. Install expansion joints in accordance with manufacturer's instructions.

B. Align joints to avoid end loading and torsional stress.

END OF SECTION

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SECTION 220519 - METERS AND GAUGES FOR PLUMBING PIPING

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section includes the following types of meters and gauges:

1. Temperature gauges and fittings.

2. Pressure gauges and fittings.

1.2 SUBMITTALS

A. General: Submit the following in accordance with conditions of Contract and Division 1 Specification Sections.

1. Product data for each type of meter and gauge. Include scale range, ratings, and calibrated performance curves, certified where indicated. Submit meter and gauge schedule showing manufacturer's figure number, scale range, location, and accessories for each meter and gauge.

2. Product certificates signed by manufacturers of meters and gauges certifying accuracy under specified operating conditions and products' compliance with specified requirements.

3. Maintenance data for each type of meter and gauge for inclusion in Operating and Maintenance Manuals specified in Division 1 and Division 22 Section "General Plumbing Requirements."

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

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

1. Glass Tube Industrial Thermometers:

a. H. O. Trerice Co.

b. Marshalltown Instruments, Inc.

c. Miljoco Corporation

d. Weiss Instruments, Inc.

e. Weksler Instruments Corp.

f. Winters Instruments

2. Thermometer Wells: Same as for thermometers.

3. Pressure Gauges:

a. Ametek, U.S. Gauge Div.

b. Ashcroft Dresser Industries Instrument Div.

c. Ernst Gage Co.

d. H. O. Trerice Co.

e. Marsh Instrument Co., Unit of General Signal.

f. Marshalltown Instruments, Inc.

g. Miljoco Corporation

h. Weiss Instruments, Inc.

i. Weksler Instruments Corp.

j. WIKA Instruments Corp.

k. Winters Instruments

4. Pressure Gauge Accessories: Same manufacturers as for pressure gauges.

2.2 THERMOMETERS, GENERAL

A. Accuracy: Plus or minus 1 percent of range span or plus or minus one scale division to maximum of 1.5 percent of range span.

B. Scale range: Temperature ranges for services listed as follows:

1. Domestic Hot Water: 30 to 240 deg with 2-degree scale divisions (0 to 115 deg C with 1-degree scale divisions).

2. Domestic Cold Water: 0 to 100 deg F with 2-degree scale divisions (minus 18 to 38 deg C with 1-degree scale divisions).

2.3 GLASS TUBE INDUSTRIAL THERMOMETERS

A. Case: Die cast, aluminum finished, in baked epoxy enamel, glass front, spring secured, 9 inches long.

B. Adjustable Joint: Finished to match case, 180-degree adjustment in vertical plane, 360-degree adjustment in horizontal plane, with locking device.

C. Tube: Non-red color reading, non-toxic organic spirit-filled glass tube, magnifying lens.

D. Scale: Satin-faced, nonreflective aluminum, with permanently etched markings.

E. Stem: Copper-plated steel, aluminum or brass, for separable socket, length to suit installation.

THERMOMETER WELLS

A. Thermometer Wells: Brass or stainless steel, pressure rated to match piping system design pressure; with 2-inch extension for insulated piping and threaded cap nut with chain permanently fastened to well and cap.

2.5 PRESSURE GAUGES

A. Type: General use, ASME B40.1, Grade A, phosphor bronze bourdon-tube type, bottom connection.

B. Case: Cast aluminum or stainless steel case, glass lens, 4-1/2-inches diameter.

C. Connector: Brass, 1/4-inch NPS.

D. Scale: White coated aluminum, with permanently etched markings.

E. Accuracy: Plus or minus 1 percent of range span.

F. Range: Conform to the following:

1. Vacuum: 30 inches Hg to 15 psi.

2. All fluids: 2 times operating pressure.

G. Liquid-Filled: Provide liquid filled gauges where specified in Part 3 of this section.

2.6 PRESSURE GAUGE ACCESSORIES

A. Snubber: 1/4-inch NPS brass bushing with corrosion-resistant porous metal disc. Disc material shall be suitable for fluid served and rated pressure.

PART 3 - EXECUTION

3.1 THERMOMETERS INSTALLATION

A. Install in the following locations and elsewhere as indicated:

1. At inlet and outlet of each domestic water heater.

2. At inlet and outlet of each thermal storage tank.

B. Thermometer Wells: Install in piping tee where thermometers are indicated, in vertical position. Fill well with oil or graphite and secure cap.

3.2 INSTALLATION OF PRESSURE GAUGES

A. Install in the following locations, and elsewhere as indicated:

1. Provide liquid-filled gauge at suction and discharge of each pump.

2. At discharge of each pressure-reducing valve.

3. At building water service entrance.

B. Pressure Gauge Needle Valves: Install in piping tee with snubber.

END OF SECTION 220519

SECTION 220523 - GENERAL DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section includes general duty valves common to most plumbing water distribution piping systems.

1. Special purpose valves are specified in individual piping system specifications.

B. Contractors Option:

1. The Division 22 contractor may provide mechanically joined plumbing piping systems to connect mechanical joints, couplings, fittings, valves and related components as an option in lieu of, in whole or in part, copper sweat, brazing, threaded or flanged piping methods. Mechanically joined plumbing piping systems to connect plumbing piping where used shall be provided in compliance with specification Section 221111 "Mechanically Joined Plumbing Piping Systems".

1.2 DEFINITIONS

A. Lead Free: Refers to the wetted surface of pipe, fittings and fixtures in potable water systems that have a weighted average lead content ≤0.25% per Safe Drinking Water Act as amended January 4th 2011 Section 1417.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

1. Product data, including body material, valve design, pressure and temperature classification, end connection details, seating materials, trim material and arrangement, dimensions and required clearances, and installation instructions.

B. Submit certification that valves for domestic water distribution comply with NSF 61 Annex G and / or NSF 372.

1.4 QUALITY ASSURANCE

A. Single Source Responsibility: Provide products specified in this section from the same manufacturer where products are available and conform to the specification requirements.

B. American Society of Mechanical Engineers (ASME) Compliance: Comply with ASME B31.9 for building services piping and ASME B31.1 for power piping.

C. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS) Compliance: Comply with the MSS Standard Practices below:

1. MSS SP 67 "Butterfly Valves"
2. MSS SP 70 "Gray Iron Gate Valves, Flanged and Threaded Ends"
3. MSS SP 71 "Gray Iron Swing Check Valves, Flanged and Threaded Ends"
4. MSS SP 72 "Ball Valves with Flanged or Butt Welding Ends"
5. MSS SP 80 "Bronze Gate, Globe, Angle and Check Valves"
6. MSS SP 85 "Gray Iron Globe and Angle Valves, Flanged and Threaded Ends"
7. MSS SP 110 "Ball Valves, Threaded, Socket Welding, Solder Joint, Grooved and Flared Ends"
8. MSS SP 125 "Check Valves: Gray Iron and Ductile Iron, In-Line, Spring Loaded, Center-Guided"
9. MSS SP 139 "Copper Alloy Gate, Globe, Angle and Check Valves for Low Pressure/Low Temperature Plumbing Applications"

D. Valves shall be manufactured in plants located in the United States or certified that they comply with applicable ANSI, ASTM and MSS standards.

E. Comply with NSF 61 Annex G and / or NSF 372 for wetted surfaces of valves containing no more than 0.25% lead by weight compliance for valves for domestic water distribution.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide products from one of the manufacturers listed in valve schedule.

2.2 VALVE FEATURES, GENERAL

A. Valve Design: Rising stem or rising outside screw and yoke stems.

1. Non-rising stem valves may be used where headroom prevents full extension of rising stems.

B. Pressure and Temperature Ratings: As scheduled and required to suit system pressures and temperatures.

C. Sizes: Same size as upstream pipe, unless otherwise indicated.

D. Operators: Provide the following special operator features:

1. Handwheels, fastened to valve stem, for valves other than quarter turn.
2. Lever handles, on quarter-turn valves 6-inch and smaller.

3. Chain-wheel operators, for valves 2-1/2-inch and larger, installed 72 inches or higher above finished floor elevation. Extend chains to an elevation of 5'-0" above finished floor elevation.

4. Gear drive operators, on quarter-turn valves 8-inch and larger.

E. Extended Stems: Where insulation is indicated or specified, provide extended stems arranged to receive insulation.

F. End Connections: As indicated in the valve specifications.

1. Threads: Comply with ANSI B1.20.1.

2. Flanges: Comply with ANSI B16.1 for cast iron, ANSI B16.5 for steel, and ANSI B16.24 for bronze valves.

3. Solder-Joint: Comply with ANSI B16.18.

a. Caution: Where soldered end connections are used, use solder having a melting point below 840 deg F for gate, globe, and check valves; below 421 deg F for ball valves.

2.3 GATE VALVES

A. Gate Valves, 2-1/2-Inch and Larger: Meeting MSS SP-70 and lead free; Class 125, 200-psi CWP, iron body, lead free bronze mounted, with body and bonnet conforming to ASTM A 126 Class B; with lead free brass or steel stem, with flanged ends, non-asbestos composition packing, and two-piece packing gland assembly.

2.4 BALL VALVES

A. Ball Valves, 2-1/2" Inch and Smaller: Meeting MSS SP 110, Class150, 600-psi CWP; two-piece construction; with ASTM B 584 cast lead free bronze, full port, blowout-proof stem and chrome-plated lead free brass ball], with replaceable "Teflon" or "TFE" seats and seals, solder ends and vinyl-covered steel handle.

2.5 BUTTERFLY VALVES

A. Butterfly Valves, 2-1/2-Inch and Larger: Meeting MSS SP-67 and lead free; 200-psi CWP; lug-type body constructed of ductile iron conforming to ASTM A 536. Provide valves with field replaceable EPDM sleeve/seat, CF8M (316) stainless steel disc, 416 stainless steel stem, and EPDM O-ring stem seals. Provide lever operators, (10 position minimum), with lock and stops with locks for sizes 2-1/2 through 6 inches and gear operators with position indicator for sizes 8 inch and larger. Drill and tap valves on dead-end service or requiring additional body strength. Valves must be rated for dead end service at 150 psi with no downstream flange required.

2.6 CHECK VALVES

A. Swing Check Valves, 2-Inch and Smaller: Meeting MSS SP-80; Class 125, 200-psi CWP, body and cap of ASTM B 584 cast lead free bronze; with horizontal swing, Y-pattern, disc and disc holder of ASTM

B 283 alloy C46400 naval brass; solder ends. Provide valves capable of being reground while the valve remains in the line.

B. Swing Check Valves, 2-1/2-Inch and Larger: Meeting MSS SP-71 and lead free; Class 125 200-psi CWP, cast iron body and bolted cap conforming to ASTM A 126, Class B; with horizontal swing, lead free bronze disc with lead free bronze disc face ring, and bronze seat ring; and flanged ends. Provide valves capable of being refitted while the valve remains in the line.

C. Wafer Check Valves: Meeting MSS SP 125, Class 125, 200-pis CWP, lead free cast-iron body; with replaceable bronze seat, and non-slam design lapped and balanced twin bronze flappers and stainless steel trim and torsion spring. Provide valves designed to open and close at approximately one foot differential pressure.

D. Lift Check Valves, 2-Inch and Smaller: Meeting MSS SP-139; 250-psi CWP, body, disc holder and cap of ASTM B 584 cast lead free bronze; horizontal or angle pattern, lift-type valve, with stainless steel spring, renewable "Teflon" disc and solder ends. Provide valves capable of being refitted and ground while the valve remains in the line.

PART 3 - EXECUTION

3.1 INSTALLATIONS

A. Install valves in accordance with manufacturer's installation instructions.

B. Locate valves for easy access and provide separate support where necessary. Provide access doors and fire rated access doors as required.

C. Install valves and unions for each fixture and item of equipment arranged to allow equipment removal without system shutdown. Unions are not required on flanged devices.

D. Install three-valve bypass around each pressure reducing valve using throttling-type valves.

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

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

G. Installation of Check Valves: Install for proper direction of flow as follows:

H. Swing Check Valves: Horizontal position with hinge pin level.

I. Wafer Check Valves: Horizontal or vertical position, between flanges.

J. Lift Check Valve: With stem upright and plumb.

3.2 VALVE ENDS SELECTION

A. Select valves with the following ends or types of pipe/tube connections:

1. Copper Tube Size, 2-Inch and Smaller: Solder ends.

2. Copper Tube Sizes 2-1/2 Inch and Larger: flanged end.

3.3 VALVE PRESSURE/TEMPERATURE CLASSIFICATION SCHEDULES

A. Domestic Hot and Cold Water Service

VALVE TYPE	2" AND SMALLER		2-1/2" AND LARGER	
Ball	150		200	
Butterfly		N/A		200
Gate	125		125	
Check	125		125	

3.4 VALVE SCHEDULE

A. Gate Valves - 2-1/2 inch and larger:

MANUFACTURER	OS&Y RS	NRS
Apollo	NA	610F-LFA
Milwaukee	F2885-M26	NA

B. Ball Valves (full port) – 2-1/2" inch and smaller:

MANUFACTURER	SOLDER ENDS	THREADED ENDS
Apollo (Conbraco)	77C-LF-200	77C-LF-100
Hammond	UP8311A	UP8301A
Milwaukee	UPBA-450	UPBA-400
NIBCO	S-585-80-LF	T-585-80-LF

C. Butterfly Valves (stainless steel disc) - 2-1/2 inch and larger:

MANUFACTURER	LEVER	GEAR
Apollo (Conbraco)	LD141 xx SE11*	LD141 xx SE12*
Hammond	6421-01	6421-03
Keystone	222	222
Milwaukee	ML234E	ML334E
NIBCO	LD-2022-3	LD-2022-5
Watts	XXBF-03-131-15	XXBF-03-131-1G

* xx = Valve Size

D. Swing Check Valves – 2 inch and smaller:

MANUFACTURER	SOLDER ENDS	THREADED ENDS
Apollo	161S-LF	161T-LF
Milwaukee	UP1509	UP509
NIBCO	S-413-Y-LF	T-413-Y-LF

E. Swing Check Valves - 2-1/2 inch and larger:

MANUFACTURER	CLASS 125	CLASS 175
Apollo	910F-LFA	x
Milwaukee	F2974A26	x

1. x means not available.

F. Wafer Check Valves – Class 125:

MANUFACTURER	MODEL
Hammond	IR9253
Metraflex	CVOSS
Milwaukee	1400
NIBCO	W910-B-LF

G. Lift Check Valves – 2 inch and smaller:

MANUFACTURER	SOLDER ENDS	THREADED ENDS
Hammond	UP947	UP943
Milwaukee	UP1548T	UP548T
NIBCO	S-480-Y-LF	T-480-Y-LF

3.5 APPLICATION SCHEDULE

A. General Application: Use gate, ball and butterfly valves for shutoff duty; globe, ball, and butterfly for throttling duty. Refer to piping system Specification Sections for specific valve applications and arrangements.

B. Domestic Water Systems: Use the following valve types:

1. Gate Valves, 2-1/2": Class 125 with cast-iron body.

2. Ball Valves, 2" and Smaller: Class 150, 600-psi CWP, with stem extension if installed in insulated pipe.,.

3. Ball Valves, 2-1/2" and larger: 200-psi CWP cast iron body.

4. Butterfly Valves, 2-1/2" and larger200-psi working pressure with cast or ductile iron body

5. Swing Check, 2-1/2" and smaller: Class 125, cast bronze, with rubber seat.

6. Check Valves, 2-1/2" and larger: Class 125, swing or wafer type as indicated.

3.6 FIELD QUALITY CONTROL

A. Tests: After piping systems have been tested and put into service, but before final adjusting and balancing, inspect valves for leaks. Adjust or replace packing to stop leaks; replace valves if leak persists.

3.7 ADJUSTING AND CLEANING

A. Cleaning: Clean mill scale, grease, and protective coatings from exterior of valves and prepare valves to receive finish painting or insulation.

B. Inspect valves for leaks after piping systems have been tested and put into service, but before final adjusting and balancing. Adjust or replace packing, as required, on valves with leaks. Replace valve if leak persists.

END OF SECTION 220523

SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section includes the following:

1. Horizontal-piping hangers and supports.
2. Vertical-piping clamps.
3. Saddles and Shields.
4. Hanger-rod attachments.
5. Building attachments.
6. Spring hangers and supports.
7. Pre-engineered support strut systems
8. Pipe alignment guides.
9. Anchors.
10. Expansion Anchors.
11. Equipment supports.
1. Pre-engineered roof supports
12. Miscellaneous materials.

B. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 22 Section "Plumbing Insulation", for high density insulation for protecting insulation vapor barrier and materials and methods for piping hanger installations.
2. Division 22 "Water Distribution Piping and Specialties", for pipe hanger types and spacing for horizontal and vertical domestic water distribution and heat traced piping of sizes and materials indicated.
3. Division 22 "Sanitary Drainage & Vent Piping and Specialties", for pipe hanger types and spacing for heat traced and cold sanitary piping of sizes and materials indicated.
4. Division 22 "Storm Drainage & Piping and Specialties", for pipe hanger types and spacing for horizontal and vertical storm drainage piping of sizes and materials indicated.

1.2 DEFINITIONS

A. Terminology used in this Section is defined in MSS SP-90.

1.3 SUBMITTALS

A. General: Submit the following in accordance with conditions of contract and Division 01 specification Sections.

1. Product data, including installation instructions for each type of support and anchor. Submit pipe hanger and support schedule showing Manufacturer's figure number, size, location, and features for each required pipe hanger and support.

2. Product certificates signed by the manufacturer of hangers and supports certifying that their products meet the specified requirements.

3. Welder certificates signed by Contractor certifying that welders comply with requirements specified under "Quality Assurance" Article.

4. Assembly-type shop drawings for each type of support and anchor, indicating dimensions, weights, required clearances, and methods of assembly of components.

5. Maintenance data for supports and anchors for inclusion in Operating and Maintenance Manual specified in Division 01 and Division 22 Section "General Plumbing Requirements."

6. Submit style and type of anchors to Architect or Structural Engineer for approval prior to installation.

1.4 QUALITY ASSURANCE

A. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel."

1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

B. Qualify welding processes and welding operators in accordance with ASME "Boiler and Pressure Vessel Code," Section IX, "Welding and Brazing Qualifications."

C. Regulatory Requirements: Comply with applicable plumbing codes pertaining to product materials and installation of supports and anchors.

D. Nationally Recognized Testing Laboratory and NEMA Compliance (NRTL): Hangers, supports, and components shall be listed and labeled by a NRTL where used for fire protection piping systems. The term "NRTL" shall be as defined in OSHA Regulation 1910.7.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

A. Hangers and Supports

1. Armacell.
2. Anvil International.
3. B-Line.
4. Elite Components
5. Halfen-DEHA.
6. Hilti.
7. ERICO\Michigan Hanger Co..
8. FNW
9. Midwest.
10. National Pipe Hanger Corporation.
11. Power-Strut.
12. Truscon.
13. Unistrut.

B. Pre-Insulated Supports:

1. Calcium Silicate Shield Supports:
   a. Cooper B-Line, Inc.
   b. Buckaroos, Inc.
2. Pre-Engineered Thermal Hanger Inserts:
   a. Armacell "Armafix".
   b. Cooper B-Line, Inc.

C. Expansion Anchors:

1. Hilti.
2. Phillips.

3. Power Fasteners.

4. Rawl.

D. Pre-Engineered Roof Pipe Supports:

1. Airtec.

2. B-Line.

3. ERICO.

4. FNW

5. MIRO.

6. Roof Top Blox.

2.2 SUPPORT MATERIALS

A. Hangers and support components shall be factory fabricated of materials, design, and manufacturer complying with MSS SP-58.

1. Components shall have galvanized coatings where installed for piping and equipment that will not have field-applied finish.

2. Pipe attachments shall be copper-plated or have nonmetallic coating for electrolytic protection where attachments are in direct contact with copper tubing.

3. Components as listed below shall be made of 304 stainless steel where indicated.

2.3 SADDLES AND SHIELDS

A. Pipe Covering Protection Saddles:

1. Sheet metal construction, meeting MSS SP-58 Type 39A or B, 100-psi average compressive strength, with center rib for pipes 12" and larger. Saddles shall cover approximately one sixth of the circumference of the pipe and shall be 12" long.

B. Pre-Insulated Supports:

1. Calcium Silicate Shield Supports:

a. Waterproofed calcium silicate conforming to ASTM C795 encased with an insulation protection shield.

2. Pre-Engineered Thermal Hanger Inserts:

a. Flexible elastomeric insulation conforming to ASTM C534, Type I with integral high density pipe support.

C. Insulation Protection Shield:

1. Sheet metal construction, meeting MSS SP-69 & SP-58 Type 40, of 18 gauge for 5-1/2" inside dimension and smaller, 16 gauge for 6-1/2" to 10-3/4" inside dimension 14 gauge for 11-3/4" to 17" inside dimension, and 12 gauge for 18" to 28" inside dimension. Shield shall cover half of the circumference of the pipe and shall be of length indicated by manufacturer for pipe size and thickness of insulation.

a. Length: Minimum 8 inch long section at each support joint.

b. For pipes 2 inch and smaller using fiberglass or flexible elastomeric insulation without pre-insulated supports, provide insulation protection shields installed between hanger and pipe which meets the following minimum length requirements:

Pipe Size (NPS)	Insulation Thickness (inches)	Minimum Shield Length, (in) Hanger Spacing, (ft) 5	6	7	8	9	10
	0.5	5	6	8	-	-	-
	1	3	5	5	-	-	-
≤ 1	1.5	3	5	5	-	-	-
	2	3	3	3	-	-	-
	3	3	3	3	-	-	-
	0.5	8	8	11	11	12	14
	1	5	6	8	9	11	11
≤ 2	1.5	5	6	8	8	9	9
	2	5	5	6	6	8	8
	3	5	5	6	6	6	8

2. 360° Insulation Protection Shield: Shield shall cover all of the circumference of the pipe with two half circumference sections held together with bolts and nuts and shall be of length indicated by manufacturer for pipe size and thickness of insulation.

D. Hangers with pre-manufactured polymer inserts:

1. Strut-mounted pipe clamps and clevis hangers with pre-manufactured polymer inserts designed to receive butted insulation internally may be used in lieu of other insulated pipe support systems. Inserts shall support piping independent of insulation to avoid crushing. Installed system shall provide equal thermal and vapor barrier performance as systems with continuous unbroken insulation. Note: Metal shields are not required with clevis hangers of this type. Approved manufacturers include:

a. Klo-Shure.

b. Anvil.

c. Holdrite.

2.4 PRE-ENGINEERED SUPPORT STRUT SYSTEMS

A. Support strut systems shall comply with MSS SP-69, Type 59. Shop- or field-fabricated pipe-support assembly shall be made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts. Minimum 14 gauge galvanized steel with factory-punched attachment holes.

Two piece straps shall be captivated at the shoulder when attachment nut is tightened and designed for use with strut system. Long or short pipe rollers designed for use with strut system, where indicated, shall attach to the channel with brackets and nuts. Provide plastic galvanic isolators for connecting bare copper pipe for use with pre-engineered support strut system where indicated. All nuts, brackets and clamps shall have the same finish as the channels.

2.5 PIPE ALIGNMENT GUIDES

A. Factory fabricated, of cast semi-steel or heavy fabricated steel, consisting of bolted two-section outer cylinder and base with two-section guiding spider that bolts tightly to pipe. Length of guides shall be as recommended by manufacturer to allow indicated travel.

2.6 EXPANSION ANCHORS

A. Self drilling, drilled flush or shell type.

2.7 PRE-ENGINEERED ROOF PIPE SUPPORTS

A. Nominal 4" X 4" X 12" long closed cell polyethylene blocks with embedded pre-engineered support strut or pre-engineered support struts with factory plastic bases. Two piece straps shall be captivated at the shoulder when attachment nut is tightened and designed for use with strut system. All nuts, brackets and clamps shall have the same finish as the channels.

2.8 MISCELLANEOUS MATERIALS

A. Steel Plates, Shapes, and Bars: Conforming to ASTM A 36.

B. Cement Grout: Portland cement (ASTM C 150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix ratio shall be 1.0 part cement to 3.0 parts sand, by volume, with minimum amount of water required for placement and hydration.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install hangers and supports in accordance with manufacturer's installation instructions.

3.2 INSTALLATION OF HANGERS AND SUPPORTS

A. Install hangers, supports, clamps and attachments to support piping properly from building structure.

B. Do not attach to ceilings, equipment, ductwork, conduit and other non-structural elements such as floor and roof decking.

C. Hanger and clamps sizing:

1. Cold Piping: Provide pipe hangers sized for the pipe outside diameter plus insulation thickness.

2. Hot Piping: Provide pipe hangers sized for the pipe outside diameter.

3. Vertical Piping: Provide clamps sized for the pipe outside diameter and extend clamp through insulation.

4. Refer to Section 220700 for definition of hot and cold piping and required insulation thickness.

D. Arrange for grouping of parallel runs of horizontal piping supported together on field-fabricated, heavy-duty trapeze hangers where possible. Install supports with maximum spacing complying with MSS SP-69. Where piping of various sizes is supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe as specified above for individual pipe hangers.

E. Install building attachments within concrete or to structural steel. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert to forms. Where concrete with compressive strength less than 2,500 psi is indicated, install reinforcing bars through openings at top of inserts.

F. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories. Provide two nuts on threaded supports to securely fasten the support.

G. Field-Fabricated, Heavy-Duty Steel Trapezes: Fabricate from steel shapes selected for loads required; weld steel in accordance with AWS D-1.1.

H. Support fire protection systems piping independently from other piping systems.

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

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

K. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes, and so that maximum pipe deflections allowed by ASME B31.9 Building Services Piping Code is not exceeded.

L. Insulated Piping: Comply with the following installation requirements.

1. Riser Clamps: Attach riser clamps, including spacers (if any), to piping with riser clamps projecting through insulation; do not exceed pipe stresses allowed by ASME B31.9. Do not use riser clamps to support horizontal, insulated piping. Seal insulation for hot piping and protect vapor barrier for cold piping as specified in Division 22 Section "Plumbing Insulation".

2. Pipe Covering Protection Saddles: Install pipe covering protection saddles where insulation without vapor barrier is indicated. Fill interior voids with segments of insulation that match adjoining pipe insulation.

3. Insulation Protection Shield: Install insulation protection shield and high density insulation where vapor barrier is indicated, sized for the insulation thickness used as specified in Division 22 Section "Plumbing Insulation".

   a. Exception for horizontal cold piping with fiberglass or flexible elastomeric insulation 2 inch and smaller: Rest fiberglass insulated pipe on hanger shield with length specified for pipe size and insulation thickness to prevent puncture or other damage as specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

4. Contractor's Option: Provide pre-engineered thermal hanger inserts for piping insulated with flexible elastomeric insulation at pipe supports for piping 2-1/2 inch and larger.

5. Contractor's Option: Provide strut-mounted pipe clamps and clevis hangers with pre-manufactured polymer inserts.

M. Pre-engineered Support Strut Systems: Channel strut systems can be used at the Contractors option in lieu of individual hangers for horizontal pipes. Space channel strut systems at the required distance for the smallest pipe supported. Provide channel gauge and hanger rods per the manufacturer's recommendations for the piping supported. Where strut systems are attached to walls, install anchor bolts per manufacturer's recommendations.

1. Uninsulated Copper Pipe: Install with plastic galvanic isolators

2. Insulated Tube or Pipe: Install with 360° insulation protection shields or pre-engineered thermal hanger-shield inserts as specified in Division 22 Section "Plumbing Insulation".

N. Expansion Anchors: Use in existing concrete, masonry or in pre-cast concrete construction.

O. Pre-Engineered Roof Pipe Supports: Set supports on an 18" X 18" x 3/16" thick roof walkway material compatible with the roof material.

3.3 INSTALLATION OF PIPE ALIGNMENT GUIDES

A. Install pipe alignment guides on piping that adjoins expansion joints, as required by expansion joint manufacturer, and elsewhere as indicated on plans and specification sections to eliminate binding and torsional stress on piping systems. Install guides per ASME B31.9 unless noted otherwise.

B. Anchor to building substrate.

3.4 INSTALLATION OF ANCHORS

A. Install anchors at proper locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

B. Fabricate and install anchors by welding steel shapes, plates, and bars to piping and to structure. Comply with ASME B31.9 and with AWS Standards D1.1.

C. Where expansion compensators are indicated, install anchors in accordance with expansion unit manufacturer's written instructions to control movement to compensators.

D. Anchor Spacing: Where not otherwise indicated, install anchors at ends of principal pipe runs, at intermediate points in pipe runs between expansion loops and bends. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

3.5 EQUIPMENT SUPPORTS

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

B. Grouting: Place grout under supports for piping and equipment.

3.6 METAL FABRICATION

A. Cut, drill, and fit miscellaneous metal fabrications for pipe anchors and equipment supports. Install and align fabricated anchors in indicated locations.

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

C. Field Welding: Comply with AWS D1.1 for procedures of manual shielded metal-arc welding, appearance and quality of welds made, methods used in correcting welding work, and 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 that no roughness shows after finishing, and so that contours welded surfaces to match adjacent contours.

3.7 ADJUSTING

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

B. For galvanized surfaces clean welds, bolted connections and abraded areas and apply galvanizing repair paint to comply with ASTM A 780.

END OF SECTION 220529

SECTION 220550 - VIBRATION ISOLATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. It is the intent of this specification to provide vibration isolation supports for Plumbing equipment as scheduled at the end of this Section.

B. This work shall include all materials and labor required for the installation of the vibration isolation devices.

C. Vibration isolators shall be selected by the weight distribution to produce reasonably uniform deflection. Deflections shall be as noted on the equipment schedule included at the end of this Section.

D. All vibration isolation equipment shall be furnished by one manufacturer unless specifically approved otherwise in writing by the Engineer.

E. All vibration isolation devices shall be treated for corrosion resistance using galvanization for exterior applications and painting for interior applications.

F. Related Sections:

1. Division 22 Section "Common Work Results for Plumbing" for materials and methods for concrete equipment pads.

2. Division 22 Section "Basic Piping Material and Methods," for materials and methods for flexible connectors.

3. Division 22 Section "Hangers and Supports for Plumbing Piping," for materials and methods for hangers and supports.

4. Division 22 Section "Domestic Booster Pumps," for materials and methods for domestic booster pumps.

1.2 WORK INCLUDED

A. Provide complete vibration isolation systems as shown or specified and in accordance with the requirements of the Contract Documents. System shall be complete with:

1. Foundations, vibration isolation, and supports for rigidly supported equipment.

2. Vibration Isolation

1.3 RELATED WORK SPECIFIED ELSEWHERE

1.4 CONTRACTOR'S RESPONSIBILITY

A. Consult all other Section to determine the extent of work specified elsewhere but related to this Section. This work shall be properly coordinated to produce an installation satisfactory to the Owner. The Contractor shall be responsible for verifying the completeness of the isolation installation and the overall suitability of the equipment to meet the intent of this specification. Any additional equipment needed to meet the intent of this specification, even if not specifically mentioned herein or in the Contract Documents, shall be provided by the Contractor without claim for additional payment.

B. Performance or waiving of inspection, testing or surveillance for any portion of the Work shall not relieve the Contractor of the responsibility to conform strictly to the Contract Documents. The Contractor shall not construe performance or waiving of inspection, testing or surveillance by the Owner or Architects to relieve the Contractor from total responsibility to perform in strict accordance with the Contract Documents.

1.5 MANUFACTURER'S RESPONSIBILITIES

A. Manufacturer of vibration isolation equipment shall have the following responsibilities:

1. Determine vibration isolation for all equipment and systems in accordance with the local governing code.

2. Provide piping and equipment isolation systems as scheduled or specified.

3. Guarantee specified isolation system deflection.

4. Provide installation instructions, drawings and field supervision to assure proper installation and performance.

5. The vibration isolation systems shall be guaranteed to have deflection indicated on the schedule on the drawings. Mounting sizes shall be determined by the mounting manufacturer, and the sizes shall be installed in accordance with the manufacturer's instructions.

6. The vibration isolator vendor shall ensure that all equipment to be isolated has sufficient support structure to distribute equipment loads onto isolators. Where additional support structure is required, this shall be provided by vibration isolator vendor.

1.6 SUBMITTALS

A. Submittal data shall show type, size, and deflection of each isolator proposed. Include clearly outlined procedures for installing and adjusting the isolators.

B. Submit a vibration isolation system schedule indicating the following:

1. Manufacturer, type, model number, size

2. Height when uncompressed and static deflection of each isolation element

3. Spring constant of each isolation element

4. Estimated imposed load on each isolation element

5. Spring o.d., free operating, and solid heights

6. Design of supplementary bases.

7. Layout of isolator hangers, mounts, and other elements shown on an outline of the isolated equipment, including complete details of attachment to load-bearing structure or supplementary framing.

8. Piping isolators shown and identified on piping layout drawings.

9. All concrete foundations and supports (and required reinforcing and forms) will be furnished and installed by another trade. However, this trade shall furnish shop drawings showing adequate concrete reinforcing steel details and templates for all concrete foundations and supports, and all required hanger bolts and other appurtenances necessary for the proper installation of his equipment. Although another trade will complete all concrete work, all such work shall be shown in detail on the shop drawings, prepared by this trade which drawings shall be submitted showing the complete details of all foundations including necessary concrete and steel work, vibration isolation devices, etc.

1.7 QUALITY ASSURANCE

A. It is the objective of this Specification to provide for the control of vibration due to the operation of machinery or equipment, and/or due to interconnected piping or conduit.

B. The installation of all vibration isolation systems shall be under the supervision of the manufacturer's representative.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

A. All vibration isolation equipment and materials shall be provided by a single manufacturer. The following manufacturers are approved provided systems are in compliance with the specified design and performance requirements:

1. Amber Booth.

2. Kinetics Noise Control.

3. Mason Industries, Inc.

4. Vibration Eliminator Co., Inc.

5. Vibration Mounting and Controls.

2.2 GENERAL

A. All equipment provided for vibration isolation shall be new and manufactured specifically for the purpose intended.

2.3 VIBRATION ISOLATORS

A. GENERAL

1. The static deflection of isolators shall be as given in the equipment schedule and specified below. The isolator schedule shall take precedence.

2. Vibration isolator sizes and layout shall be determined by the vibration isolator supplier.

3. All vibration isolators shall have either known undeflected heights or calibration markings so that, after adjustment, the amount of deflection can be verified, thus determining that the load is within the proper range of the device and that the correct degree of vibration isolation is being provided according to the design.

4. All isolators shall operate in the linear portion of their load versus deflection curve. Load versus deflection curves shall be furnished by the manufacturer, and must be linear over a deflection range of not less than 50% above the design deflection.

5. The theoretical vertical natural frequency for each support point, based upon load per isolator and isolator stiffness, shall not differ from the design objectives for the equipment as a whole by more than ±10%.

6. All neoprene mountings shall have a Shore hardness of 30 to 60 ±5, or as specified herein, after minimum aging of 20 days or corresponding over-aging.

7. Housed or caged spring isolators are not acceptable.

8. Where steel spring isolation systems are described in the specifications, the mounting assemblies shall utilize bare springs with the spring diameter not less than 0.8 of the loaded operating height of the spring. Each spring isolator shall be designed and installed so that the ends of the spring remain parallel during and after the spring installation. All isolators shall operate in the linear portion of their load versus deflection curve and have 50% excess capacity without becoming coil bound.

9. All mounting systems exposed to weather and other corrosive environments shall be protected with factory corrosion resistance. All metal parts of mountings (except springs and hardware) shall be hot dip galvanized. Springs shall be cadmium plated and neoprene coated. Nuts and bolts shall be cadmium plated.

B. ISOLATOR TYPE WP

1. Type WP (Waffle Pads) shall be 5/16 inch thick neoprene pads ribbed or waffled on both sides. The pads shall be manufactured with bridge bearing quality neoprene, and selected for a maximum durometer of 50 and designed for 15% strain. Where required, steel load-spreading plates shall be incorporated between the equipment and the neoprene pad.

2. If the isolator is bolted to the structure, a neoprene vibration isolation washer and sleeve (Uniroyal Type 620/660 or as approved) shall be installed under the bolt head between the steel washer and the base plate.

3. (Type WP: Mason Industries Type W or as approved.)

C. ISOLATOR TYPE MWP

1. Type MWP (Metal and Waffle Sandwich Pads) shall consist of two 5/16 inch thick ribbed or waffle neoprene pads sandwiching a 16 gauge stainless steel shim plate. The pad shall be manufactured with bridge bearing quality neoprene, and selected for a maximum durometer of 50 and designed for 15% strain.

2. If the isolator is bolted to the structure, a neoprene vibration isolation washer and sleeve (Uniroyal Type 620/660, or as approved) shall be installed under the bolt head between the steel washer and the base plate.

3. (Type MWP: Mason Industries Type WSW or as approved.)

D. ISOLATOR TYPE DDNM

1. Type DDNM (Double Deflection Neoprene Mounts) shall be laterally stable, double deflecting, molded neoprene isolators. All metal surfaces shall be covered with neoprene. The top and bottom surfaces shall be ribbed and bolt holes shall be provided in the base. The mounts shall have leveling bolts rigidly secured to the equipment.

2. The isolator shall be manufactured with bridge bearing quality neoprene, and selected for a maximum durometer of 50 and designed for 15% strain. DDNM mounts shall be selected for a static deflection of 3/8 inch unless otherwise specified.

3. (Type DDNM: Mason Industries Type ND or as approved.)

E. ISOLATOR TYPE DDNH

1. Type DDNH (Double Deflection Neoprene Hangers) shall consist of a molded neoprene isolating element in a steel hanger box. A neoprene sleeve shall be provided where the lower hanger rod passes through the steel hanger box, such that the hanger rod cannot contact the steel hanger. The diameter of the clear hole in the hanger box shall be at least 3/4 inch larger than the diameter of the hanger rod and permit the hanger rod to swing through a 30 degree arc. When installed, the hanger box shall be allowed to rotate through a full 360 degrees without encountering any obstructions.

2. The isolator shall be manufactured with bridge bearing quality neoprene, and selected for a maximum durometer of 50 and designed for 15% strain. Unless otherwise specified, the static deflection of DDNH hangers shall be 0.3 inches.

F. NEOPRENE MOUNTING SLEEVES

1. Neoprene mounting sleeves for hold-down applications of equipment with vibration isolators shall be Uniroyal Type 620/660 or as approved.

G. PIPE FLEXIBLE CONNECTORS

1. Refer to Section "Basic Piping Materials and Methods" for requirements for flexible pipe connectors.

PART 3 - EXECUTION

3.1 GENERAL

A. All equipment, piping, etc. shall be mounted on or suspended from approved foundations and supports, all as specified herein, or as shown on the drawings.

B. All floor-mounted equipment shall be erected on concrete equipment pads over the complete floor area of the equipment, unless otherwise specified herein. Refer to Section "Basic Piping Materials and Methods" for concrete equipment pad requirements. These pads shall be integrally keyed to structural slab. Wherever vibration eliminating devices and/or concrete inertia blocks are specified, these items shall, in all cases, be mounted on concrete equipment pads unless otherwise specified herein.

C. Furnish and install neoprene mounting sleeves for hold-down bolts to prevent any metal to metal contact.

D. All equipment shall be provided with lateral restraining isolators as required to limit horizontal motion to 1/4" maximum, under all operating conditions. Lateral restraining isolators shall have the same static deflection as the vertical isolators for the equipment being isolated.

E. Unless otherwise indicated, all equipment mounted on vibration isolators shall have a minimum operating clearance of 2 inches between the bottom of the equipment or inertia base (and height-saving bracket) and the concrete equipment pad (or bolt heads) beneath the equipment. The clearance shall be checked by the Contractor to ensure that no material has been left to short- circuit the vibration isolators. There shall be a minimum 4 inch clearance between isolated equipment and the walls, ceiling, floors, columns and any other equipment not installed on vibration isolators.

F. Piping or plumbing equipment shall be supported from building structure, not hung from or supported on other equipment, pipes, or ductwork.

G. Equipment connected to water or other fluid piping shall be erected on isolators or isolated foundations at correct operating heights prior to connection of piping, and blocked-up with temporary shims to final operating height. When the system is assembled and fluid is added, the isolators shall be adjusted to allow removal of the shims.

H. All plumbing equipment not specifically identified in this specification that contains rotating or vibrating elements, and any associated electrical apparatus installed by this division that contains transformers or inductors shall be installed on Type DDNM neoprene isolators as appropriate.

I. All wiring connections to plumbing equipment on isolators shall be made with a minimum 18 inch long flexible conduit in a "U" shaped loop.

J. Elastomeric isolators that will be exposed to temperatures below 32 degrees F shall be fabricated from natural rubber instead of neoprene.

K. Springs shall be designed and installed so that ends of springs remain parallel and all springs installed with adjustment bolts.

L. Springs shall be sized to be non-resonant with equipment forcing frequencies or support structure natural frequencies.

M. Refer to Vibration Isolation Schedule at the end of this Section.

DOMESTIC BOOSTER PUMPS

A. Packaged domestic booster pumps installed on slab on grade shall be bolted and grouted thru their factory provided equipment frames to equipment pads and be provided with vibration isolators as scheduled in the table at the end of this section.

B. Packaged domestic booster pumps installed on suspended slabs shall be bolted and grouted thru their factory provided equipment frames to a spring supported concrete inertia base and be provided with vibration isolators as scheduled in the table at the end of this section. Provide concrete inertia base with thickness as scheduled in the table at the end of this section and provide with a 2" minimum operating clearance between the base and equipment pads.

3.3 SUPPORT OF PIPING

A. The following water and condensate piping shall be resiliently supported:

1. Piping within 50 feet of connected rotating equipment.

2. Piping installed below or adjacent to noise sensitive areas.

B. Piping that is connected only to machinery installed on neoprene isolators shall be either supported from the floor on Type DDNM mounts or suspended from the structure on Type DDNH hangers.

C. Where a pipe run connects multiple items of equipment in the mechanical room the pipe isolators for the entire run shall be chosen to suit the connected equipment of greatest static deflection.

D. Resilient diagonal mountings or other approved devices shall be provided as required to limit piping motion due to equipment startup or shut down, to a maximum of 1/8".

E. Water piping hanger rod isolators shall contain a steel spring in series with a 1/4" acoustical neoprene pad within a steel box retainer. The hanger rod isolator assembly shall be rigidly supported from the spring sub-assembly and shall not contact the steel box retainer. Clearances in the isolator design shall be capable of accepting a 15 degree misalignment in any direction from the vertical.

F. The steel spring element of the assembly shall be designed to have a minimum surge frequency of 340 HZ and a minimum deflection of 3/4".

G. Hanger rod isolators for steam and condensate piping including steam pressure reducing valve stations shall be supported by means of neoprene-in-shear mountings providing a minimum static deflection of 1/2".

H. Where supplementary steel is required to support piping, the supplementary steel shall be sized so that maximum deflection between supports does not exceed 0.08" and shall be resiliently supported from the building structure with mountings as described above. Supported piping from the supplementary steel shall be rigidly suspended or supported.

I. Pre-compressed type hanger rod isolators shall be provided for all water piping greater than 12" diameter and all supplementary steel supports. The pre-compression shall be factory set at 75% of rated deflection.

3.4 PIPING ANCHORS, GUIDES AND SUPPORTS

A. Piping Supports:

1. Piping supports within shafts shall be provided with suitable bearing plates and two layers 1/4" thick ribbed or waffled neoprene pad loaded for 50 psi maximum. The isolation pads shall be separated with 1/4" steel plate. The isolation pads shall be Type WP or approved equal.

2. Piping isolation supports at the base of risers shall be two layers of 1/2" thick heavy duty neoprene and canvas duct isolation pad separated by 1/4" thick steel plate. Suitable bearing plates sized to provide a pad loading of 500 psi maximum shall be provided. The stanchion between the pipe and isolation support shall be welded to the pipe and welded or bolted to the isolation support. The isolation support shall be bolted to the floor slab with resilient sleeves and washers. All pipe support resilient materials shall be HL Mason Industries, Inc., or as approved.

3.5 FLEXIBLE PIPING CONNECTORS

A. Flexible piping connectors shall be installed to connect piping diameter 2" or greater to reciprocating or rotating equipment.

3.6 WIRING

A. All wiring connections to plumbing equipment on vibration isolators (either spring or neoprene type) shall be made with a minimum 18 inch long flexible conduit in a "U" shaped loop. This Contractor shall coordinate wiring connections with the Electrical Contractor.

3.7 FIELD QUALITY

A. Contractor shall work in accord with best trade practices, shall fabricate and install all items in accordance with manufacturer's recommendations and Architect's directions, and shall consult with trades doing adjoining work in order to provide an installation of first class quality.

3.8 ADJUSTMENT AND TESTING

A. Site Access: During installation of equipment, Contractor shall arrange for access as necessary for inspection of isolation and noise control equipment by Architect and his representatives.

B. Contractor's Vibration Isolation Report: The vibration isolation vendor shall inspect and approve the installation of the vibration isolators and shall submit a report to the Architect which verifies that all of the isolation equipment has been properly installed and that the installation is in full conformance with the specification. The report shall record the vibration isolator identification and model or type. For isolators containing steel springs the report shall also record the size and uncompressed height, design static deflection and measured static deflection of the isolators provided.

C. Consultant's Inspection: Upon completing installation and adjustment for suitable operation of all work specified under this section, the Contractor shall notify the Architect in writing. The letter shall certify that all work specified under this section is complete, operational and adjusted in every respect, and that all work is ready for the completion checkout. The notification letter shall be accompanied by the vibration isolation report.

3.9 GUARANTEE

A. If, in the actual installation, any equipment fails to meet the vibration control requirements specified herein, that equipment shall be corrected or replaced without claim for additional payment, inclusive of all labor and material costs. Such corrective measures shall be done within a time schedule specified by the Owner.

3.10 SCHEDULE OF VIBRATION ISOLATORS

EQUIPMENT	BASE TYPE	ISOLATOR TYPE	STATIC DEFLECTION
Domestic Booster Pumps (Slab on Grade)	Equipment Pad	MWP	0.25
Piping		Isolation as per specification.	

END OF SECTION 220550

SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. Extent of Plumbing work to be identified as required by this Section is indicated on drawings and/or specified in other Division 22 Sections.

B. Types of identification devices specified in this Section include the following:

1. Plastic Pipe Markers
2. Plastic Tape
3. Underground-Type Plastic Line Marker
4. Valve Tags
5. Valve Schedule Frames
6. Engraved Plastic-Laminate Signs
7. Plastic Equipment Markers
8. Ceiling Markers
9. Plasticized Tags

1.2 CODES AND STANDARDS:

A. ANSI Standards: Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data and installation instructions for each identification material and device required. Sumbit list of equipment to be provided with ceiling markers.

B. Samples: Submit samples of each color, lettering style, wording and other graphic representation required for each identification material or system. Terminology shall exactly match contract documents and shall be approved by Engineer prior to fabrication.

C. Schedules: Submit valve schedule for each piping system, typewritten and reproduced on 8-1/2" x 11" bond paper. Tabulate valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), and variations for identification (if any). Mark valves which are intended for emergency shut-off and similar special uses, by special "flags", in margin of schedule. In addition to mounted copies, furnish extra copies for Maintenance Manuals as specified in Division 1.

D. Maintenance Data: Include product data and schedules in Maintenance Manuals as specified in Division 1 and Section "General Plumbing Requirements."

1.4 SPARE PARTS

A. Furnish minimum of 5% extra stock of each plumbing identification material required, including additional numbered valve tags (not less than 3) for each piping system, additional piping system identification markers, and additional plastic laminate engraving blanks of assorted sizes.

1. Where stenciled markers are provided, clean and retain stencils after completion of stenciling and include used stencils in extra stock, along with required stock of stenciling paints and applicators.

PART 2 - PRODUCTS AND MATERIALS

2.1 ACCEPTABLE MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide plumbing identification materials of one of the following:

1. Allen Systems, Inc.

2. Brady (W.H.) Co.; Signmark Div.

3. Brimar Industries, Inc.

4. Seton Name Plate Corp.

2.2 PLUMBING IDENTIFICATION MATERIALS

A. General: Provide manufacturer's standard products of categories and types required for each application as referenced in other Division 22 sections. Where more than single type is specified for application, selection is Installer's option, but provide single selection for each product category.

2.3 PLASTIC PIPE MARKERS

A. Snap-On Type: Provide manufacturer's standard pre-printed, semi-rigid snap-on, color-coded pipe markers, complying with ANSI A13.1.

B. Pressure-Sensitive Type: Provide manufacturer's standard pre-printed, permanent adhesive, color-coded, pressure-sensitive vinyl pipe markers, complying with ANSI A13.1. Each end of the marker shall be secured to the pipe with one complete wrapping of pressure-sensitive tape.

C. Insulation: Furnish 1" thick molded fiberglass insulation with jacket for each plastic pipe marker to be installed on uninsulated pipes subjected to fluid temperatures of 125 degrees F (52 degrees C) or greater. Cut length to extend 2" beyond each end of plastic pipe marker.

D. Small Pipes: For external diameters less than 6" (including insulation if any), provide full-band pipe markers, extending 360 degrees around pipe at each location, fastened by one of the following methods:

1. Snap-on application of pre-tensioned semi-rigid plastic pipe marker.

2. Adhesive lap joint in pipe marker overlap.

3. Laminated or bonded application of pipe marker to pipe (or insulation).

4. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 3/4" wide; full circle at both ends of pipe marker, tape lapped 1-1/2".

E. Large Pipes: For external diameters of 6" and larger (including insulation if any), provide either full-band or strip-type pipe markers, but not narrower than 3 times letter height (and of required length), fastened by one of the following methods:

1. Laminated or bonded application of pipe marker to pipe (or insulation).

2. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 1-1/2" wide; full circle at both ends of pipe marker, tape lapped 3".

3. Strapped-to-pipe (or insulation) application of semi-rigid type, with manufacturer's standard stainless steel bands.

F. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), as a separate unit of plastic, or printed on pressure sensitive tape.

G. Lettering: Comply with piping system nomenclature as specified, scheduled, or shown, and abbreviate only as necessary for each application length.

A. Weather resistance: Where pipe markers shall be exposed to the weather, provide products suitable for use in weather.

2.4 PLASTIC TAPE

A. General: Provide manufacturer's standard color-coded pressure-sensitive (self-adhesive) vinyl tape, not less than 3 mils thick.

B. Width: Provide 1-1/2" wide tape markers on pipes with outside diameters (including insulation, if any) of less than 6", 2-1/2" wide tape for larger pipes.

C. Color: Comply with ANSI A13.1, except where another color selection is indicated.

2.5 UNDERGROUND-TYPE PLASTIC LINE MARKER

A. General: Manufacturer's standard permanent, bright-colored, continuous-printed plastic tape, intended for direct-burial service; not less than 6" wide x 4 mils thick. Provide tape with printing which most accurately indicates the type of service of buried pipe.

1. Provide multi-ply tape consisting of solid aluminum foil core between 2-layers of plastic tape.

2.6 VALVE TAGS

A. Brass Valve Tags: Provide 19-gauge polished brass valve tags with stamp-engraved piping system abbreviation in 1/4" high letters and sequenced valve numbers 1/2" high, and with 5/32" hole for fastener.

1. Provide 1-1/2" diameter tags, except as otherwise indicated.

2. Fill tag engraving with black enamel.

B. Valve Tag Fasteners: Provide manufacturer's standard solid brass chain (wire link or beaded type), or solid brass S-hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.

2.7 ACCESS PANEL MARKERS

A. Access Panel Markers: Provide manufacturer's standard 1/16" thick engraved plastic laminate access panel markers, with abbreviations and numbers corresponding to concealed valve. Include 1/8" center hole to allow attachment.

2.8 VALVE SCHEDULE FRAMES

A. General: For each page of valve schedule, provide glazed display frame, with screws for removable mounting on masonry walls. Provide frames of finished hardwood or extruded aluminum, with SSB-grade sheet glass.

2.9 ENGRAVED PLASTIC-LAMINATE SIGNS

A. General: Provide engraving stock melamine plastic laminate, complying with ASTM D 709 and Fed. Spec. L-P-387, in the sizes and thickness indicated, engraved with engraver's standard letter style of the sizes and wording indicated, black with white core (letter color) except as otherwise indicated, punched for plumbing fastening except where adhesive mounting is necessary because of substrate.

B. Thickness: 1/16" for units up to 20 sq. in. or 8" length; 1/8" for larger units.

C. Size: 1-1/2" high for single line, 2" high for two lines

D. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.

1.2 CEILING MARKERS

A. Description: Paper dot, self-adhesive with 3/4 inch diameter color coded head.

B. Color to match service of equipment or control device.

2.10 PLASTIC EQUIPMENT MARKERS

A. General: Provide manufacturer's standard laminated plastic, color coded equipment markers. Conform to the following color code:

1. Green: Cooling equipment and components.

2. Yellow: Heating equipment and components.

3. Yellow/Green: Combination cooling and heating equipment and components.

4. Brown: Energy reclamation equipment and components.

5. Blue: Equipment and components that do not meet any of the above criteria.

6. For hazardous equipment, provide colors and designs recommended by ANSI A13.1.

B. Nomenclature: Include the following, matching terminology on schedules as closely as possible:

1. Name and plan number.

2. Equipment service.

3. Design capacity.

4. Other design parameters such as pressure drop, entering and leaving conditions, rpm, etc.

C. Size: Provide 2-1/2" x 4" markers for control devices, dampers, and valves; and 4-1/2" x 6" for equipment.

2.11 PLASTICIZED TAGS

A. General: Manufacturer's standard pre-printed or partially pre-printed accident-prevention tags, of plasticized card stock with matt finish suitable for writing. Tags shall be minimum 3-1/4" x 5-5/8" in size, provided with brass grommets and wire fasteners, and with appropriate pre-printed wording including large-size primary wording (as examples; DANGER, CAUTION, DO NOT OPERATE).

2.12 LETTERING AND GRAPHICS

A. General: Coordinate names, abbreviations and other designations used in plumbing identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of plumbing systems and equipment.

1. Multiple Systems: Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (as examples; Boiler No. 3, Air Supply No. 1H, Standpipe F12).

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in finished plumbing spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

3.2 PIPING SYSTEM IDENTIFICATION

A. General: Install pipe markers of one of the following types on each system indicated to receive identification, and include arrows to show normal direction of flow:

1. Plastic pipe markers, with application system as indicated under "Materials" in this section. Install on pipe insulation segment where required for hot non-insulated pipes.

B. Application: Provide piping system identification for the following systems:

1. Domestic cold water piping.

2. Domestic hot water piping.

3. Domestic hot water recirculating piping.

4. Non potable water piping

5. Sanitary and waste piping.

6. Storm water piping.

7. Vent piping.

8. Insulated and non-insulated storm water piping.

9. Natural gas piping.

C. Location: Install pipe markers and color bands in the following locations where piping is exposed to view, concealed only by a removable ceiling system, installed in machine rooms, installed in accessible maintenance spaces (shafts, tunnels, plenums) and exterior non-concealed locations. All identification signs and markers shall be easily visible and legible. Relocate signs or markers that become visually blocked by work of others.

1. Within 5 feet of each valve and control device.

2. Within 5 feet of each branch, excluding take-offs less than 25 feet in length for fixtures; mark flow direction of each pipe at branch connection.

3. Within 5 feet where pipes pass through walls, floors or ceilings or enter non-accessible enclosures. Provide identification on each side of wall, floor or ceiling.

4. At access doors, manholes and similar access points which permit view of concealed piping.

5. Within 5 feet of major equipment items and other points of origination and termination.

6. Spaced intermediately at maximum spacing of 50' along each piping run, except reduce spacing to 25' in congested areas of piping and equipment where there are more than two piping systems or pieces of equipment.

7. On piping above removable acoustical ceilings.

3.3 UNDERGROUND PIPING IDENTIFICATION

A. General: During back-filling/top-soiling of each exterior underground piping systems, install continuous underground-type plastic line marker, located directly over buried line at 6" to 8" below finished grade. Where multiple small lines are buried in common trench and do not exceed overall width of 16", install single line marker. For tile fields and similar installations, mark only edge pipe lines of field.

3.4 VALVE IDENTIFICATION

A. General: Provide valve tag on every valve, cock and control device in each piping system; exclude check valves, valves within factory-fabricated equipment units, plumbing fixture faucets, convenience and lawn-watering hose bibbs, and shut-off valves at plumbing fixtures and similar rough-in connections of end-use fixtures and units.

B. List each tagged valve in valve schedule for each piping system. Mount valve schedule frames and schedules in machine rooms where indicated or, if not otherwise indicated, where directed by Architect/Engineer.

1. Where more than one major machine room is shown for project, install mounted valve schedule in each major machine room, and repeat only main valves which are to be operated in conjunction with operations of more than single machine room.

3.5 PLUMBING EQUIPMENT IDENTIFICATION

A. General: Install engraved plastic laminate sign or plastic equipment marker on or near each major item of plumbing equipment and each operational device, as specified herein if not otherwise specified for each item or device. Provide signs for the following general categories of equipment and operational devices:

1. Main control and operating valves, including safety devices and hazardous units such as gas outlets.

2. Meters, gauges, thermometers and similar units.

3. Pumps

4. Water heaters, tanks and pressure vessels.

5. Strainers, water treatment systems and similar equipment.

B. Optional Sign Types: Where lettering larger than 1" height is needed for proper identification, because of distance from normal location of required identification, stenciled signs may be provided in lieu of engraved plastic, at Installer's option.

C. Lettering Size: 1/2" high for distances up to 6'-0", and proportionately larger lettering for greater distances. Provide secondary lettering of 2/3 to 3/4 of size of the principal lettering.

D. Text of Signs: In addition to name of identified unit, provide lettering to distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.

E. Terminology:

1. Boilers: B-1, B-2, etc.

2. Water heaters: WH-1, WH-2, etc.

3. Pumps: P-1, P-2, etc.

4. Expansion tanks: ET-1, ET-2, etc.

END OF SECTION 220553

SECTION 220700 - PLUMBING INSULATION

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. Extent of Plumbing insulation required by this Section is indicated on drawings and schedules, and by requirements of this Section.

B. Types of Plumbing insulation specified in this Section include the following:

1. Piping Systems Insulation:

a. Fiberglass

b. Flexible Elastomeric

2. Equipment Insulation:

a. Fiberglass

b. Flexible Elastomeric

1.2 QUALITY ASSURANCE

A. Flame/Smoke Ratings: Provide composite Plumbing insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by UL 723 or ASTM E 84 (NFPA 255) method.

1. Exception: Industrial Plumbing insulation that will not affect life safety egress of building may have flame spread index of 75 and smoke developed index of 150.

B. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 22 Section "Hangers and Supports for Plumbing Piping," for insulation shields for protecting insulation vapor barrier and materials and methods for piping installations.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data and installation instructions for each type of Plumbing insulation. Submit schedule showing manufacturer's product number, k-value, thickness, and furnished accessories for each Plumbing system requiring insulation.

B. Maintenance Data: Submit maintenance data and replacement material lists for each type of Plumbing insulation. Include this data and product data in maintenance manual.

PART 2 - PRODUCTS AND MATERIALS

2.1 ACCEPTABLE MANUFACTURERS

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

1. Aeroflex USA, Inc.
2. Armacell LLC.
3. CertainTeed Corp.
4. Knauf Insulation
5. Johns Manville
6. K-Flex USA
7. Owens Corning

2.2 PIPING INSULATION MATERIALS

A. Fiberglass Piping Insulation: ASTM C 547, Class 1 unless otherwise indicated.

B. Flexible Elastomeric Piping Insulation: ASTM C534, Type I.

C. Jackets for Piping Insulation: ASTM C1136, Type I for piping with temperatures below ambient, Type II for piping with temperatures above ambient. Type I may be used for all piping at Installers option.

1. PVC: One-piece, pre-molded PVC cover conforming to ASTM D1784, Johns Manville Zeston 2000 PVC or approved equivalent. Factory supplied, pre-cut insulation blanket inserts for use with PVC fitting covers are acceptable.

D. Staples, Bands, Wires, and Cement: As recommended by insulation manufacturer for applications indicated.

E. Adhesives, Sealers, and Protective Finishes: As recommended by insulation manufacturer for applications indicated.

F. Insulation Diameters: Comply with ASTM C585 for inner and outer diameters of rigid thermal insulation.

G. Pipe, Valve and Fitting Covers: Comply with ASTM C450 for fabrication of fitting covers for pipe, valves and fittings.

H. High Density Insulation Billets:

1. Calcium Silicate: ASTM C533 and C795.

2.3 EQUIPMENT INSULATION MATERIALS

A. Rigid Fiberglass Equipment Insulation: ASTM C612, Class 2.

B. Flexible Fiberglass Equipment Insulation: ASTM C553, Type I, Class B-4.

C. Flexible Elastomeric Equipment Insulation: ASTM C534, TYPE II.

D. Jacketing Material for Equipment Insulation: Provide pre-sized glass cloth jacketing material, not less than 7.8 ounces per square yard, or metal jacket at Installer's option, except as otherwise indicated.

E. Equipment Insulation Compounds: Provide adhesives, cements, sealers, mastics and protective finishes as recommended by insulation manufacturer for applications indicated.

F. Equipment Insulation Accessories: Provide staples, bands, wire, wire netting, tape, corner angles, anchors and stud pins as recommended by insulation manufacturer for applications indicated.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install in accordance with manufacturer's installation instructions.

3.2 PLUMBING PIPING SYSTEM INSULATION

A. Insulation Omitted: Omit insulation on the following:

1. Chrome-plated exposed piping
2. Water Hammer Arrestors
3. Balancing and flow valves
4. Drain lines from water coolers
5. Drainage piping located in crawl spaces or tunnels
6. Exterior condensate drain piping
7. Buried piping
8. Pre-insulated equipment.

Cold Piping:

1. Application Requirements: Insulate the following cold plumbing piping systems:

a. Potable cold water piping.

b. Non-potable cold water piping

c. Potable chilled water piping.

d. Plumbing vents within 6 lineal feet of roof outlet.

e. Horizontal and vertical interior above-ground storm drainage piping and vertical run from roof drain to horizontal run.

f. Condensate piping inside the building.

2. Insulate each piping system specified above with one of the following types and thicknesses of insulation:

a. Fiberglass: 1" thickness.

b. Flexible Elastomeric: 1" thickness

C. Hot Piping:

1. Application Requirements: Insulate the following hot plumbing piping systems:

a. Potable hot water piping.

b. Potable hot water recirculation piping.

c. Hot drain piping (where indicated).

D. P-traps:

1. Insulate P-traps receiving chilled water waste and P-traps of water coolers as described below:

a. Flexible Elastomeric: 1/2" thick for pipe sizes up to and including 2", 1" thick for pipe sizes 2" to 6" (largest size permitted).

b. Flexible Elastomeric (high temp formula up to 300F): 1" thickness.

E. Piping Inside Masonry Wall Units:

1. Insulate cold, hot and hot water recirculation piping installed inside of masonry walls where the piping needs to be insulated as the wall is constructed as described below:

a. Flexible Elastomeric: 1/2" thick for pipe sizes up to and including 2", 1" thick for pipe sizes 2" to 6" (largest size permitted).

3.3 EQUIPMENT INSULATION

A. Cold Equipment (Below Ambient Temperature):

1. Application Requirements: Insulate the following cold equipment:

a. Drip pans under chilled equipment.

b. Pneumatic water tanks.

c. Roof drain bodies.

2. Insulate each item of equipment specified above with one of the following types and thicknesses of insulation:

a. Fiberglass: 2" thick for cold surfaces above 35 degrees F (2 degrees C) and 3" thick for surfaces 35 degrees F (2 degrees C) and lower.

b. Flexible Elastomeric: 1" thick.

B. Hot Equipment (Above Ambient Temperature):

1. Application Requirements: Insulate the following hot equipment:

a. Hot water storage tanks.

b. Hot water pumps.

2. Insulate each item of equipment specified above with one of the following types and thicknesses of insulation:

a. Fiberglass: 2" thick, except 3" thick for low-pressure boilers and steam-jacketed heat exchangers.

3.4 INSTALLATION OF PIPING INSULATION

A. General: Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.

B. Maintain continuous thermal and vapor-retarder integrity throughout entire installation unless otherwise indicated.

C. Install insulation on pipe systems subsequent to installation of heat tracing, painting, testing, and acceptance of tests.

D. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with a single cut piece to complete run. Do not use cut pieces or scraps abutting each other.

E. Clean and dry pipe surfaces prior to insulating.

F. Provide high density insulation material under supports or pre-insulated supports for cold piping. Protect insulation with shields to prevent puncture or other damage. Refer to Division 22 Section "Hangers and Supports for Plumbing Piping" for pre-insulated supports and insulation shields.

1. Insulation material shall extend a minimum 2 inches past the pipe shield on each side.

G. Provide pipe hangers for hot piping sized for the outside diameter of piping. Butt insulation to hanger or riser clamp for vertical pipe. Butt pipe insulation tightly at insulation joints. For hot pipes, apply 3" wide vapor barrier tape or band over the butt joints. For cold piping apply wet coat of vapor barrier lap cement on butt joints and seal joints with 3" wide vapor barrier tape or band.

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

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

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

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

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

5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.

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

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

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

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

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

J. 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 at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.

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

4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

K. Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where otherwise indicated.

3.5 INSTALLATION OF EQUIPMENT INSULATION

A. General: Install equipment thermal insulation products in accordance with manufacturer's written instructions, and in compliance with recognized industry practices to ensure that insulation serves intended purpose.

B. Install insulation materials with smooth and even surfaces and on clean and dry surfaces. Redo poorly fitted joints. Do not use mastic or joint sealer as filler for gapping joints and excessive voids resulting from poor workmanship.

C. Maintain integrity of vapor-barrier on equipment insulation and protect it to prevent puncture and other damage.

D. Do not apply insulation to equipment, breechings, or stacks while hot.

E. Apply insulation using the staggered joint method for both single and double layer construction, where feasible. Apply each layer of insulation separately.

F. Coat insulated surfaces with layer of insulating cement, troweled in workmanlike manner, leaving a smooth continuous surface. Fill in scored block, seams, chipped edges and depressions, and cover over wire netting and joints with cement of sufficient thickness to remove surface irregularities.

G. Cover insulated surfaces with all-service jacketing neatly fitted and firmly secured. Lap seams at least 2". Apply over vapor barrier where applicable.

H. Do not insulate boiler manholes, handholes, cleanouts, ASME stamp, and manufacturer's nameplate. Provide neatly beveled edge at interruptions of insulation.

I. Provide removable insulation sections to cover parts of equipment which must be opened periodically for maintenance; include metal vessel covers, fasteners, flanges, frames and accessories.

3.6 EXISTING INSULATION REPAIR

A. Repair damaged sections of existing Plumbing insulation, both previously damaged or damaged during this construction period. Use insulation of same thickness as existing insulation, install new jacket lapping and sealed over existing.

3.7 PROTECTION AND REPLACEMENT

A. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.

B. Protection: Insulation Installer shall advise Contractor of required protection for insulation work during remainder of construction period, to avoid damage and deterioration.

END OF SECTION 220700

SECTION 221100 - WATER DISTRIBUTION PIPING AND SPECIALTIES

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section includes domestic cold water, hot water, and hot water recirculation piping, fittings, and specialties within the building to a point 5 feet outside the building.

B. Contractors Option:

1. The Division 22 contractor may provide mechanically joined plumbing piping systems to connect mechanical joints, couplings, fittings, valves and related components as an option in lieu of, in whole or in part, copper sweat, brazing, threaded or flanged piping methods. Mechanically joined water distribution piping systems where used shall be provided in compliance with specification Section 221111 "Mechanically Joined Plumbing Piping Systems".

The Division 22 contractor may provide stainless steel water distribution piping systems in lieu of, in whole or in part, for copper tube water distribution systems 3" and larger. Stainless steel water distribution piping systems are specified in Division 22 Section 221114 "Stainless steel Water Distribution Piping and Specialties".

C. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 22 Section "General Plumbing Requirements," for trenching and backfilling materials and methods for underground piping installations.

2. Division 2 Section "Water Service Systems," for water service piping beginning from 5'-0" outside the building.

3. Division 7 Section "Joint Sealers," for materials and methods for sealing pipe penetrations through basement and foundation walls, and fire and smoke barriers.

4. Division 11 Section "Kitchen and Food Service Equipment," for faucets and valves furnished with the food service and kitchen equipment.

5. Division 12 Section "Laboratory Casework and Fixtures," for laboratory trim installed in the casework.Division 22 Section "Identification, for Plumbing Piping and Equipment" for labeling and identification of water distribution piping.

6. Division 22 Section "Common Work Results for Plumbing," for materials and methods for fire barrier penetrations, wall penetrations and equipment pads.

7. Division 22 Section "Basic Piping Material and Methods," for materials and methods for strainers, flexible connectors, unions, dielectric unions, dielectric flanges and mechanical sleeve seals.

8. Division 22 Section "General Duty Valves for Plumbing Piping," for materials and methods for installing water distribution piping valves.

9. Division 22 Section "Hangers and Supports for Plumbing Piping," for insulation shields, materials and methods for hanging and supporting water distribution piping.

10. Division 22 Section "Plumbing Insulation," for materials and methods for insulating water distribution piping.

11. Division 22 Section "Sanitary Drainage and Vent Piping and Specialties," for material and methods for trap primer outlet piping.

1.2 DEFINITIONS

A. Water Distribution Pipe: A pipe within the building or on the premises that conveys water from the water service pipe or meter to the points of usage.

B. Water Service Pipe: The pipe from the water main or other source of potable water supply to the water distribution pipe of the building served.

C. Pipe sizes used in this Specification are nominal pipe size (NPS).

D. Lead Free: Refers to the wetted surface of pipe, fittings and fixtures in potable water systems that have a weighted average lead content ≤0.25% per Safe Drinking Water Act as amended January 4th 2011 Section 1417.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specifications Sections.

1. Product data for each piping specialty and valve specified.

2. Welder Certificates signed by Contractor certifying that welders comply with requirements specified in Article "Quality Assurance" below.

3. Certification of Compliance with ASME and UL fabrication requirements specified in Article "Quality Assurance" below.

4. Maintenance data for each piping specialty and valve specified for inclusion in Maintenance Manual specified in Division 1 and Division 22 Section "General Plumbing Requirements."

5. Test reports specified in Part 3 of this Section.

6. Submit certification that specialties and fittings for domestic water distribution for drinking or cooking comply with NSF 61 Annex G and / or NSF 372. The following specialties need not comply:

a. Hose bibbs

b. Wall, yard and roof hydrants

c. Backflow preventers isolating irrigation or mechanical make-up systems

d. Emergency mixing valves

e. Trap primers

1.4 QUALITY ASSURANCE

A. Qualify welding processes and welding operators in accordance with ASME Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications."

B. Regulatory Requirements: Comply with the provisions of the following codes:

1. ASME B31.9 "Building Services Piping" for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label.

2. ASME Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications" for Qualifications for Welding Processes and Operators.

C. Comply with NSF 61 Annex G and / or NSF 372 for wetted surfaces of specialties and fittings containing no more than 0.25% lead by weight for domestic water distribution for drinking or cooking.

D. Pipe, fittings and specialties shall be manufactured in the United States or be certified to meet ASTM and ANSI standards.

1.5 SPARE PARTS

A. Maintenance Stock: Furnish one valve key for each key-operated wall hydrant, hose bibb, fixture supply, or faucet installed.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

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

1. Automatic Flow Control Valves:

a. Flow Design, Inc., Autoflow Div

b. Victaulic Company

c. Calefi

2. Hose Bibbs:

a. Lee Brass Co.

b. Mansfield Plumbing Products

c. Nibco, Inc.

d. Prier, Inc.

e. Watts Regulator Co.

f. Woodford Mfg. Co.

a. Mifab Manufacturing, Inc.

3. Wall/Yard Hydrants:

a. Josam Co.

b. Smith (Jay R.) Mfg. Co.

c. Prier, Inc.

d. Watts Drainage

e. Woodford Mfg. Co.

f. Zurn Industries Inc., Hydromechanics Div.

4. Backflow Preventers:

a. Bradley

b. Febco

c. Watts Regulator Co.

5. Relief Valves:

a. Cash (A. W.) Valve Mfg. Corp.

b. Conbraco Industries, Inc.

c. Watts Regulator Co.

d. Zurn Industries, Inc. Wilkins Regulator Div.

6. Piston Type Water Hammer Arresters:

a. Amtrol, Inc.

b. Josam Co.

c. Precision Plumbing Products, Inc.

d. PROFLO

e. Sioux Chief Manufacturing Co.

f. Tyler Pipe/Wade Div.; Subs. of Tyler Corp.

g. Watts Regulator Co.

h. Zurn Industries, Inc. Wilkins Regulator Div.

7. Point of Use Thermostatic Mixing Valves

a. Acorn Engineering Co.

b. Cash Acme

c. Leonard Valve Co.

d. Powers Process Controls

8. Emergency Mixing Valves

a. Acorn Engineering Co.

b. Bradley

c. Haws Corp.

d. Lawler Manufacturing Co., Inc.

e. Leonard Valve Co.

f. Stingray Systems

9. Trap Primers and Distribution Units

a. Precision Plumbing Products, Inc.

b. MIFAB MANUFACTURING, INC.

c. PROFLO

d. Sioux Chief

10. Plumbing Pipe Support Brackets

a. Holdrite

b. PROFLO

c. Sioux Chief

11. Tube Suspension Clamps

a. PROFLO

b. Sioux Chief or approved Equivalent

2.2 PIPE AND TUBE MATERIALS, GENERAL

A. Pipe and Tube: Refer to Part 3, Articles "Above Ground Water Distribution Pipe and Fittings" or "Below Ground Water Distribution Pipe and Fittings", for identification of systems where the materials listed below are used.

B. Copper Tube: ASTM B88, Type L Water Tube, drawn temper.

C. Copper Tube: ASTM B88, Type K Water Tube, annealed temper.

D. Ductile-Iron Pipe: AWWA C151 or AWWA C115 ductile-iron pipe, with AWWA C104 cement-mortar lining.

E. Brass Pipe: Chrome Plated Schedule 40 ASTM B43 iron pipe size (IPS.)

2.3 FITTINGS

A. Wrought Copper Solder-Joint Fittings: ANSI B16.22, streamlined pattern.

B. Ductile-Iron Gasketed Fittings: AWWA C110 or AWWA C153, 150 psi rating, with cement mortar lining and AWWA C111 rubber gaskets.

C. Brass Fittings: Chrome plated ANSI B16, Class 125 with threaded connections.

D. Cast-Iron Threaded Flanges: ANSI B16.1, Class 125, raised ground face, bolt holes spot faced.

E. Bronze Flanges: ANSI B16.24, Class 150, raised ground face, bolt holes spot faced.

2.4 JOINING MATERIALS

A. Solder Filler Metal: ASTM B32 Alloy Sb-5, 95-5 Tin-Antimony.

B. Brazing Filler Metals: AWS A5.8, BAg Silver.

C. Gasket Material: Thickness, material, and type suitable for fluid to be handled and design temperatures and pressures.

2.5 GENERAL-DUTY VALVES

A. General-duty valves (i.e., gate, check, ball, and butterfly valves) are specified in Division 22 Section "General Duty Valves for Plumbing Piping." Special duty valves are specified below by their generic name; refer to Part 3, Article "Valve Applications" for specific uses and applications for each valve specified.

2.6 SPECIAL DUTY VALVES

A. Automatic Flow Control Valves: 400 PSI WOG, flow regulator, with series 300 stainless steel body, series 300 stainless steel automatic pre-set flow balancing cartridge, union connection body, and threaded-end connections.

2.7 PIPING SPECIALTIES

A. Hose Connections: Hose connections shall have garden hose thread outlets conforming to ASME B1.20.7.

B. Hose Bibbs: Bronze body, renewable composition disc, tee handle, 1/2- or 3/4-inch solder inlet, hose outlet.

C. Recessed Nonfreeze Wall Hydrants: Cast-bronze box, with chrome-plated face, tee handle key, vacuum breaker, hinged locking cover, 3/4-inch inlet, and hose outlet. Bronze casing shall be length to suit wall thickness.

D. Roof Hydrants: As specified on the drawings.

E. Backflow Preventers: Comply with requirements of ASSE Standard 1013 and as specified on the drawings.

F. Pressure Reducing Valves: Comply with requirements of ASSE Standard 1003 and as specified on the drawings.

G. Relief Valves: Sizes for relief valves shall be in accordance with ASME Boiler and Pressure Vessel Codes for indicated capacity of the appliance for which installed.

1. Combined Pressure-Temperature Relief Valves: Bronze body, test lever, thermostat, complying with ANSI Z21.22 listing requirements for temperature discharge capacity. Temperature relief valves shall be factory set at 210 deg F, and pressure relief at 150 psi.

H. Piston Type Water Hammer Arresters: Piston type, with casing of type "L" copper tube and spun copper ends, nylon piston with two EPDM "O"rings pressure lubricated with FDA approved silicone, pressure rated for 250 psi, tested and certified in accordance with PDI Standard WH-201.

I. Point of Use Thermostatic Mixing Valves:

1. Lead free bronze or brass body meeting ASTM B584 with non-corrosive parts, tamper resistant temperature adjustment, checks, stops, other components as scheduled and meeting ASSE 1070. Valve shall be designed to fail to the cold side of the system. Maximum pressure drop shall not be exceeded for the scheduled flow rate.

J. Emergency Mixing Valves:

1. Bronze body construction meeting ASTM B584, non-corrosive parts, tamper resistant temperature adjustment, union inlets. Valve shall be designed to fail to the cold side of the system with full cold water flow. Maximum pressure drop shall not be exceeded for the scheduled flow rate.

K. Trap Primers: Brass construction, line pressure operation, capacity to prime number of traps as indicated with distribution units complying with requirements of ASSE Standard 1018.

L. Pipe Support Brackets:

1. Sheet Stud Bracket: 20 gauge copper with nominal copper tube holes of ½" on 2" centers and holes of ¾" or 1" on 4" centers.

2. Pipe Mounted Bracket: 20 gauge copper or plastic bracket with clamps for securing copper water tube and stainless steel hose clamp for securing bracket to vertical waste and vent pipe in wall.

3. Carrier Bracket: 20 gauge copper bracket with 1" hole for supporting rough-in for flush valve copper tube and bolt slot for attaching to chair carrier.

M. Tube Suspension Clamps

1. Combination plastic supports and insulators for installing copper tube in stud walls with integral bracket for securing to stud with screws.

PART 3 - EXECUTION

1.1 INSTALLATION, GENERAL

A. Install piping, valves and specialties in accordance with manufacturer's installation instructions.

3.2 PREPARATION FOUNDATION FOR BELOW GROUND WATER DISTRIBUTION PIPE AND FITTINGS

A. Ductile Iron Pipe: Shape bottom of trench to fit bottom of pipe for 90-degrees (bottom 1/4 of the circumference). Fill unevenness with tamped sand bedding. At each pipe joint dig bell holes to relieve the bell of the pipe of all loads, and to ensure continuous bearing of the pipe barrel on the foundation. For piping with rock trench bottoms, provide sand pipe bed 6" underneath and around sides of pipe up to middle half of the pipe, including fittings. After pressure testing is complete, provide first layer of pea gravel backfill 6" above pipe, tamp backfill with mechanical tamper and install bedding at fittings and install subbase. Refer to Section "General Plumbing Requirements" for bedding and subbase materials, excavation, trenching, backfill and compaction requirements.

3.3 ABOVE GROUND WATER DISTRIBUTION PIPE AND FITTINGS

A. Install Type L, drawn copper tube with wrought copper fittings and solder joints for pipe sizes 8 inches and smaller, within the building.

B. Install chrome plated brass pipe and fittings for exposed water piping within the building where indicated on the drawings.

3.4 BELOW GROUND WATER DISTRIBUTION PIPE AND FITTINGS

A. Install Type K, soft annealed copper tube and brazed joints for pipe sizes 2 inches and smaller, with minimum number of joints, inside and outside building.

B. Install cement-lined ductile-iron pipe with rubber gasketed joints, inside and outside building, for pipe 3" and larger.

3.5 PIPING INSTALLATION

A. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated.

B. Use fittings for all changes in direction and branch connections.

C. Install piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.

D. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.

E. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.

F. Install horizontal piping as high as possible allowing for proper slope and coordination with other components. Install vertical piping tight to columns or walls. Provide space to permit insulation applications, with 1-inch clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.

G. Locate groups of pipes parallel to each other, spaced to permit applying full insulation and servicing of valves.

H. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, 3/4-inch ball valve, and short 3/4-inch threaded nipple and cap.

I. Fire Barrier Penetrations: Where pipes pass though fire-rated walls, partitions, ceilings, and floors, maintain the fire-rated integrity. Refer to Division 22 Section "Common Work Results for Plumbing" for special sealers and materials.

J. Exterior Wall Penetrations: Seal pipe penetrations through exterior wall constructions with sleeves packing, and sealant. Refer to Division 22 Section "Basic Piping Materials and Methods" for additional information.

K. Underground Exterior Wall Penetrations: Seal pipe penetrations through underground exterior walls with sleeves and mechanical sleeve seals. Refer to Division 22 Section "Basic Piping Materials and Methods" for additional information.

L. Elevated Floor Penetrations of Waterproof Membrane, Interior Penetrations of Non-Fire Rated Walls and Concrete Slab on Grade Penetrations: Provide sleeves and seal pipes that pass through waterproof

floors, non-fire rated walls, partitions and ceilings or concrete slab on grade. Refer to Division 22 Section "Basic Piping Materials and Methods" for special sealers and materials.

1. Install piping level with no pitch.

3.6 HANGERS AND SUPPORTS

A. General: Hanger, support, insulation protection shield and anchor components and installation procedures conforming to MSS SP-58 and SP-69 are specified in Division 22 Section "Hangers and Supports for Plumbing Piping". Conform to the table below for maximum spacing of supports.

B. Pipe Attachments: Install the following:

1. Adjustable steel clevis hangers, MSS SP-69 Type 1, for individual horizontal runs.

2. Riser clamps, MSS SP-69 Type 8, for individual vertical runs. Provide copper coated riser clamps when in contact with copper tube.

3. Insulation protection shields and high density insulation at each hanger for insulated pipe as specified in Division 22 Sections "Supports and Anchors" and "Plumbing Insulation".

4. Copper coated extension split ring pipe clamp, MSS SP-69 Type 12, for individual vertical exposed runs of copper tube 2" and smaller on walls and for securing 1-1/4" to 2" copper tube inside walls and chases for battery fixtures. Secure clamp to the copper tube.

    a. Seal each joint with insulation and split ring pipe to maintain the insulation barrier. Refer to Section "Plumbing Insulation" for requirement for maintenance of the vapor barrier and vapor barrier seal method.

5. Extension split ring pipe clamp, MSS SP-69 Type 12, for individual vertical exposed runs of stainless steel tube 2" and smaller on walls or for securing tube inside walls for connection to faucets.

6. Support copper tube in chases and walls at plumbing fixtures with plastic or copper brackets secured to structure and U-bolts sized to bare on the pipe.

7. Engineered strut support system may be provided, at the contractor's option, in lieu of individual hangers for horizontal pipes as specified in Division 22 "Hangers and Supports for Plumbing Piping". Provide two piece straps for uninsulated pipe secured to the bare pipe and provide plastic galvanic isolators for bare copper tube. Provide two piece straps and 360° insulation protection shields sized for the insulation thickness used for the pipe for all insulated pipes.

8. Secure copper tube rough-in for individual fixtures with sheet stud brackets attached to the wall studs or pipe mounting brackets attached to the fixture waste & vent pipe at each plumbing fixture.

9. Secure 1" and smaller copper water tubing in stud walls at stud penetrations with tube suspension clamps.

    a. Cut hole through non-supporting studs with a minimum 1/8" clearance around each uninsulated copper tube or insulated copper tube.

b. Seal each joint of insulation and tube suspension clamp to maintain the insulation barrier. Refer to Division 22 "Plumbing Insulation" for requirement for maintenance of the vapor barrier similar to insulation butted against insulation inserts and vapor barrier seal method.

10. Secure copper tubes for flush valve wall mounted water closets to the chair carrier with carrier brackets.

C. Install hangers for horizontal piping with the following maximum spacing and minimum rod sizes:

Nom. Pipe Size - In.	Steel Pipe Max. Span - Ft.	Copper Tube Max. Span - Ft.	Min. Rod Dia. - In.
Up to 3/4	7	5	3/8
1	7	6	3/8
1-1/4	7	7	3/8
1-1/2	9	8	3/8
2	10	8	3/8
2-1/2	11	9	1/2
3	12	10	1/2
3-1/2	13	11	1/2
4	14	12	5/8 (1/2 for copper)

1. Support vertical steel pipe at each floor.

2. Support vertical copper tube at each floor and in intervals not to exceed 10 feet.

D. Support water piping within 12" of each elbow or tee and for water piping 2-1/2" and larger at each valve or strainer.

E. Support water piping above the floor with pipe supports attached to the floor with anchor bolts where indicated on the drawings. Conform to the table above for maximum spacing of supports.

F. Provide vibration isolation for piping connected to rotating equipment. Vibration isolators are specified in Division 22 specification Section "Vibration Isolation for Plumbing Piping and Equipment".

3.7 PIPE AND TUBE JOINT CONSTRUCTION

A. Soldered Joints: Comply with the procedures contained in the AWS "Soldering Manual."

B. Brazed Joints: Comply with the procedures contained in the AWS "Brazing Manual."

1. CAUTION: Remove stems, seats, and packing of valves and accessible internal parts of piping specialties before soldering and brazing.

2. Fill the tubing and fittings during brazing with an inert gas (nitrogen or carbon dioxide) to prevent formation of scale.

3. Heat joints to proper and uniform temperature.

C. Threaded Joints: Conform to ASME B1.20.1, tapered pipe threads for field-cut threads. Join pipe fittings and valves as follows:

1. Note the internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.

2. Align threads at point of assembly.

3. Apply appropriate tape or thread compound to the external pipe threads (except where dry seal threading is specified).

4. Assemble joint wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.

a. Damaged Threads: Do not use pipe with corroded or damaged threads. If a weld opens during cutting or threading operations, that portion of pipe shall not be used.

D. Flanged Joints: Align flange surfaces parallel. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly with a torque wrench.

E. Joints Containing Dissimilar Metals: Provide dielectric unions for 2" and smaller and dielectric flanges for piping 2-1/2" and larger. Provide dielectric waterway fittings for 2" and smaller in concealed locations. Dielectric unions, waterway fittings and flanges are specified in Section "Basic Piping Materials and Methods".

F. Joints at Valve Assemblies or Connections to Equipment: Provide unions downstream of shutoff valves at valve assemblies or equipment connections. Unions are not required at flanged connections. Unions are specified in Division 22 section "Basic Piping Materials and Methods".

3.8 SERVICE ENTRANCE

A. Extend water distribution piping to connect to water service piping, of size and in location indicated for service entrance to building. Water service piping is specified in a separate section of Division 2.

B. Underground exterior water distribution piping to be a depth as required by local conditions, in accordance with authority having jurisdiction's requirements and at depth no less than 18" below grade.

C. Install sleeve and mechanical sleeve seal at penetrations through foundation wall for watertight installation.

D. Install sleeve and caulk at penetrations through building floor for watertight installation.

E. Install shutoff valve at service entrance inside building; complete with strainer, pressure gauge, and test tee with valve.

F. Ductile-Iron Pipe: Install in accordance with AWWA C-600. Pipe below ground inside building and to a point 5 feet outside of building shall have restrained joints.

3.9 VALVE APPLICATIONS

A. General-Duty Valve Applications: The Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Shut-off duty: Use gate, ball, and butterfly valves.

B. Throttling duty: Use globe, ball, and butterfly valves.

3.10 INSTALLATION OF VALVES

A. Sectional Valves: Install sectional valves on each branch and riser, close to main, where branch or riser serves 2 or more plumbing fixtures or equipment connections, and elsewhere as indicated. For sectional valves 2 inches and smaller, use gate or ball valves; for sectional valves 2-1/2 inches and larger, use ball, gate or butterfly valves.

B. Shutoff Valves: Install shutoff valves on inlet of each plumbing equipment item, on each supply to each plumbing fixture, and elsewhere as indicated. For shutoff valves 2 inches and smaller, use ball valves; for shutoff valves 2-1/2 inches and larger, use ball, gate or butterfly valves. Valves shall be installed in an accessible location.

C. Drain Valves: Install drain valves on each plumbing equipment item, located to drain equipment completely for service or repair. Install drain valves at the base of each riser, at low points of horizontal runs, and elsewhere as required to drain distribution piping system completely. For drain valves 2 inches and smaller, use gate or ball valves; for drain valves 2-1/2 inches and larger, use ball, gate or butterfly valves.

1.

D. Check Valves: Install swing check valves on discharge side of each pump and elsewhere as indicated.

E. Hose Bibbs: Install on exposed piping where indicated with vacuum breaker.

F. Wall Hydrants: Install where indicated with vacuum breaker.

G. Emergency Mixing Valves: Install where indicated on the plans with hot and cold water branch lines connecting to the mains without any shutoff valves. No other fixtures shall connect to the branch lines feeding the emergency mixing valve. Install ball valves with locking handles at the emergency mixing valve as indicated on the plans.

H. Point-of-Use Thermostatic Mixing Valve: Install valve complying with ASSE 1070 on all public lavatories and handwashing sink locations. Install valve to be accessible by maintenance staff. Set temperature limit to 110F for dual temperature faucet or 100F for single temperature faucet."

3.11 INSTALLATION OF FLOW CONTROL VALVES

A. Install flow control valves or automatic flow control valves in each hot water recirculating loop, and elsewhere as indicated. Install a shutoff valve and strainer upstream and a union, check valve and shutoff valve downstream of each flow control or automatic flow control valve.

B. Set flow control valve flow rate as follows:

1. Preliminary Procedures For Hot Water Return System Balancing:

a. Before operating the system perform these steps:

1) Open valves at recirculation pump and flow control valves to full open position.

2) Remove and clean all strainers.

3) Check recirculation pump rotation.

4) Set water heater temperature as indicated on the drawings.

2. Procedures For Hot Water Return System Balancing

a. Refer to the drawings for required flow rate for each flow control valve.

b. Provide required instrumentation to obtain proper measurements. Instruments shall be properly maintained and protected against damage.

c. Apply instrument as recommended by the manufacturer.

d. Take readings with the eye at the level of the indicated value to prevent parallax.

e. Mark flow control valve setting with memory stop. Mark with paint or other suitable, permanent identification materials.

f. Retest, adjust, and balance systems subsequent to significant system modifications, and resubmit test results.

C. Reports: Prepare hot water return system balancing reports signed and submit to the Architect upon completion of the project. Include the following information:

a. Valve tag number and description of location

b. Valve body size

c. Differential pressure reading from instrument in psi

d. Actual flow rate derived from the manufacturer's charts and tables for the valve size and measured differential pressure.

3.12 TRAP PRIMERS

A. Install trap primers where indicated on plans, and where required by local authorities having jurisdiction. Coordinate floor drains with Owner.

B. Connect trap primer supply line to the top of domestic cold water line no larger than 1 ½" in diameter.

C. Provide trap primer distribution units for trap primers serving more than one trap.

D. Install trap primer distribution level to insure even water distribution unit to each circuit.

E. Where applicable, adjust the trap primer for proper flow.

F. Install trap primers a minimum of 12 inches above finished floor for every 20 feet of horizontal outlet piping to floor drains served.

G. Install trap primers in an accessible location.

H. Refer to Division 22 Section "Sanitary Drainage and Vent Piping and Specialties" for trap primer outlet pipe requirements.

3.13 INSTALLATION OF PIPING SPECIALTIES

A. Install backflow preventers at each connection to mechanical equipment and systems and in compliance with the plumbing code and authority having jurisdiction. Locate in same room as equipment being connected. Backflow preventers shall be installed a maximum of 5'-0" above finished floor. Install air gap fitting and pipe relief outlet drain without valves to nearest floor drain.

3.14 EQUIPMENT CONNECTIONS

A. Piping Runouts to Fixtures: Provide hot and cold water piping runouts to fixtures of sizes indicated, but in no case smaller than required by plumbing code.

B. Mechanical Equipment Connections: Connect hot and cold water piping system to mechanical equipment as indicated. Provide shutoff valve and union for each connection; provide drain valve on drain connection. For connections 2-1/2 inches and larger, use flanges instead of unions.

3.15 FIELD QUALITY CONTROL

A. Inspections: Inspect water distribution piping as follows:

1. Do not enclose, cover, or put into operation water distribution piping system until it has been inspected and approved by the authority having jurisdiction.

2. During the progress of the installation, notify the plumbing official having jurisdiction at least 24 hours prior to the time such inspection must be made. Perform tests specified below in the presence of the plumbing official.

   a. Rough-in Inspection: Arrange for inspection of the piping system before concealed or closed in after system is roughed in and prior to setting fixtures.

   b. Final Inspection: Arrange for a final inspection by the plumbing official to observe the tests specified below and to ensure compliance with the requirements of the plumbing code.

   c. Reinspections: Whenever the plumbing official finds that the piping system will not pass the test or inspection, make the required corrections and arrange for reinspection by the plumbing official.

d. Reports: Prepare inspection reports signed by the plumbing official and turn over to the Architect upon completion of the project.

B. Piping System Test: Test water distribution systems in accordance with the procedures of the authority having jurisdiction, or in the absence of a published procedure, as follows:

1. Test for leaks and defects all new water distribution piping systems and parts of existing systems that have been altered, extended or repaired. If testing is performed in segments, submit a separate report for each test, complete with a diagram of the portion of the system tested.

2. Leave uncovered and unconcealed all new, altered, extended, or replaced water distribution piping until it has been tested and approved. Expose all such work for testing that has been covered or concealed before it has been tested and approved.

3. Cap and subject the piping system to a static water pressure of 50 psig above the operating pressure without exceeding the pressure rating of the piping system materials. Isolate the test source and allow to stand for 4 hours. Leaks and loss in test pressure constitute defects that must be repaired.

4. Repair all leaks and defects with new materials and retest system or portion thereof until satisfactory results are obtained.

5. Reports: Prepare inspection reports and required corrective action signed by the plumbing official and turn over to the Architect upon completion of the project.

3.16 ADJUSTING AND CLEANING

A. Clean and disinfect water distribution piping as follows:

1. Purge all new water distribution piping systems and parts of existing systems that have been altered, extended, or repaired prior to use.

2. Use the purging and disinfecting procedure proscribed by the authority having jurisdiction or, in case a method is not prescribed by that authority, the procedure described in either AWWA C651, or AWWA C652, or as described below:

a. Flush the piping system with clean, potable water until dirty water does not appear at the points of outlet.

b. Fill the system or part thereof with a water/chlorine solution containing at least 50 parts per million of chlorine. Isolate (valve off) the system or part thereof and allow to stand for 24 hours.

c. Drain the system or part thereof of the previous solution and refill with a water/chlorine solution containing at least 200 parts per million of chlorine and isolate and allow to stand for 3 hours.

d. Following the allowed standing time, flush the system with clean, potable water until chlorine residual is lowered to incoming city water level.

e. Submit water samples in sterile bottles to the authority having jurisdiction. Repeat the procedure if the biological examination made by the authority shows evidence of contamination.

3. Reports: Prepare disinfection reports signed by the authority having jurisdiction and turn over to the Architect upon completion of the project.

3.17 COMMISSIONING

A. Fill the system. Check compression tanks to determine that they are not air bound and that the system is completely full of water.

B. Before operating the system, perform these steps:

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

2. Open valves to full open position.

3. Remove and clean strainers.

4. Check pumps for proper direction of rotation. Correct improper wiring.

5. Lubricate pump motors and bearings.

END OF SECTION 221100

SECTION 221111 - MECHANICALLY JOINED PLUMBING PIPING SYSTEMS

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section only applies to Mechanically Joined Plumbing Piping Systems for joining piping for Plumbing applications as defined in Division Section 22 "Water Distribution Piping and Specialties".

B. The Division 22 contractor may provide mechanically joined, couplings, fittings, valves and related components as an option in lieu of, in whole or in part, copper sweat, brazing, threaded or flanged piping methods.

C. Mechanically joined couplings, fittings, valves and related components specified in this section shall not be provided for natural gas piping in lieu of welded, threaded or flanged piping methods.

1.2 DEFINITIONS

A. Lead Free: Refers to the wetted surface of pipe, fittings and fixtures in potable water systems that have a weighted average lead content ≤0.25% per Safe Drinking Water Act as amended January 4th 2011 Section 1417.

B. CWP: Cold working pressure in psi.

C. CTS: Copper tube size.

1.3 RELATED SECTIONS INCLUDE THE FOLLOWING:

A. Division 22 section "Basic Plumbing Piping Materials and Methods" for materials for dielectric water-way fittings and flange kits.

B. Division 22 Section "Water Distribution Piping and Specialties" for related sections.

1.4 SUBMITTALS

A. Product Data: Submit data for each type of coupling, fitting and special-duty valve indicated. Include flow and pressure drop curves based on manufacturer's testing.

B. Shop Drawings: Detail fabrication of pipe anchors, hangers, special pipe support assemblies, alignment guides, expansion joints and loops, and their attachment to the building structure.

1. If an assembly of flexible couplings are used for seismic vibration, thermal expansion, or noise and vibration reduction, submit shop drawings indicating location of assembly, including anchors and guides. Include movement analysis of the assembly, and performance data of the assembly.

C. Maintenance Data: Include for each piping specialty and valve in Maintenance Manual specified in Division 01 and Division 22 Section "General Plumbing Requirements."

D. Field Test Reports: Written reports of tests specified in Part 3 of this Section. Include the following:

1. Test procedures used.

2. Test results that comply with requirements.

3. Failed test results and corrective action taken to achieve requirements.

E. Submit a schedule of dissimilar metal joints and adaptor flanges and flange kits. Include joint type material, connection method and proposed flange kits to isolate dissimilar metals. Include minimum and maximum torque requirements for flange connections to valves. Dielectric flange kits are specified in Division 22 section "Basic Plumbing Piping Materials and Methods".

F. Submit certification that valves and fittings for domestic water distribution comply with NSF 61 Annex G and / or NSF 372.

G. Submit certification that pipe, pipe fittings, pipe specialties, and valves and fittings are manufactured in plants located in the United States or certified that they comply with applicable ANSI, ASTM and MSS standards.

H. Submit contractor certificates indicating completion of installation training course from manufacturer of piping to be used.

1.5 QUALITY ASSURANCE

A. All grooved and press to connect components shall be of one manufacturer, be date and origin stamped for quality assurance and traceability.

B. Grooved mechanical piping shall conform to local code approval and/or as listed by ANSI-B-31.1, B-31.3, B-39.1, ASME, UL/ULC, FM, IAPMO or ICC.

1. Components shall be capable of providing system rigidity to accommodate hanging and support in accordance with ANSI B31.1 and ANSI B31.9.

C. Grooved and press to connect end product manufacturer shall be ISO certified.

D. Grooved couplings shall meet the requirements of ASTM F-1476.

E. Grooving tools shall be of an approved manufacturer by the grooved fittings manufacturer. Verify tolerances of and maintain grooving tool components for duration of grooving processes. Replace grooving tool components that are found out of tolerance with new as required.

F. Obtain training from the grooved and press to connect manufacturer for all workers that will be installing or handling the grooved or press to connect piping systems.

G. Comply with NSF 61 Annex G and / or NSF 372 for wetted surfaces of valves and fittings containing no more than 0.25% lead by weight for domestic water distribution.

H. Pipe, fittings, specialties, and valves shall be manufactured in plants located in the United States or certified to meet the specified ASTM, ANSI, and MSS standards.

1.6 COORDINATION

A. Reference Division 22 Section "Water Distribution Piping and Specialties" for coordination.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Refer to manufacturer's current literature for comparable products and pressure ratings of couplings and standard fittings for various pipe sizes and pipe schedules. Products identified by model number are based on available size ranges from that manufacturer. Products offered by manufacturers with extended ranges are acceptable provided they meet the specified requirements.

B. Copper Grooved Copper Tubing System

1. Anvil International "Gruvlok".

2. Shurjoint Piping Products.

3. Victaulic Company of America.

C. Press to Connect Copper Tubing System

1. Apollo "Xpress"

2. GRINNELL Mechanical Products "G-Press"

3. NIBCO Inc., Press System.

4. Viega ProPress

2.2 COPPER GROOVED TUBING SYSTEM

A. Pipe:

1. 2 inch through 8 inch: CTS, ASTM B88 Type K or L, hard drawn.

2. Ends: Roll grooved only in accordance to manufacturer's current listed standards. Flaring of tube ends to IPS dimensions or to accommodate alternate sized couplings is not allowed.

B. General requirements for couplings, adapters, and standard fittings:

1. Full-flow type, compatible with ASTM B75 or B88 CTS grooved joints.

2. Flaring of tube ends to IPS dimensions or to accommodate alternate sized couplings is not allowed.

C. Couplings:

1. Material: Cast of ductile iron conforming to ASTM A536, Grade 65-45-12 or ASTM A395 Grade 65-45-15, coated with suitable enamel or epoxy.

Constructed of two-piece housing attached with bolts and nuts with pressure responsive elastomeric gasket, with pressure rating of 300 PSI at 180F. Provide washers where required by the manufacturer.

2. Rigid Type:

a. Anvil International Gruvlok Series # 6402.

b. Shurjoint Piping Products Styles #305, #306, and #307.

c. Victaulic Style # 607.

3. Bolts, nuts, and washers:

a. Track-head bolts of heat treated carbon or manganese steel conforming to ASTM A183 or A449 with a minimum tensile strength of 110,000 psi.

b. Heavy-duty hexagonal nuts conforming to ASTM A563, Grade B.

c. Plated carbon steel flat washers conforming to ASTM F436.

d. Zinc-electroplated conforming to ASTM B633.

e. Type 304 or 316 stainless steel bolts and nuts conforming to ASTM A193, Grade B8/B8M, Class 2 or ASTM F593 and F594, Group 2, Condition CW.

f. Type 304 or 316 stainless steel washers.

D. Flange Adapters:

1. For connection to ANSI class components according to ANSI B16.1 (steel) or ANSI B16.24 (copper).

2. Material: Cast of ductile iron conforming to ASTM A536, Grade 65-45-12 or ASTM A395 Grade 65-45-15, coated with suitable enamel or epoxy.

3. 2 inch-6 inch (ANSI class 125/150):

a. Anvil International Gruvlok Series # 6084.

b. Shurjoint Piping Products Styles # C341.

c. Victaulic Style # 641.

E. Fittings:

1. Materials:

a. Wrought copper conforming to ASTM B75 alloy C12200 or ASTM B152 alloy C1100.

b. Lead free bronze sand cast conforming to ASTM B584 alloy UNS C89836.

F. Gaskets:

1. EPDM Gaskets:

a. Grade "E", "EHP" or "EHT" EPDM compound (green or red/green color coded, respectively) conforming to ASTM D2000 designation 2CA615A25B24F17Z.

b. Temperature operating range: -30 degrees F to +230 degrees F.

c. Style suitable for the application.

2. Fluoroelastomer Gaskets

a. Fluoroelastomer compound specifically formulated for compatibility with potable water systems resistant to chlorine and chloramine disinfectants (red and blue stripe color code).

b. Temperature operating range: 0 degrees F to +180 degrees F.

c. Style suitable for the application.

G. Valves:

1. Provide valves as specified in Division 22 section "General Duty Valves for Plumbing Piping."

H. Adapters – Grooved X Plain Copper

1. Wrought copper conforming to ASTM B75 alloy C12200 or ASTM B152 alloy C1100. CTS grooved end x plain end for press or sweat connection.

a. Anvil International Gruvlok Series #652

b. Shurjoint #C52

2.3 PRESS TO CONNECT COPPER TUBING SYSTEM

A. Copper Tube:

1. CTS ½inch through 4inch: ASTM B-88 Type K or L.

B. General requirements for couplings, adapters, and standard fittings:

1. Acceptable body materials:

a. Wrought copper conforming to ASTM B75 alloy C12200 or ASTM B152 alloy C1100.

b. Cast copper conforming to ASTM B584 alloy C87600 or C84400.

2. Coupling and fitting housings with soldered ends shall conform to ASME B16.18 and B16.22.

3. Coupling and fitting housings with flared ends shall conform to ASME B16.26.

4. Coupling and fitting housings with threaded ends shall conform to ASME B1.20.1.

5. Coupling and fitting housings for press ends shall have self-contained O-ring seals in the coupling/fitting ends.

6. Rated for 200 psi CWP up to 250 degrees F maximum.

C. O-Ring Seals: EPDM compound conforming to ASME B16.51, style suitable for the application.

D. Flange Adapters:

1. For connection to ANSI class components according to ANSI B16.1 (steel) or ANSI B16.24 (copper).

2. 2-1/2 inch through 4 inch (ANSI class 125/150):

a. Steel flange with NSF 14 compliant fused epoxy coating, copper or brass press to connect joint with copper face ring and plastic or rubber dielectric isolating ring separating the flange from the press to connect joint.

3. Rated for 200 psi CWP up to 250 degrees F maximum.

E. Valves:

1. Provide 2 inch and smaller press to connect valves listed in this section or lead free cast bronze valves 2 inch and smaller listed in Division 22 section "Water Distribution Piping and Specialties" may be used with sweat connections or sweat X press adapters.

2. Ball Valve:

a. Rated for 200 psi CWP up to 250 degrees F maximum, conforming to MSS SP-110.

b. Body and trim: Lead free cast bronze conforming to ASTM B62 or B584.

c. Ends: Female press to connect ends of copper material.

d. Ball: Full port, stainless steel ball.

e. Stem: Blow-out proof, of material silicon bronze conforming to ASTM B371 or ASTM B99, or stainless steel.

f. Seat: PTFE or TFE, suitable for intended service.

g. Operator: Lever handle with non-thermal conductive material for insulated piping. Provide with 2 inch extended sleeve to allow valve operation without disturbing the insulation and with memory stop for throttling, metering or balancing service.

h. 2 inch and smaller:

1) Apollo # 77WLF-140

2) NIBCO # PC-585-66-LF

3) Milwaukee # UPBA-450S-12

4) Viega # 2971.1 ZL

5) Apollo # 120T-PRLF

3. Check Valves (Y pattern, swing type or in-line)

a. Rated for 200 psig CWP up to 250 degrees F maximum, conforming to MSS SP-80.

b. Body and trim: Cast bronze conforming to ASTM B62.

c. Disc: PTFE renewable seat and disc.

d. Ends: Female press to connect ends of copper or brass material.

e. 2 inch and smaller:

1) Apollo # 163T-PRLF

4. Check Valves (lift type, in-line)

a. Rated for 250 psig CWP up to 250 degrees F maximum, conforming to MSS SP-80.

b. Body: Cast bronze conforming to ASTM B584.

c. Spring: 316 stainless steel.

d. Ends: Female press to connect ends of copper or brass material.

e. 2 inch and smaller:

1) Apollo # 61LF

5. Gate Valves -2-1/2 inch and Larger

a. MSS SP-70; Class 125, 200-psi CWP, iron body, bronze mounted, with body and bonnet conforming to ASTM A 126 Class B; with flanged ends, non-asbestos composition packing, and two-piece packing gland assembly. Provide with factory installed press to connect flange adapters, as described herein, with bolts, nuts and washers.

1) NIBCO

6. Butterfly Valves – 2-1/2 inch and Larger

a. MSS SP-67; 200-psi CWP; lug-type body constructed of cast-iron conforming to ASTM A 126, Class B or ductile iron conforming to ASTM A 536. Provide valves with field replaceable EPDM sleeve/seat, CF8M (316) stainless steel disc, 416 stainless steel stem, and EPDM O-ring stem seals. Provide lever operators, (10 position minimum), with lock and stops with locks. Drill and tap valves on dead-end service or requiring additional body strength. Valves must be rated for dead end service at 150 psi with no downstream flange required. Provide with factory installed press to connect flange adapters, as described herein, with bolts, nuts and washers.

1) NIBCO # PFD2022

1) Viega # 2873.81

F. Strainers:

1. Provide 2 inch and smaller press to connect strainers listed in this section or lead free cast bronze strainers 2 inch and smaller listed in Division 22 section "Basic Piping Materials and Methods" may be used with sweat connections or sweat X press adapters.

2. Strainers (Y pattern)

a. Rated for 250 psig CWP up to 250 degrees F maximum.

b. Body: Cast bronze conforming to ASTM B584.

c. Screen: Stainless steel mesh with 0.062" perforations.

d. Ends: Female press to connect ends of copper or brass material.

e. 2 inch and smaller:

1) Apollo # 59LF

PART 3 - EXECUTION

3.1 PIPING INSTALLATIONS

A. Install pipe, fittings, valves and specialties in accordance with manufacturer's installation instructions.

B. Water distribution piping installations shall be installed subject to Division 22 Section "Water Distribution Systems and Specialties" in addition to those requirements specified in this Section.

C. Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of piping systems. Locations and arrangements of piping take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated.

3.2 PIPE APPLICATIONS ABOVE GRADE

A. Water piping in sizes 2-1/2 to 8 inches shall be Type L drawn copper tube with roll-grooved ends and copper tube dimensioned mechanical couplings and fittings or water piping sizes 2-1/2 inch to 4 inch shall be Type L drawn copper tube with plain ends and copper tube dimensioned press to connect fittings.

B. Water piping in sizes 2 inches and smaller shall be Type L drawn copper tube with plain ends and copper tube dimensioned press to connect copper couplings and fittings.

3.3 HANGERS AND SUPPORTS

A. Support of piping must account for expansion and contraction, vibration, and the dead load of the piping and its contents.

B. General: Hanger supports, and anchors devices are specified in Division 22 Section "Hangers and Supports for Plumbing Piping." Reference Division 22 Section "Water Distribution Systems and Specialties" for pipe spacing limitations.

3.4 PIPE JOINT CONSTRUCTION

A. Copper Grooved tubing System

1. Pipe ends shall be clean and free from oils, indentations, projections and roll marks in the area from pipe end to groove for proper gasket sealing.

2. Roll and cut groove ends in accordance to manufacturer's current listed standards. Use rolls sets designed and intended for use on the appropriate pipe material when grooving pipe.

3. Flaring of CTS tube ends to IPS dimensions or to accommodate alternate sized couplings is not allowed.

4. Verify the gasket style and elastomeric material (grade) is suitable for the intended service as specified and in combination with any system chemical additive.

5. Reference latest published manufacturer's product data for additional pressure ratings and application information.

6. Reference latest published manufacturer's field installation instructions or other included installation instruction prior to attempting assembly.

7. Ream, debur and clean tube ends and verify they are free from indentations, projections and roll marks in the area from tube end to groove for proper gasket sealing.

8. All grooved components (couplings, fittings, valves, gaskets, bolts and nuts) shall be of one manufacturer. All grooving tools shall be of one manufacturer, though not necessarily the same as the grooved component manufacturer.

9. Install gaskets with lubricant suitable for all piping services. Lubricant shall be by one manufacturer.

B. Press to connect Copper Tubing System

1. Ream, debur and clean tube ends and verify they are free from indentations, projections, burrs and foreign matter.

2. Install permanent inspection mark on tube.

3. Clean tube and fittings of all dirt and oil. Verify O-ring is in place and free of oil, grease or dirt.

4. Push copper tube into fittings with twisting action to all the way to the fitting stop or shoulder.

5. Mark tube with permanent marker to indicate proper tube insertion depth.

6. Verify press tool has correct size jaw set for tube size used.

7. Complete one tool cycle with empty jaw to calibrate tool for each time new jaw is inserted into tool.

8. Squeeze jaw arms to open tool jaws and place jaws around the contour of the fitting. Verify tool is perpendicular to the fitting and depress tool switch.

9. Squeeze jaw open to remove the tool and observe witness mark.

10. Verify crimped fitting connection for misalignment of the copper tube, misalignment of the tool or improper insertion of the tube. If any of these conditions are found cut out the joint and provide a new joint.

11. Maintain minimum distance between joints per the manufacturer's published installation instructions.

C. Dielectric Isolation Requirements for Copper Grooved Connections: Provide dielectric grooved waterway fittings or couplings at grooved galvanized steel, stainless steel or ductile iron to grooved copper joints. Dielectric waterway fittings are specified in Section "Basic Piping Materials and Methods".

D. Dielectric Isolation Requirements for Press to Connect Adapter Flange Connections: Provide dielectric flanges or flange kits for the following joint types:

1. Adapter Flanges to Iron, Ductile Iron or Steel Body Valves and Fittings (Except Butterfly Valves with EPDM Sleeve/Seats): Provide full face gaskets between flanges and adapter flanges. At each bolt provide, steel washers, thermoplastic washers and bolt isolation sleeves or thermoplastic combination washers and bolt sleeves on valve and adapter flanges.

2. Adapter Flanges to Butterfly Valves with EPDM Sleeve/Seats in Series with Iron, Ductile Iron or Steel Body Valves and Fittings: At each bolt provide, steel washers, thermoplastic washers and

bolt isolation sleeves or thermoplastic combination washers and bolt sleeves on adapter flange. Provide steel bolts on butterfly valve flange.

3. Adapter Flanges to Butterfly Valves in Copper Tubing: Install flat washers at each bolt on adapter flange. Provide full face gasket only for butterfly valves without integral liner acting as a gasket.

4. Full face gaskets, thermoplastic washers and bolt isolation sleeves or thermoplastic combination washers and bolt sleeves are specified in Section "Basic Piping Materials and Methods".

E. Flange Adapters:

1. Install flange adapter washers when flange adapters are used against the following surfaces:

a. Rubber.

b. Adapting to ANSI/AWWA cast flanges.

c. Rubber faced lug valves.

d. Serrated flanged surfaces.

2. Do not install flange adapters for applications that incorporate tie rods for anchoring or on standard grooved-end fittings within 90 degrees of each other.

3.5 VALVE APPLICATIONS

A. Reference Division 22 Section "Water Distribution Piping and Specialties" for valve applications.

3.6 EQUIPMENT CONNECTIONS

A. Grooved flexible style couplings may be used at equipment connections where specified for vibration isolation control only.

B. Press to connect joints shall not be provided for equipment connections. Provide flanges, unions, or di-electric waterway fittings. Flanges, unions, di-electric waterway fittings are specified in Division 22 specification section "Basic Piping Materials and Methods"

3.7 EXPANSION JOINTS:

A. Provide expansion joints where indicated. Expansion joints and their installation requirements are specified in Division 22 specification section "Expansion Fittings and Loops for Plumbing Piping".

1. Provide with copper press to connect ends or copper press to connect X screwed NPT adapters for 2 inches and smaller.

2. Provide with copper press to connect ends or press to connect adapter flanges for 2-1/2 inches to 4 inches.

3. Provide copper grooved adapter flanges for 2-1/2 inches to 8 inches.

B. Where field conditions allow and as a contractor's option, provide expansion joints consisting of an assembly of flexible couplings: Fabricated from a combination of couplings and nipples with rolled groove short type "K" or "L" copper tube nipples and flexible CTS couplings. Install with removable ties to hold joint compressed or expanded during piping fabrication. Provide the same gaskets as specified above for rigid couplings. Provide expansion joints of an assembly of flexible couplings with displacement identical expansion joints as indicated.

3.8 STRAINERS

A. Provide strainers as specified in part 2 of this specification section or Division 22 specification section "Basic Piping Materials and Methods".

1. Provide manufacturer strainer with press to connect ends for 2 inches and smaller.

2. Provide copper press to connect X screwed NPT adapters for 2 inches and smaller.

3. Provide press to connect adapter flanges for 2-1/2 inches to 4 inches.

4. Provide copper grooved adapter flanges for 2-1/2 inches to 8 inches.

3.9 WATER DISTRIBUTION SPECIALTIES INSTALLATION

A. Reference Division 22 Section "Water Distribution Systems and Specialties" for water distribution specialties and installation requirements.

3.10 FIELD QUALITY CONTROL

A. The following procedures are paraphrased from the ASME B-31.9, code for pressure piping, building services piping.

B. Installing contractor shall schedule training session with the grooved or press to connect manufacturer for all workers that will be installing or handling the grooved or press to connect piping systems. Submit certification letter along with list of attendees to engineer of record within 30-days of mobilization. Include copy of certification letter with closeout documents.

C. Grooved and Press to connect fitting manufacturer shall provide certification training to contractor without cost and without additional cost to Owner.

D. Provide testing procedures as defined in Division 22 Section "Water Distribution Systems and Specialties" and as specified in grooved mechanical piping manufacturer's installation instructions.

E. Installing contractor shall visually inspect couplings and repair or replace any misaligned couplings and couplings with gaps prior to calling for inspection as defined in Division 22 Section "General Plumbing Requirements."

F. Grooved and Press to connect fitting manufacturer's representative shall make periodic visits to the jobsite during construction to ensure the installing contractor is following the latest published manufacturer's field installation instructions and best practice procedures provided during the training session.

3.11 STARTUP

A. Refer to Division 22 Section "Water Distribution Piping and Specialties" for startup procedures.

END OF SECTION 221111

SECTION 221123 - DOMESTIC WATER PUMPS

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section includes the following types of plumbing pumps:

1. Cartridge type inline circulators
2. Inline circulator pumps
3. Packaged domestic booster pumps

B. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 3 Section "Concrete Work" for specifications on concrete and reinforcing materials and concrete placing requirements for equipment pads.
2. Division 22 Section "Coordination" for basic requirements for electrical components that are an integral part of packaged system components.
3. Division 22 Section, "Basic Piping Materials and Methods" for rubber flexible connectors.
4. Division 22 Section "Vibration Isolation for Plumbing Piping and Equipment" for inertia pads, isolation pads, spring supports, and spring hangers.
5. Division 26 Section "Common Work Results for Electrical" required electrical devices.
6. Division 26 Sections "Enclosed Switches and Circuit Breakers" for field-installed disconnects.

1.2 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

1. Product data including standard performance curves, weights (shipping, installed, and operating), furnished specialties, and accessories, plus installation and start-up instructions.
2. Shop drawings showing layout and connections for plumbing pumps. Include setting drawings with templates, and directions for installation of foundation bolts, anchor bolts, and other anchorages.
3. Wiring diagrams detailing wiring for power, signal, and control systems; differentiating between manufacturer-installed wiring and field-installed wiring.
4. Maintenance data for plumbing pumps, for inclusion in Operating and Maintenance Manuals specified in Division 1 and Division 22 Section "General Plumbing Requirements."

1.3 QUALITY ASSURANCE

A. Hydraulic Institute Compliance: Design, manufacture, and install plumbing pumps in accordance with "Hydraulic Institute Standards."

B. National Electrical Code Compliance: Components shall comply with NFPA 70 "National Electrical Code."

C. UL Compliance: Plumbing pumps shall be listed and labeled by UL and comply UL Standard 778 "Motor Operated Water Pumps."

D. UL Compliance: Control panels shall be listed and labeled by UL and comply with Standard 508A "Control Panels".

E. NEMA Compliance: Electric motors and components shall be listed and labeled NEMA.

F. Single-Source Responsibility: Obtain plumbing pumps of the same type from a single manufacturer.

G. Design Criteria: The Drawings indicate sizes, profiles, connections, and dimensional requirements of plumbing pumps and are based on the specific manufacturer types and models indicated. Pumps having equal performance characteristics by other manufacturers may be considered, provided that deviations in dimensions and profiles do not change the design concept or intended performance as judged by the Architect. The burden of proof for equality of plumbing pumps is on the proposer.

H. Valves, pumps and fittings shall be manufactured in plants located in the United States or certified that they comply with applicable ANSI, ASTM and MSS standards.

1.4 SPARE PARTS

A. Furnish spare parts described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Mechanical Seals: One mechanical seal for each pump.

1.5 WARRANTY

A. Warranty on Pumps: Provide written warranty, signed by manufacturer, agreeing to replace/repair, within warranty period, pumps with inadequate or defective materials and workmanship, including leakage, breakage, improper assembly, or failure to perform as required; provided manufacturer's instructions for handling, installing, protecting, and maintaining units have been adhered to during warranty period. Replacement includes both parts and labor for removal and reinstallation.

1. Warranty Period: One year from date of substantial completion.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide one of the following:

1. Cartridge Type Inline Circulators:

a. Armstrong Pumps, Inc.

b. Bell & Gossett, ITT.

c. Grundfos Pumps, Corp.

d. Taco, Inc.

2. Packaged Domestic Booster Pumps – Variable Speed Multistage

a. Armstrong

b. Bell & Gossett, ITT

c. Canariss Corp.

d. Delta P Carver

e. Grundfos Pumps, Corp.

f. QuantumFlo, Inc.

3. Aquastats:

a. Dayton

b. Honeywell

c. Penn

d. White-Rodgers

2.2 PUMPS, GENERAL

A. Pumps and circulators: factory assembled and factory tested.

B. Preparation for shipping: After assembly and testing, clean flanges and exposed machined metal surfaces and treat with an anticorrosion compound. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

C. Motors: Conform to NEMA standards; single, multiple, or variable speed with type of enclosure and electrical characteristics as indicated; have built-in thermal-overload protection and grease-lubricated

ball bearings. Select motors that are nonoverloading within the full range of the pump performance curve.

D. Apply factory finish paint to assembled, tested units prior to shipping.

2.3 CARTRIDGE TYPE CIRCULATOR PUMPS

A. General Description: Leakproof, inline, seamless, volute-type pump. Pump and motor shall be assembled on a common shaft in a single hermetically sealed unit, without stuffing boxes or mechanical seals. Accomplish sleeve bearings lubrication by circulating pumped liquid through the motor section. Isolate motor section from the motor stator windings with a thin corrosion- resistant, nonmagnetic, alloy liner. Pumps shall be rated for 125 psig working pressure and 225 deg F continuous water temperature.

B. Casings: Cast lead free bronze, with stainless steel liner and static O-ring seal to separate motor section from motor stator, and with union piping connections.

C. Impeller: Overhung, single-suction, closed or open nonmetallic impeller.

D. Pump Shaft and Sleeve: Stainless steel shaft with carbon steel bearing sleeve.

E. Motors: 1750 RPM one piece sealed type.

PACKAGED DOMESTIC BOOSTER PUMPS – VARIABLE SPEED MULTISTAGE

A. Packaged, constant pressure type with triplex vertical multiple stage centrifugal pumps, control panel, motors, variable frequency drives, gauges, ball type isolation valves, dielectric isolators, accumulator tank, thermal bleed aquastat and solenoid valve and accessories. The packaged system, including all items listed below, shall be factory assembled on a fabricated steel base plate with structural steel framework. The completed package shall be factory tested, adjusted and certified for the specified flow conditions, and shipped as an integral unit ready for plumbing and electrical connections.

B. Pumps: Provide multiple stage vertical multiple stage centrifugal type with close-coupled motors, cast iron suction / discharge chamber, motor stool and pump shaft couplings, mechanical seals, 304 stainless steel and impellers, chambers, straps, suction interconnector and neck rings, 431 stainless steel pump shaft and 316 stainless steel bearings, neck rings retainers, split cones, split cone nuts, wear and lock rings.

C. Motors: Provide variable speed, totally enclosed fan cooled type, operate at 3500 rpm and shall not overload at any point of the pump curve.

D. Piping: Suction and discharge headers shall be 316 stainless steel with ANSI class 150 pressure rating and flanges welded to the headers. Peak velocity in headers shall not exceed 8 feet per second. Furnish with the following valves:

a. Butterfly Valves, 2-1/2-Inch and Larger: MSS SP-67; 200-psi CWP; lug-type body constructed of cast-iron conforming to ASTM A 126, Class B or ductile iron conforming to ASTM A 536. Provide valves with field replaceable EPDM sleeve/seat, CF8M (316) stainless steel disc, 416 stainless steel stem, and EPDM O-ring stem seals. Provide lever operators, (10 position minimum), with lock and stops with locks for sizes 2-1/2 through 6 inches and gear operators with position indicator for sizes 8 inch and larger. Drill and tap

valves on dead-end service or requiring additional body strength. Valves must be rated for dead end service at 150 psi with no downstream flange required.

b. Cast Iron Body Ball Valves, 2-1/2" and larger: 200 CWP, maximum operating temperature of 140F; two piece cast iron body meeting ASTM A126 Class B with flanged ends, 304 stainless steel full port ball and shaft, ductile iron handle, PTFE gasket, stem seal and seat.

c. Wafer Check Valves: Class 150, stainless steel body; with replaceable stainless steel seat, and non-slam design lapped and balanced twin stainless steel flappers and stainless steel trim and torsion spring. Provide valves designed to open and close at approximately one foot differential pressure.

E. Accumulator Tank: Provide tank size as scheduled on the drawings with a minimum pressure rating of 125psig; FDA approved elastomer bladder, tank bottom connection and air charge valve. Tank shall be complete with check valves, isolation valves and pressure reducing valve for remote installation.

F. Controls and Instruments: Control panel shall be mounted on the pump package and shall include a NEMA 1 enclosure, through door fusible disconnect, disconnect for each pump, overload relays and indicator lights, 120V control circuit transformer with primary and secondary fuse protection, low suction pressure limit switch, suction and discharge header pressure sensors, programmable logic controller and variable speed drives. Touchscreen operator interface for monitoring and adjustment of the programmable controller variables with virtual on-off-automatic selector switch for each pump, low pressure alarm, high system pressure alarm, pump running indicators and hour meter for each pump. Controls shall be arranged for termination of 1 incoming power feeder. Control panel shall have a unit short circuit current rating equal to or greater than the available short circuit current as indicated on the electrical drawings.

1. Programmable Logic Controller (PLC): Designed specifically for the control of pumps with variable speed drives capable of receiving two analog pressure inputs, analog flow input, automatic pump alternating and On-line field modified data entries for staging pumps, with software memory stored in non-volatile EPROM memory, furnish with user interface keypad with LED display.

2. Variable Frequency Drive: The variable speed drives (VFD) shall be adjustable frequency type which employs a pulse width modulated inverter. The drive shall include built in diagnostics. Diagnostics shall be annunciated through the alpha numeric keypad. The drive shall be listed UL, ETL and/or CSA. To insure safety of the equipment, the VFD shall include these protective features and options:

a. NEMA 1 enclosure.

b. Static instantaneous over-current and over-voltage trip.

c. Static over-speed (over-frequency) protection.

d. Line or fuse loss and under-voltage protection.

e. Power unit over-temperature protection.

f. Motor inverse time overload protection.

g. Input fused disconnect or circuit breaker.

h. Total voltage harmonic distortion from the VFD shall be less than 5% to meet IEEE requirements.

i. Speed meter.

j. Automatic restart after power failure or minor drive fault. The drive shall attempt a minimum of two restarts before a complete drive shut-down.

k. Power on light.

l. Manual speed potentiometer or control capability through the keypad.

m. Hand/Off/Automatic Switch or Manual/Automatic Switch with start/stop pushbutton.

n. Test switch

o. VFD fault light and reset.

p. Output to the PLC and integral LED display

q. The VFD shall be microprocessor based and utilize digital input for all parameter adjustments. The VFD shall include a digital display for monitoring system parameters and for first fault indication, and digital input programming capability on the main logic board.

r. The VFD shall operate on a frequency range of 1 to 66 Hz with resolution of 0.1% of base speed with analog input or 0.025% with digital input and have accuracy within 0.05% of set point. VFD shall operate in environment of 0 to 40 degrees C, 3,300 feet altitude and 95% non-condensing humidity without derating.

s. All control circuit voltages shall be physically and electrically isolated from power circuit voltages.

t. All VFD's shall be tested/run in the equivalent of NEMA 1 enclosure and burned in at rated ambient (40° C) with a fully loaded motor.

u. Configured for mounting on top of motor or outside of control panel.

3. Pressure Sensors: NEMA 4 water tight enclosure with pressure rating of 2,000psi, stainless steel wetted parts, 0.25" male NPT connection, calibration from 0 to 150 psi with 4-20mA DC signal at 24 VDC.

4. Sequence of Operation: The domestic water booster pump shall be in automatic mode per the design conditions shown on the booster pump schedule. The pump shall modulate its speed to maintain the discharge head pressure setpoint, as determined by the internal control algorithm, simulating the performance of a system utilizing a remote differential pressure sensor. The pumps shall run in a lead/lag operation based on user defined run-time setpoint. When the flow capacity of the lead pump is exceeded, the lag pump shall start after an adjustable time delay. If the capacity of the lead pump and lag pump is exceeded, the second lag pump (and the N+1 sequencing shall continue based on the number of pumps in the system) shall start.

a. When a single pump operates at minimum flow rate, the pump speed shall be reduced to the minimum discharge header pressure as scheduled. When required flow increases, the pump speed shall increase linearly to the discharge pressure as scheduled at full flow, simulating the performance of a system utilizing a remote differential pressure sensor.

b. When the lead pump is stopped because of required zero flow, the pump speed shall increase linearly to the discharge pressure as scheduled to charge the tank, then stop.

5. Safeties:

a. Low Suction Pressure

1) When the suction pressure drops below the low suction pressure alarm point as determined by the integral suction pressure sensor, the pumps shall be disabled and an audible alarm shall be sent to the BMS or local building alarm system.

b. High Discharge Pressure

1) When the discharge pressure rises above the high discharge pressure alarm point as determined by the integral discharge pressure sensor, the pumps shall be disabled and an audible alarm shall be sent to the BMS or local building alarm system

c. High Flow Shutdown

1) When the discharge flow, as calculated by the control system, rises above the high flow alarm point, the pumps shall be disable and an audible alarm shall be sent to the BMS or local building alarm system.

6. Control Wire: Domestic booster pump manufacturer shall furnish the appropriate type and amount of wire for interlock of the remote sensors with the domestic booster pump control panel.

G. Startup Services: Domestic booster pump manufacturer shall provide factory start-up and check out of the booster pump. He shall provide the Owner's Representative with certification of proper installation and system operation.

2.5 AQUASTATS:

A. Remote sensing bulb type, non-modulating, single pole double pole throw with surface mount sensing bulb and mounting bracket, adjustable direct reading scale for set point with adjustable differential.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install pumps in accordance with manufacturer's installation instructions.

B. General: Comply with the manufacturer's written installation and alignment instructions.

C. Install pumps in locations and arrange to provide access for periodic maintenance, including removal of motors, impellers, couplings, and accessories.

D. Support pumps and piping separately so that the weight of the piping system does not rest on the pump.

E. Suspend inline pumps with althread hanger rod and vibration isolation hangers of sufficient size to support the weight of the pump independent from the piping system.

3.2 EXAMINATION

A. Examine areas, equipment foundations, and conditions with Installer present, for compliance with requirements for installation and other conditions affecting performance of plumbing pumps. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Examine rough-in for plumbing piping systems to verify actual locations of piping connections prior to installation.

3.3 CONCRETE EQUIPMENT BASES

A. Refer to Division 22 Section "Basic Mechanical Materials and Methods" for concrete equipment bases.

1. Form concrete equipment bases by using framing lumber with form release compounds. Chamfer top edge and corners of pad.

2. Install reinforcing bars, tied to frame, and place anchor bolts and sleeves using manufacturer's installation template.

3. Place concrete and allow to cure before installation of pumps.

3.4 ALIGNMENT

A. Align pump and motor shafts and piping connections after setting on foundations, after grout has been set and foundations bolts have been tightened, and after piping connections have been made.

1. Adjust alignment of pump and motor shafts for angular and parallel alignment by one of the two methods specified in the Hydraulic Institute "Centrifugal Pumps - Instructions for Installation, Operation and Maintenance."

B. After alignment is correct, tighten the foundation bolts evenly but not too firmly. Fill the base plate completely with nonshrink, nonmetallic grout, with metal blocks and shims or wedges in place. After grout has cured, fully tighten foundation bolts.

1. Alignment tolerances shall meet manufacturers recommendations.

3.5 CONNECTIONS

A. General: Install valves that are same size as the piping connecting the pump.

B. Install suction and discharge pipe sizes equal to or greater than the diameter of the pump nozzles.

C. Install a nonslam check valve and shutoff valve on the discharge side of pumps.

D. Install a valve and strainer on the suction side of inline pumps.

E. Install pressure gauge connector plugs in suction and discharge piping around pump. Pressure gauge connector plugs are specified in Division 22 Section "Meters and Gauges for Plumbing Piping."

F. Interlock aquastat and or timer with hot water recirculation pump motor. Electrical wiring and connections are specified in Division 26 section "Common Work Results for Electrical".

G. Electrical wiring and connections are specified in Division 26 section "Common Work Results for Electrical".

H. Install domestic booster pump remote sensors as recommended by the manufacturer. Coordinate interlock of the sensors and domestic booster pump. Install control wire furnished with the domestic booster pump for interlock with the sensors. Electrical wiring and connections are specified in Division 26 section "Common Work Results for Electrical".

I. Install flexible connectors at the header inlet and outlet of domestic booster pump, refer to Division 22 Section "Basic piping Materials and Methods".

J. Provide equipment pad and vibration isolators, refer to Division 22 Section "Vibration Isolation for Plumbing Piping and Equipment".

1. Extend equipment pads to 2" beyond elbows, shutoff valves and flexible connectors. Anchor elbows and shutoff valves to equipment pad.

K. Coordinate interlock of high flow rate, low suction pressure and high discharge pressure level alarms with the building automation system. Alarm wiring and alarm interlock with the building automation system are specified in Division 23 Section "Direct-Digital Control for HVAC".

3.6 FIELD QUALITY CONTROL

A. Check suction lines connections for tightness to avoid drawing air into the pump.

3.7 STARTUP

A. Final Checks Before Start-Up: Perform the following preventative maintenance operations and checks before start-up:

1. Lubricate oil-lubricated bearings.

2. Remove grease-lubricated bearing covers and flush the bearings with kerosene and thoroughly clean. Fill with new lubricant in accordance with the manufacturer's recommendations.

3. Disconnect coupling and check motor for proper rotation. Rotation shall match direction of rotation marked on pump casing.

4. Check that pump is free to rotate by hand. For pumps handling hot liquids, pump shall be free to rotate with the pump hot and cold. If the pump is bound or even drags slightly, do not operate the pump until the cause of the trouble is determined and corrected.

B. Starting procedure for pumps with shutoff power not exceeding the safe motor power:

1. Prime the pump, opening the suction valve, closing the drains, and prepare the pump for operation.

2. Open the valve in the cooling water supply to the bearings where applicable.

3. Open the sealing liquid supply valve if the pump is so fitted.

4. Open the warm-up valve of a pump handling hot liquids if the pump is not normally kept at operating temperature.

5. Open the recirculating line valve if the pump should not be operated against dead shutoff.

6. Start motor.

7. Open the discharge valve slowly.

8. Observe the leakage from the stuffing boxes and adjust the sealing liquid valve for proper flow to ensure the lubrication of the packing. Do not tighten the gland immediately, but let the packing run in before reducing the leakage through the stuffing boxes.

9. Check the general mechanical operation of the pump and motor.

10. Close the recirculating line valve once there is sufficient flow through the pump to prevent overheating.

C. If the pump is to be started against a closed check valve with the discharge gate valve open, the steps are the same except that the discharge gate valve is opened some time before the motor is started.

D. Start Up Services for Booster Pump:

1. Certification: Prepare certificates for factory compliance of the installation and completion of factory training signed by the factory-authorized service representative and turn over to the Architect upon completion of the project.

END OF SECTION 221123

SECTION 221300 - SANITARY DRAINAGE AND VENT PIPING AND SPECIALTIES

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section includes building sanitary drainage and vent piping systems, including drains and drainage specialties.

B. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 22 Section "General Plumbing Requirements," for trenching and backfilling materials and methods for underground piping installations.

2. Division 33 Section "Sanitary Sewage Systems," for sanitary drainage piping beginning from 5'-0" outside the building.

3. Division 7 Section "Joint Sealers," for materials and methods for sealing pipe penetrations through basement and foundation walls, and fire and smoke barriers.

4. Division 11 Section "Kitchen and Food Service Equipment," for drains and trim furnished with the food service and kitchen equipment.

5. Division 12 Section "Laboratory Casework and Fixtures," for laboratory drains and trim furnished with the casework.

6. Division 22 Section "Plumbing Identification," for labeling and identification of drainage and vent piping.

7. Division 22 Section "Common Work Results for Plumbing," for materials and methods for fire barrier penetrations, wall and floor penetrations and equipment pads

8. Division 22 Section "Basic Piping Material and Methods," for materials and methods for mechanical sleeve seals.

9. Division 22 Section "Hangers and Supports for Plumbing Piping," for materials and methods for hanging and supporting drainage and vent piping.

10. Division 22 Section "Plumbing Insulation," for materials and methods for insulating drainage piping.

11. Division 22 Section "Water Distribution Piping and Specialties," for material and methods for trap primers and trap primer inlet piping.

1.2 DEFINITIONS

A. Sanitary Building Drain: That part of the lowest piping of a drainage system which receives the discharge from soil, waste and other drainage pipes inside the walls of the building and conveys it to the building sewer.

B. Sanitary Building Sewer: That part of the drainage system which extends from the end of the building drain and conveys its discharge to a public sewer, private sewer, individual sewage disposal system, or other point of disposal.

C. Drainage System: Includes all the piping within a public or private premises which conveys sewage or other liquid wastes to a point of disposal. It does not include the mains of public sewer systems or a private or public sewage treatment or disposal plant.

D. Vent System: A pipe or pipes installed to provide a flow of air to or from a drainage system, or to provide a circulation of air within such system to protect trap seals from siphonage and back pressure.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specifications Sections.

B. Product data for the following products:

1. Drainage piping

2. Drainage piping specialties

3. Floor drains

4. Trench drains

5. Interceptors

6. No-hub fitting restraints

C. Test reports specified in Part 3 of this Section.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with the provisions of the following codes:

1. 2018 International Plumbing Code

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

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

1. Drainage Piping Specialties, including backwater valves, expansion joints, cleanouts, floor drains, cast-iron trench drains and vandal-proof vent caps:

a. Josam Mfg. Co.

b. Sioux Chief Manufacturing Co. Inc.

c. Jay R. Smith Mfg. Co.

d. Tyler Pipe/Wade Div.; Subs. of Tyler Corp.

e. Watts Industries, Inc.

f. Zurn Industries, Inc.; Hydromechanics Div.

g. Mifab Manufacturing Co.

Heavy Duty Hubless Couplings

a. Anaco Husky HD-2000

b. Clamp-All 80in. lb.

c. Ideal Tridon "HD"

d. ProFlo "HD"

e. Mission Rubber Company, "Heavy Weight"

3. Cast Iron Soil Pipe and Fittings

a. AB & I Foundry

b. Charlotte Pipe and Foundry Company

c. Tyler Pipe / Soil Pipe Division

4. Shielded Transition Couplings

a. FERNCO, "Proflex 3000 Series"

b. Mission Rubber Company, "Band Seal Specialty Couplings"

5. Underground Shielded Adapter Couplings

a. FERNCO, "1056 Series with SR73 Shear Ring"

b. Mission Rubber Company, "MR56 Series"

6. Floor Troughs

a. Advance TABCO

b. Designers Choice / PROMAX

c. IMC Teddy

7. PVDF Process Piping

a. Orion

8. Trap Seals

a. Jay R. Smith Mfg. Co.

b. Mifab Manufacturing, Inc.Proset Systems "Trap Guard"

c. Sure Seal, Inc.

d. Zurn Industries, Inc.; Hydromechanics Div.

9. Hubless Couplings:

a. Anaco

b. Ideal Tridon

c. Mission Rubber Company

d. ProFlo "PFNH"

e. Tyler Pipe / Soil Pipe Division

10. Plastic Gravity Interceptors

a. Green Turtle, Inc.

b. Mifab Manufacturing, Inc.

c. Schier Products

d. Thermaco, Inc.

e. Xerxes Corp.

11. No-Hub Fitting Restraints

a. Holdrite

2.2 ABOVE GROUND DRAINAGE AND VENT PIPE AND FITTINGS

A. Cast-Iron Soil Pipe: CISPI 301 and ASTM A888, no-hub pipe and fittings and bearing the trademark of CISPI and NSF.

1. Couplings and compression gaskets, NSF certified: ASTM C564 and CISPI 310.

2. Heavy duty couplings and compression gaskets: ASTM C1540 and meeting FM 1680.

B. Copper Tube: ASTM B306, Type DWV, hard drawn for pipe, and cast copper alloy solder joint drainage fittings (DWV) meeting ASME / ANSI B16.23.

1. Solder Filler Materials: ASTM B32, 95-5 tin-antimony solder.

C. Copper Tube: ASTM B88, Type M, hard drawn for pipe and wrought copper fittings with soldered joints.

1. Solder Filler Materials: ASTM B32, 95-5 tin-antimony solder.

D. PVC DWV Pipe and Fittings: Schedule 40 pipe meeting ASTM D1785 and ASTM D2665 with "solid wall" PVC meeting ASTM D1784 with cell class 12454-B.

1. Fittings: DWV pattern meeting ASTM D2665 with solvent cement socket joints.

2. Solvent: ASTM D2564.

E. Shielded Transition Couplings: ASTM C1460 with neoprene adapter gasket with stainless steel Shield and hose clamps.

2.3 UNDERGROUND BUILDING DRAIN AND VENT PIPE AND FITTINGS

A. Cast-Iron Soil Pipe: ASTM A74, Service weight, hub-and-spigot soil pipe and fittings. Pipe and fittings shall have a heavy coating of coal tar varnish or asphaltum on both inside and outside surfaces and bearing the trademark of CIPSI and NSF.

1. Neoprene Compression Gaskets: ASTM C564.

B. PVC DWV Pipe and Fittings: Schedule 40 pipe meeting ASTM D1785 and ASTM D2665 with "solid wall" PVC meeting ASTM D1784 with cell class 12454-B.

1. Fittings: DWV pattern meeting ASTM D2665 with solvent cement socket joints.

2. Solvent: ASTM D2564.

C. Underground Shielded Adapter Couplings: ASTM C1173 with neoprene adapter gasket with stainless steel shield and stainless steel hose clamps.

2.4 DRAINAGE PIPING SPECIALTIES

A. Cleanout Plugs: Cast bronze or brass, threads complying with ANSI B2.1, countersunk head.

B. Floor Cleanouts: Cast iron body and frame, cleanout plug, adjustable nickel-bronze top, exposed flush type, standard non-slip scored or abrasive finish.

C. Wall Cleanouts: As specified on the drawings.

D. Floor Drains: As specified on the drawings.

E. Floor Troughs: As specified on the drawings.

F. Trap seals: Provide trap seals meeting either description below:

1. Smooth, soft, flexible, elastomeric PVC material with a flapper closure. The flow of wastewater allows flapper to open and adequately discharge to floor drain through its opening. The flapper closes and returns to original position after wastewater discharge is complete.

2.5 NO-HUB FITTING RESTRAINTS

A. Pre-engineered kits of galvanized steel pipe straps with stainless steel band clamps and tee bolts, meeting requirements of the CISPI Installation Handbook.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install pipe and specialties in accordance with manufacturer's installation instructions.

3.2 PREPARATION FOUNDATION FOR UNDERGROUND SANITARY BUILDING DRAINS

A. Pipe Beds:

1. PVC and ABS Pipe: Support pipe in trench with sand bags level and true to prevent sand, gravel or debris from interfering with the solvent cement process. After pressure testing is complete, gradually install bedding to maintain continuous pipe slope and prevent pipe deflection and then install subbase. Refer to Section "General Plumbing Requirements" for bedding and subbase materials, excavation, trenching, backfill and compaction requirements and refer to ASTM D2321 "Underground Installation of Thermoplastic Pipe for Sewers and Gravity-flow Applications" for additional requirements.

3.3 PIPE APPLICATIONS - ABOVE GROUND, WITHIN BUILDING

A. Install hubless, cast-iron soil pipe and fittings for 15" and smaller soil, waste, and vent pipe.

B. Install Type DWV copper tube with cast copper alloy solder joint drainage fittings (DWV) fittings, copper sweat X screwed with solder joints, for waste connections from urinals, lavatories, sinks, water coolers, and kitchen equipment to cast iron drainage piping.

C. Install Type M copper tube with wrought copper fittings with solder joints, 1" and smaller, with ¾" minimum size and install Type DWV copper tube with cast copper alloy solder joint drainage fittings (DWV) fittings for 1-1/4" and larger for condensate connections from mechanical equipment inside the building to be installed in return air plenums and terminate over floor receptors with air gap. Provide galvanic isolators as specified in Division 22 "Basic Piping Materials and Methods".

D. Install Type M copper tube with wrought copper fittings with solder joints, 1" and smaller, with ¾" minimum size and install Type DWV copper tube with cast copper alloy solder joint drainage fittings (DWV) fittings for 1-1/4" and larger for condensate connections from mechanical equipment outside the building and terminate over roof receptors with air gap at roof drains as indicated on the plans. Where condensate from multiple units is combined to a single drain, provide cleanout at the start of the pipe and as required for Above Grade Cleanouts in this section. Provide galvanic isolators as specified in Division 22 "Basic Piping Material and Methods".

E. As a contractor's option install PVC Type DWV Plastic pipe and fittings for drainage and vent pipe, except install no plastic pipe in return air plenums.

F. Condensate piping shall match equipment connection size with cleanout at trap. Provide condensate pump at each unit where proper slope cannot be maintained. Double tee cross fitting shall not be used with exception to vents.

G. Install ½" type L copper tube for trap primer outlet piping.

3.4 PIPE APPLICATIONS - BELOW GROUND, WITHIN BUILDING

A. Install hub-and-spigot, service weight, cast-iron, soil pipe and fittings with gasketed joints for 15 inch and smaller for soil, waste, and vent pipe.

1. Install PVC Type DWV Plastic pipe and fittings for drainage and vent pipe for 24" and smaller. Install fabricated fittings for 16 inch and larger.

B. Install type "K" soft copper tube with wrought copper fittings with solder joints for sump pump discharge pipe, 2" and smaller.

C. Install ½" type K soft copper tube for trap primer outlet piping.

3.5 PIPE AND TUBE JOINT CONSTRUCTION

A. Copper Tubing: Solder joints in accordance with the procedures specified in AWS "Soldering Manual."

B. Cast-Iron Soil Pipe: Make hubless joints in accordance with the Cast-Iron Soil Pipe & Fittings Handbook, Chapter IV. Install Couplings as followings:

1. Install hubless couplings complying with CISPI 310 on soil, waste and vent piping.

2. Install hubless couplings complying with CISPI 310 on and soil and waste piping 3" and smaller and all vent piping.

3. Install heavy duty hubless couplings on soil or waste stacks, soil and waste piping connections to soil or waste stacks and all soil and waste piping 4" and larger.

4. Install No-Hub fitting restraints on joints 5" and larger at:

   a. Changes of direction from vertical to horizontal

   b. 4" branch connections, including tees, wyes and wye combination fittings to soil and waste piping 5" and larger

   c. Horizontal changes of direction 22-1/2 degrees and greater

C. PVC DWV Pipe: Joining and installation of PVC drainage pipe and fittings shall conform to ASTM D2665.

D. ABS to PVC Transition Joints: When joining ABS to PVC components (such as an ABS building drain to PVC sewer pipe) make joints using solvent cements conforming to ASTM D3138.

E. Cast Iron to PVC Below Grade: Join cast iron to PVC with underground shielded adapter couplings.

3.6 INSTALLATION

A. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing, slope, expansion, and other design considerations. So far as practical, install piping as indicated.

B. Use fittings for all changes in direction and all branch connections.

C. Install piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.

D. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.

E. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.

F. Install horizontal piping as high as possible allowing for proper slope and coordination with other components. Install vertical piping tight to columns or walls. Provide space to permit insulation applications, with 1-inch clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.

G. Paint exposed copper drain lines serving kitchen equipment with a minimum of two coats of chromium-base paint.

H. Exterior Wall Penetrations: Seal pipe penetrations through exterior walls using sleeves and sealer. Refer to Division 22 Section " Basic Piping Material and Methods" for special sealers and materials.

I. Underground Exterior Wall Penetrations: Seal pipe penetrations through underground exterior walls using sleeves and mechanical sleeve sealers. Refer to Division 22 Section "Basic Piping Material and Methods" for additional information.

J. Fire Barrier Penetrations: Where pipes pass through fire rated walls, partitions, ceilings and floors, maintain the fire rated integrity. Refer to Division 22 Section " Basic Piping Material and Methods" for special sealers and materials.

K. Foundation Penetrations: Where pipes pass through foundation walls above strip footings or under strip footings, protect pipes from building load with cast iron soil pipe sleeves two pipe sizes larger than the pipe. Sleeves installed under the strip footing shall be encased in concrete.

L. Elevated Floor Penetrations of Waterproof Membrane, Interior Penetrations of Non-Fire Rated Walls and Concrete Slab on Grade Penetrations: Provide sleeves and seal pipes that pass through waterproof floors, non-fire rated walls, partitions and ceilings or concrete slab on grade. Refer to Division 22 Section "Common Work Results for Plumbing" for special sealers and materials.

M. Make changes in direction for drainage and vent piping using appropriate 45 degree wyes, combination wye and eighth bend, or long sweep, quarter, sixth, eighth, or sixteenth bends. Sanitary tees or quarter bends may be used on vertical stacks of drainage lines where the change in direction of flow is from horizontal to vertical, except use long-turn pattern combination wye and eighth bends where two fixtures are installed back to back and have a common drain. Straight tees, elbows, and crosses may be used on vent lines. Double wyes or double wye combinations shall not be used in the horizontal. No change in direction of flow greater than 90 degrees shall be made. Where different sizes of drainage pipes and fittings are connected, use proper sized standard increasers and reducers. Reduction of the size of drainage piping in the direction of flow is prohibited.

N. Install underground building drains to conform with the plumbing code, and in accordance with the Cast Iron Soil Pipe Institute Engineering Manual. Lay underground building drains beginning at low point of systems, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install required gaskets in accordance with manufacturer's recommendations for use of lubricants, cements, and other special installation requirements. Maintain swab or drag in line and pull past each joint as it is completed.

O. Install drainage piping pitched down at a minimum slope of 1/4 inch per foot (2 percent) for piping 3 inch and smaller, and 1/8 inch per foot (1 percent) for piping 4 inch and larger. Install vent piping pitched to drain back by gravity to the sanitary drainage piping system.

P. Extend building drain to connect to service piping, of size and in location indicated for service entrance to building. Sewer service piping is specified in a separate section of Division 2.

3.7 HANGERS AND SUPPORTS

A. General: Hanger, support, insulation protection shields, and anchor components and installation procedures conforming to MSS SP-58 and SP-69 are specified in Division 22 Section "Hangers and Supports for Plumbing Piping". Conform to the table below for maximum spacing of supports.

B. Install the following pipe attachments:

1. Adjustable clevis hangers, MSS SP-69 Type 1, for individual horizontal runs.

2. Riser clamps, MSS SP-69 Type 8, for individual vertical runs.

3. Insulation protection shields and high density insulation at each hanger for insulated pipe as specified in Division 22 Sections "Hangers and Supports for Plumbing Piping" and "Plumbing Insulation".

   a. Install high density insulation on insulated pipe.

4. Provide vinyl coated hangers and riser clamps for use with PVC pipe.

C. Install hangers at the following intervals and provide rods of diameter as listed below:

Nom. Pipe Size	Steel Pipe Max. Span	Copper Tube Max. Span.	Min. Rod Dia. - Inches Steel or	Min. Rod Dia. – Inches
In Inches	In Feet	In Feet	Cast Iron	Copper or PVC
Up to 3/4	7	5	3/8	3/8
1	7	6	3/8	3/8
1-1/4	7	7	3/8	3/8
1-1/2	9	8	3/8	3/8
2	10	8	3/8	3/8
2-1/2	11	9	1/2	3/8
3	12	10	1/2	1/2
3-1/2	13	11	1/2	1/2
4	14	12	5/8	1/2
5	16	13	5/8	1/2
6	17	14	3/4	5/8

1. Support all sizes of service weight horizontal cast iron piping every five feet, except up to ten feet where ten foot sections are installed. Support all sizes of hubless horizontal cast iron piping every other joint, unless over four feet, then support each joint. Provide support adjacent to joint, not to exceed 18". Provide sway brace on horizontal piping at not more than 40' intervals to prevent horizontal movement. Provide support at each horizontal branch.

2. Support all sizes of vertical cast iron piping every ten feet.

3. Support piping within 12" of each elbow or tee.

4. Support each P-trap.

D. Support condensate piping located on roof with pre-engineered roof supports, pre-engineered roof supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping". Conform to the table above for maximum spacing of supports. Adjust pipe support to maintain minimum pipe slope.

3.8 INSTALLATION OF PIPING SPECIALTIES

A. Above Ground Cleanouts: Install in above ground piping and building drain piping as indicated, and:

1. as required by plumbing code;

2. at each change in direction of piping greater than 45 degrees;

3. at minimum intervals of 50' for piping 4" and smaller and 100' for larger piping;

4. at base of each vertical soil and waste stack.

5. Locate cleanouts to allow adequate clearance in appropriate direction for ease of use.

B. Cleanout Covers: Install floor and wall cleanout covers for concealed piping, types to match adjacent building finish.

C. Floor Cleanouts: Install in below floor building drain piping at minimum intervals of 50' for piping 4" and smaller and 75' for larger piping. Cleanouts shall have a full size opening coordinated with pipe size or per code requirements.

1. Install floor cleanouts in waterproof floors with waterproof membrane securely flashed with cleanout body flashing clamp so that no leakage occurs between cleanout body and adjoining flooring. Maintain integrity of waterproof membranes, where penetrated.

D. Exterior Cleanouts: Install exterior cleanoutsin a 18" x 18" x 8" block of concrete, flush with finished grade. Include pipe sleeve through concrete to allow movement of concrete.

3.9 INSTALLATION OF FLOOR DRAINS, FLOOR SINKS AND FLOOR TROUGHS

A. Install floor drains, floor sinks, shower linear trench drains and floor troughs in locations indicated.

B. Install floor drains, trench drains and shower linear trench drains at low points of surface areas to be drained, or as indicated. Set tops of drains flush with finished floor. Set floor sinks and floor troughs flush with the level finish floor.

C. Refer to architectural documents for floor slope requirements and set floor drain elevation to match. Where architectural documents do not indicate the requirements, set the floor drain elevation depressed below the finished slab elevation as listed below to provide proper slope to drain:

DEPRESSION IN INCHES	RADIUS OF AREA DRAINED - FEET
1/2	5
3/4	10
1	15
1-1/4	20
1-1/2	25

D. Provide P-traps for drains connected to the sanitary sewer.

E. Install floor drains, floor sinks, shower linear trench drains, and floor troughs in waterproof floors with waterproof membrane securely flashed with drain flashing clamp so that no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes, where penetrated.

F. Position drains so that they are level, accessible and easy to maintain.

3.10 INSTALLATION OF TRAP PRIMERS

A. Install trap primer outlet piping with 1/32" per foot slope towards drain trap where possible.

B. Connect trap primer outlet piping only to factory installed taps on the drain body or P-trap assembly or provide an auxiliary inlet fitting with factory installed trap primer tap.

C. Install trap primer outlet piping in elevated slabs or slabs on grade below concrete reinforcing bars. Wrap with ½" thick flexible unicellular insulation, attach to the reinforcing bars with plastic ties and spacers every five feet to eliminate galvanic corrosion. Refer to Division 22 Section "Plumbing Insulation" for flexible unicellular insulation.

D. Where proper trap primer outlet piping slope can be maintained and the trap primer outlet line would not be subject to freezing, trap primer outlet lines may be installed as follows:

1. Install below elevated floor slabs.

2. Install in the sub grade of slab on grade.

E. Install sleeves and caulk at penetrations through building floor for watertight installation. In an elevated floor slab installation, bracket the piping to bottom of floor once the slab is poured.

F. Refer to Division 22 Section "Water Distribution Piping and Specialties" for trap primer and trap primer inlet pipe requirements.

3.11 INSTALLATION TRAP SEALS:

A. Install trap seals in accordance with manufacturer's written instructions and in locations indicated.

B. Make watertight seal using an adhesive type caulk along bottom of trap seal, if required by the manufacturer.

C. Employ a test plug for testing and remove before normal floor drain use. Clean inside of drain tailpiece and install trap seal after testing.

D. Do not touch elastomeric plug or allow contact with primer or solvent cement.

3.12 CONNECTIONS

A. Piping Runouts to Fixtures: Provide drainage and vent piping runouts to plumbing fixtures and drains, with approved trap, of sizes indicated; but in no case smaller than required by the plumbing code.

B. Locate piping runouts as close as possible to bottom of floor slab supporting fixtures or drains.

3.13 FIELD QUALITY CONTROL

A. Inspections

1. Do not enclose, cover, or put into operation drainage and vent piping system until it has been inspected and approved by the authority having jurisdiction.

2. During the progress of the installation, notify the plumbing official having jurisdiction, at least 24 hours prior to the time such inspection must be made. Perform tests specified below in the presence of the plumbing official.

a. Rough-in Inspection: Arrange for inspection of the piping system before concealed or closed-in after system is roughed-in, and prior to setting fixtures.

b. Final Inspection: Arrange for a final inspection by the plumbing official to observe the tests specified below and to insure compliance with the requirements of the plumbing code.

c. Reinspections: Whenever the piping system fails to pass the test or inspection, make the required corrections, and arrange for reinspected by the plumbing official.

d. Reports: Prepare inspection reports, signed by the plumbing official.

B. Piping System Test Test drainage and vent system in accordance with the procedures of the authority having jurisdiction, or in the absence of a published procedure, as follows:

1. Test for leaks and defects all new drainage and vent piping systems and parts of existing systems, which have been altered, extended or repaired. If testing is performed in segments, submit a separate report for each test, complete with a diagram of the portion of the system tested.

2. Leave uncovered and unconcealed all new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose all such work for testing, that has been covered or concealed before it has been tested and approved.

3. Rough Plumbing Test Procedure: Except for outside leaders and perforated or open jointed drain tile, test the piping of plumbing drainage and venting systems upon completion of the rough piping installation. Tightly close all openings in the piping system, and fill with water to the point of overflow, but not less than 10 feet head of water. Water level shall not drop during the period from 15 minutes before the inspection starts, through completion of the inspection or a minimum of one hour. Inspect all joints for leaks.

4. Final Plumbing Test Procedure: After the plumbing fixtures have been set and their traps filled with water, their connections shall be tested and proved gas and water-tight. Tightly close all openings, initially except vents thru the roof, in the system and fill the system with smoke from one or more smoke machines designed for smoke testing of plumbing systems. When smoke appears at a vent thru the roof, seal the vent thru roof with a test plug. Pressurize the system with 1" water column of smoke for 15 minutes. Use a "U" tube or manometer inserted in the trap of a water closet to measure this pressure. Visually verify all joints for leaks.

5. Repair all leaks and defects using new materials and retest system or portion thereof until satisfactory results are obtained.

6. Reports: Prepare inspection reports and required corrective action signed by the plumbing official and turn over to the Architect upon completion of the project.

A. Final Flow Verification test: Provide final flow verification documentation, within 10 days of Owner final acceptance of the facility. Test shall consist of providing 1500 gallon water tank and discharging through a 2-1/2" diameter hose by gravity into the main vent cleanout to verify no blockage of sewer system. Water flow shall not be throttled other than 2-1/2" diameter hose.

B. Smoke Test: Provide smoke testing of all drainage and vent systems within building when complete to confirm that all traps work properly and that all vents on roof do not recirculate into HVAC equipment outside air intake openings. Smoke test procedures are as follows:

7. Coordinate with general contractor for HVAC equipment to operate in economizer mode during the test.

1. Start at nearest manhole exterior to building by plugging manhole outlet pipe.

2. Light smoke bomb within manhole and blow air into the manhole via blower/fan located at the top of the manhole to push smoke into the sanitary drainage and vent system. Seal opening around blower/fan and manhole to prevent smoke from escaping.

3. With smoke being introduced into the sanitary drainage and vent system, observe smoke flow pattern from vents on roof. Check all interior spaces for smoke.

4. If leaks are observed, repair leaks and repeat the test. Continue testing and repairs until no leaks are observed.

5. Do not perform this test on a windy day.

6. Utilize consultant with experience in performing smoke tests.

7. Contact Architect/Engineer's office for observation of testing. Submit final results to Architect/Engineer's office for their records.

3.14 ADJUSTING AND CLEANING

A. Clean interior of piping system. Remove dirt and debris as work progresses.

B. Clean drain strainers, domes, and traps. Remove dirt and debris.

3.15 PROTECTION

A. Protect drains during remainder of construction period, to avoid clogging with dirt and debris, and to prevent damage from traffic and construction work.

B. Place plugs in ends of uncompleted piping at end of day or whenever work stops.

C. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with 2 coats of a water based latex paint.

END OF SECTION 221300

SECTION 221400 - STORM DRAINAGE PIPING AND SPECIALTIES

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section includes building storm drainage piping systems, including drains and drainage specialties.

B. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 22 Section "General Plumbing Requirements," for trenching and backfilling materials and methods for underground piping installations.

2. Division 33 Section "Storm Systems," for storm drainage piping beginning from 5'-0" outside the building.

3. Division 33 Section "Foundation Drainage," for foundation drainage piping.

4. Division 7 Section "Joint Sealers," for materials and methods for sealing pipe penetrations through basement and foundation walls, and fire and smoke barriers.

5. Division 22 Section "Identification for Plumbing Piping and Equipment," for labeling and identification of drainage piping.

6. Division 22 Section "Common Work Results for Plumbing," for materials and methods for fire barrier penetrations, wall and floor penetrations and equipment pads

7. Division 22 Section "Basic Piping Material and Methods," for materials and methods for mechanical sleeve seals.

8. Division 22 Section "Hangers and Supports for Plumbing Piping," for materials and methods for hanging and supporting drainage piping.

9. Division 22 Section "Plumbing Insulation," for materials and methods for insulating drainage piping.

1.2 DEFINITIONS

A. Storm Building Drain: That part of the lowest piping of a drainage system which receives the discharge from storm drainage pipes inside the walls of the building and conveys it to the building sewer.

B. Storm Building Sewer: That part of the drainage system which extends from the end of the building drain and conveys its discharge to a public sewer or private sewer or other point of disposal.

C. Drainage System: Includes all the piping within a public or private premises which conveys storm water or other liquid wastes to a point of disposal. It does not include the mains of public sewer systems or a private or public sewage treatment or disposal plant.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specifications Sections.

B. Product data for the following products:

1. Drainage piping

2. Drainage piping specialties

3. Roof drains

4. No-hub fitting restraints

C. Test reports specified in Part 3 of this Section.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with the provisions of the following codes:

1. 2018 International Plumbing Code

B. Comply with the installation requirements for PVC gasketed sewer pipe per the Uni-Bell PVC Pipe Association "Installation Guide for Solid Wall PVC Sewer Pipe". Comply with the installation requirements for gasketed fittings per the Uni-Bell PVC Pipe Association "Installation Guide for PVC Fittings and Laterals for Solid Wall PVC Sewer Pipe".

C. Obtain installation training from the PVC gasketed sewer pipe manufacturer for all workers that will be installing or handling the PVC gasketed sewer pipe piping systems. Submit certification letter along with each workers certificate of completion to engineer of record within 30-days of mobilization. Include copy of certification letter with closeout documents.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

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

1. Drainage Piping Specialties, including cleanouts, area/roof drains, and downspout nozzles:

a. Josam Mfg. Co.

b. Sioux Chief Manufacturing Co. Inc.

c. Smith (Jay R) Mfg. Co.

d. Tyler Pipe/Wade Div.; Subs. of Tyler Corp.

e. Watts Industries, Inc.

f. Zurn Industries, Inc.; Hydromechanics Div.

g. Mifab Manufacturing, Inc.

2. Heavy Duty Hubless Couplings

a. Anaco Husky HD-2000

b. Clamp-All 80in. lb.

c. Ideal Tridon "HD"

d. Mission Rubber Company "Heavyweight"

e. ProFlo "HD"

3. Cast Iron Soil Pipe and Fittings

a. AB & I Foundry

b. Charlotte Pipe and Foundry Company

c. Tyler Pipe / Soil Pipe Division

4. Shielded Transition Couplings

a. FERNCO, "Proflex 3000 Series"

b. Mission Rubber Company, "Band Seal Specialty Couplings"

5. Underground Shielded Adapter Couplings

a. FERNCO, "1056 Series with SR73 Shear Ring"

b. Mission Rubber Company, "MR56 Series"

6. No-Hub Fitting Restraints

a. Holdrite

2.2 ABOVE GROUND DRAINAGE PIPE AND FITTINGS

A. Cast-Iron Soil Pipe: CISPI 301 and ASTM A888, hubless pipe and fittings, and bearing the trademark of CIPSI and NSF.

1. Heavy duty couplings and compression gaskets: ASTM C1540 and meeting FM 1680.

B. Copper Tube: ASTM B306, Type DWV, hard drawn for pipe, and cast-bronze, drainage pattern fittings with soldered joints.

1. Solder Filler Materials: ASTM B32, 95-5 tin-antimony solder.

C. Shielded Transition Couplings: ASTM C1460 with neoprene adapter gasket with stainless steel Shield and hose clamps.

2.3 UNDERGROUND BUILDING DRAIN PIPE AND FITTINGS

1. .

B. PVC DWV Pipe and Fittings: Schedule 40 pipe meeting ASTM D1785 and ASTM D2665 with "solid wall" PVC meeting ASTM D1784 with cell class 12454-B.

1. Fittings: DWV pattern meeting ASTM D2665 with solvent cement socket joints.

2. Solvent: ASTM D2564.

C. Underground Shielded Adapter Couplings: ASTM C1173 with neoprene adapter gasket with stainless steel shield and stainless steel hose clamps.

2.4 DRAINAGE PIPING SPECIALTIES

A. Cleanout Plugs: Cast-bronze or brass, threads complying with ANSI B2.1, countersunk head.

B. Floor Cleanouts: Cast-iron Body and frame, cleanout plug, adjustable nickel-bronze top, exposed flush type, standard non-slip scored or abrasive finish.

C. Wall Cleanouts: Cast-iron body adaptable to pipe with cast-bronze or brass cleanout plug, stainless steel cover, including screws.

D. Roof Drains: As specified on the drawings.

2.5 NO-HUB FITTING RESTRAINTS

A. Pre-engineered kits of galvanized steel pipe straps with stainless steel band clamps and tee bolts, meeting requirements of the CISPI Installation Handbook.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install pipe and specialties in accordance with manufacturer's installation instructions.

3.2 PREPARATION FOUNDATION FOR UNDERGROUND BUILDING DRAINS

A. Pipe Beds:

1. PVC and ABS Pipe: Support pipe in trench with sand bags level and true to prevent sand, gravel or debris from interfering with the solvent cement process. After pressure testing is complete, gradually install bedding to maintain continuous pipe slope and prevent pipe deflection and then install subbase. Refer to Section "General Plumbing Requirements" for bedding and subbase materials, excavation, trenching, backfill and compaction requirements and refer to ASTM D2321 "Underground Installation of Thermoplastic Pipe for Sewers and Gravity-flow Applications" for additional requirements.

3.3 PIPE APPLICATIONS - ABOVE GROUND, WITHIN BUILDING

A. Install hubless, cast-iron soil pipe and fittings 15" and smaller for storm pipe.

B. As a contractor's option install PVC Type DWV Plastic pipe and fittings for 24 inch and smaller storm pipe. Install fabricated fittings for 16 inch and larger, except no plastic pipe shall be installed in return air plenums.

C. Install galvanized schedule 40 steel pipe and malleable iron fittings for sump pump discharge pipe.

3.4 PIPE APPLICATIONS - BELOW GROUND, WITHIN BUILDING

A. As a contractor's option, install PVC Type DWV Plastic pipe and fittings for 24 inch and smaller storm pipe. Install fabricated fittings for 16 inch and larger.

3.5 PIPE AND TUBE JOINT CONSTRUCTION

A. Cast-Iron Soil Pipe: Make hubless joints in accordance with the Cast-Iron Soil Pipe & Fittings Handbook, Chapter IV. Install Couplings as followings:

1. Install heavy duty hubless couplings on storm drainage piping, including connections to roof drains.

2. Install No-Hub fitting restraints on joints 5" and larger at:

a. Changes of direction from vertical to horizontal

b. 4" branch connections, including tees, wyes and wye combination fittings to storm drainage piping 5" and larger

c. Horizontal changes of direction 22-1/2 degrees and greater

B. PVC DWV Pipe: Joining and installation of PVC drainage pipe and fittings shall conform to ASTM D2665.

C. ABS to PVC Transition Joints: When joining ABS to PVC components (such as an ABS building drain to PVC sewer pipe) make joints using solvent cements conforming to ASTM D3138.

D. Cast Iron to PVC Above Grade: Join cast iron to PVC with shielded transition couplings.

E. Cast Iron to PVC Below Grade: Join cast iron to PVC with underground shielded adapter couplings.

F. Gasketed Fittings: Install fittings per the Uni-Bell PVC Pipe Association "Installation Guide for PVC Fittings and Laterals for Solid Wall PVC Sewer Pipe".

3.6 INSTALLATION

A. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing, slope, expansion, and other design considerations. So far as practical, install piping as indicated.

B. Use fittings for all changes in direction and all branch connections.

C. Install piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.

D. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.

E. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.

F. Install horizontal piping as high as possible allowing for proper slope and coordination with other components. Install vertical piping tight to columns or walls. Provide space to permit insulation applications, with 1-inch clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.

G. Exterior Wall Penetrations: Seal pipe penetrations through exterior walls using sleeves and sealer. Refer to Division 22 Section "Basic Piping Materials and Methods" for special sealers and materials.

H. Underground Exterior Wall Penetrations: Seal pipe penetrations through underground exterior walls using sleeves and mechanical sleeve sealers. Refer to Division 22 Section "Basic Piping Material and Methods" for additional information.

I. Fire Barrier Penetrations: Where pipes pass through fire rated walls, partitions, ceilings and floors, maintain the fire rated integrity. Refer to Division 22 Section "Common Work Results for Plumbing" for special sealers and materials.

J. Elevated Floor Penetrations of Waterproof Membrane, Interior Penetrations of Non-Fire Rated Walls and Concrete Slab on Grade Penetrations: Provide sleeves and seal pipes that pass through waterproof floors, non-fire rated walls, partitions and ceilings or concrete slab on grade. Refer to Division 22 Section "Common Work Results for Plumbing" for special sealers and materials.

K. Foundation Penetrations: Where pipes pass through foundation walls above strip footings or under strip footings, protect pipes from building load with cast iron soil pipe sleeves two pipe sizes larger than the pipe. Sleeves installed under the strip footing shall be encased in concrete.

L. Make changes in direction for drainage piping using appropriate 45 degree wyes, combination wye and eighth bend, or long sweep, quarter, sixth, eighth, or sixteenth bends. Sanitary tees or quarter bends may be used on vertical stacks of drainage lines where the change in direction of flow is from horizontal to vertical, except use long-turn pattern combination wye and eighth bends where two fixtures are installed back to back and have a common drain. No change in direction of flow greater than 90 degrees

shall be made. Where different sizes of drainage pipes and fittings are connected, use proper sized standard increasers and reducers. Reduction of the size of drainage piping in the direction of flow is prohibited.

M. Install underground building drains to conform with the plumbing code, and in accordance with the Cast Iron Soil Pipe Institute Engineering Manual. Lay underground building drains beginning at low point of systems, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install required gaskets in accordance with manufacturer's recommendations for use of lubricants, cements, and other special installation requirements. Maintain swab or drag in line and pull past each joint as it is completed.

N. Install drainage piping pitched down at a minimum slope of 1/4 inch per foot (2 percent) for piping 3 inch and smaller, and 1/8 inch per foot (1 percent) for piping 4 inch and larger.

O. Extend building drain to connect to service piping, of size and in location indicated for service entrance to building. Storm service piping is specified in a separate section of Division 2.

3.7 HANGERS AND SUPPORTS

A. General: Hanger, support, insulation protection shields, and anchor components and installation procedures conforming to MSS SP-58 and SP-69 are specified in Division 22 Section "Hangers and Supports for Plumbing Piping". Conform to the table below for maximum spacing of supports.

B. Install the following pipe attachments:

1. Adjustable clevis hangers, MSS SP-69 Type 1, for individual horizontal runs.

2. Riser clamps, MSS SP-69 Type 8, for individual vertical runs.

3. Insulation protection shields and high density insulation at each hanger for insulated pipe as specified in Division 22 Sections "Hangers and Supports for Plumbing Piping" and "Plumbing Insulation".

   a. Install high density insulation on insulated pipe.

4. Provide vinyl coated hangers and riser clamps for use with PVC pipe.

C. Install hangers at the following intervals and provide rods of diameter as listed below:

Nom. Pipe Size In Inches	Steel Pipe Max. Span In Feet	Copper Tube Max. Span. In Feet	Min. Rod Dia. - Inches Steel or Cast Iron	Min. Rod Dia. – Inches Copper or PVC
Up to 3/4	7	5	3/8	3/8
1	7	6	3/8	3/8
1-1/4	7	7	3/8	3/8
1-1/2	9	8	3/8	3/8
2	10	8	3/8	3/8
2-1/2	11	9	1/2	3/8
3	12	10	1/2	1/2
3-1/2	13	11	1/2	1/2

4	14	12	5/8	1/2
5	16	13	5/8	1/2
6	17	14	3/4	5/8
8	19	16	7/8	3/4
10	22	18	7/8	3/4
12	23	19	7/8	3/4

1. Support all sizes of hubless horizontal cast iron piping every five feet, except up to ten feet where ten foot sections are installed. Support all sizes of hubless horizontal cast iron piping every other joint, unless over four feet, then support each joint. Provide support adjacent to joint, not to exceed 18". Provide sway brace on horizontal piping at not more than 40' intervals to prevent horizontal movement. Provide support at each horizontal branch.

2. Support all sizes of vertical cast iron piping every ten feet.

3. Support piping within 12" of each elbow or tee.

3.8 INSTALLATION OF PIPING SPECIALTIES

A. Install backwater valves in storm building drain piping as indicated, and as required by the plumbing code. For interior installation, provide cleanout cover flush to floor centered over backwater valve cover and of adequate size to remove valve cover for service.

B. Install expansion joints on stacks or horizontal piping as indicated, and as required by the plumbing code.

C. Above Ground Cleanouts: Install in above ground piping and building drain piping as indicated, and:

1. as required by plumbing code;

2. at each change in direction of piping greater than 45 degrees;

3. at minimum intervals of 50' for piping 4" and smaller and 100' for larger piping;

4. at base of each vertical soil, waste, or storm water stack.

1. Locate cleanouts to allow adequate clearance in appropriate direction for ease of use.

D. Cleanout Covers: Install floor and wall cleanout covers for concealed piping, types to match adjacent building finish.

E. Floor Cleanouts: Install in below floor building drain piping at minimum intervals of 50' for piping 4" and smaller and 75' for larger piping. Cleanouts shall have a full size opening coordinated with pipe size or per code requirements.

1. Install floor cleanouts in waterproof floors with waterproof membrane securely flashed with cleanout body flashing clamp so that no leakage occurs between cleanout body and adjoining flooring. Maintain integrity of waterproof membranes, where penetrated.

F. Exterior Cleanouts: Install exterior cleanouts in a 18" x 18" x 8" block of concrete, flush with finished grade. Include pipe sleeve through concrete to allow movement of concrete.

3.9 INSTALLATION OF ROOF DRAINS

A. Install roof drains at low points of roof areas with the roof membrane securely flashed with drain flashing clamp so that no leakage occurs between drain and roof membrane.

B. Install drain flashing collar or flange so that no leakage occurs between roof drain and adjoining roofing. Maintain integrity of waterproof membranes, where penetrated.

C. Position roof drains so that they are accessible and easy to maintain.

3.10 FIELD QUALITY CONTROL

A. Inspections

1. Do not enclose, cover, or put into operation the storm drainage piping system until it has been inspected and approved by the authority having jurisdiction.

2. During the progress of the installation, notify the plumbing official having jurisdiction, at least 24 hours prior to the time such inspection must be made. Perform tests specified below in the presence of the plumbing official.

   a. Rough-in Inspection: Arrange for inspection of the storm drainage piping system before concealed or closed-in after system is roughed-in.

   b. Final Inspection: Arrange for a final inspection by the plumbing official to observe the tests specified below and to insure compliance with the requirements of the plumbing code.

   c. Reinspections: Whenever the piping system fails to pass the test or inspection, make the required corrections, and arrange for reinspected by the plumbing official.

   d. Reports: Prepare inspection reports, signed by the plumbing official.

B. Piping System Test: Test storm drainage system in accordance with the procedures of the authority having jurisdiction, or in the absence of a published procedure, as follows:

1. Test for leaks and defects all new storm drainage piping systems and parts of existing systems, which have been altered, extended or repaired. If testing is performed in segments, submit a separate report for each test, complete with a diagram of the portion of the system tested.

2. Leave uncovered and unconcealed all new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose all such work for testing, that has been covered or concealed before it has been tested and approved.

3. Rough Plumbing Test Procedure: Except for outside leaders and perforated or open jointed drain tile, test the piping of storm drainage piping systems upon completion of the rough piping installation. Tightly close all openings in the piping system, and fill with water to the point of overflow, but not less than 10 feet head of water. Water level shall not drop during the period

from 15 minutes before the inspection starts, through completion of the inspection. Inspect all joints for leaks.

4. Repair all leaks and defects using new materials and retest system or portion thereof until satisfactory results are obtained.

5. Reports: Prepare inspection reports and required corrective action signed by the plumbing official and turn over to the Architect upon completion of the project.

3.11 ADJUSTING AND CLEANING

A. Clean interior of piping system. Remove dirt and debris as work progresses.

B. Clean drain strainers and domes. Remove dirt and debris.

3.12 PROTECTION

A. Protect drains during remainder of construction period, to avoid clogging with dirt and debris, and to prevent damage from traffic and construction work.

B. Place plugs in ends of uncompleted piping at end of day or whenever work stops.

C. Exposed PVC Piping: Protect storm drainage piping exposed to sunlight with 2 coats of a water based latex paint.

END OF SECTION 221400

SECTION 221489 - SUMP PUMPS

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section includes the following types of plumbing pumps:

1. Sump pumps

B. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 3 Section "Concrete Work" for specifications on concrete and reinforcing materials and concrete placing requirements for sump basins and covers.

2. Division 22 Section "Basic Piping Material and Methods," for materials and methods for mechanical sleeve seals.

3. Division 22 Section “Coordination” for basic requirements for electrical components that are an integral part of packaged system components.

4. Division 22 Section “Storm Drainage Piping and Specialties” for sump pump discharge pipe material and installation requirements.

5. Division 23 Section “Direct-Digital Control for HVAC” for interlock of alarms with facility management system and alarm wiring.

6. Division 26 Section “Common Work Results for Electrical” required electrical devices.

7. Division 26 Sections "Enclosed Switches and Circuit Breakers" for field-installed disconnects.

1.2 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

1. Product data including standard performance curves, weights (shipping, installed, and operating), furnished specialties, and accessories, plus installation and start-up instructions.

2. Shop drawings showing layout and connections for plumbing pumps. Include setting drawings with templates, and directions for installation of foundation bolts, anchor bolts, and other anchorages.

3. Wiring diagrams detailing wiring for power, signal, and control systems; differentiating between manufacturer-installed wiring and field-installed wiring.

4. Maintenance data for plumbing pumps, for inclusion in Operating and Maintenance Manuals specified in Division 1 and Division 22 Section "General Plumbing Requirements."

5. Shop drawings showing basins with depth, inlet, outlet and vent locations, pit covers, float switches, non-clog check valves and shutoff valves.

1.3 QUALITY ASSURANCE

A. Hydraulic Institute Compliance: Design, manufacture, and install plumbing pumps in accordance with "Hydraulic Institute Standards."

B. National Electrical Code Compliance: Components shall comply with NFPA 70 "National Electrical Code."

C. UL Compliance: Control panels shall be listed and labeled by UL and comply with Standard 508A “Control Panels”.

D. NEMA Compliance: Electric motors and components shall be listed and labeled NEMA.

E. SSPMA Compliance: Test and rate sump and sewage pumps in accordance with the Sump and Sewage Pump Manufacturers Association (SSPMA) Standards.

F. Single-Source Responsibility: Obtain plumbing pumps of the same type from a single manufacturer.

G. Design Criteria: The Drawings indicate sizes, profiles, connections, and dimensional requirements of plumbing pumps and are based on the specific manufacturer types and models indicated. Pumps having equal performance characteristics by other manufacturers may be considered, provided that deviations in dimensions and profiles do not change the design concept or intended performance as judged by the Architect. The burden of proof for equality of plumbing pumps is on the proposer.

1.4 WARRANTY

A. Warranty on Pumps: Provide written warranty, signed by manufacturer, agreeing to replace/repair, within warranty period, pumps with inadequate or defective materials and workmanship, including leakage, breakage, improper assembly, or failure to perform as required; provided manufacturer's instructions for handling, installing, protecting, and maintaining units have been adhered to during warranty period. Replacement includes both parts and labor for removal and reinstallation.

1. Warranty Period: One year from date of substantial completion.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide one of the following:

1. Elevator Pit Sump Pumps:

a. ABS Pump, Inc.,

b. FLYGT

c. Weil Pump Company

2. Non-Clog “Flapper Type” Check Valves:

a. “Liberty Pumps “Series CVXXXC”

b. Zoeller Pump Company “Series 30”

c. Little Giant Pump Company “Series CV-SE”

2.2 PUMPS, GENERAL

A. Pumps and circulators: factory assembled and factory tested.

B. Preparation for shipping: After assembly and testing, clean flanges and exposed machined metal surfaces and treat with an anticorrosion compound. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

C. Motors: Conform to NEMA standards; single, multiple, or variable speed with type of enclosure and electrical characteristics as indicated; have built-in thermal-overload protection and grease-lubricated ball bearings. Select motors that are nonoverloading within the full range of the pump performance curve.

D. Apply factory finish paint to assembled, tested units prior to shipping.

2.3 ELEVATOR PIT SUMP PUMPS – ¾ HP AND SMALLER

A. General Description: Pumps shall be simplex centrifugal, direct connected, floor mounted, single stage type with cast iron body, stainless steel shaft, cast iron impeller, mechanical seal, permanently lubricated upper and lower ball bearings complete with integral inlet strainer, mechanical float switch, and power cord with ground.

B. Casing: Cast iron with integral cast-iron inlet strainer and legs to elevate the pump to permit flow into the impeller. Vertical discharge with screwed female connection.

C. Impeller: Statically and dynamically balanced, open or semiopen, overhung, single suction, fabricated from cast iron, keyed to shaft and secured by a locking capscrew.

D. Pump and Motor Shaft: Stainless steel, with factory-sealed, upper and lower grease-lubricated ball bearings.

E. Seals: Carbon steel rotating ring, stainless-steel spring, ceramic seat, and Buna-N bellows and gasket.

F. Motor: NEMA 6 with class F insulation, hermetically sealed, 1750 rpm, capacitor start, air filled with built-in overload protection, with 3-conductor, waterproof cable and grounding plug.

G. Controls: NEMA 1, tethered float switch for “on-off” control with “piggy back” power cord connection for sump pump power cord.

2.4 ELEVATOR PIT SUMP PUMP HIGH LEVEL ALARMS

A. Alarm: Remote type 120V single phase with NEMA 4X enclosure, terminal block, 5 amp isolated alarm contact, alarm horn, alarm light, test-automatic-silence switch and mechanical float switch.

Designers Note: Use flapper type for small sump pumps, under 2 inches.

2.5 NON CLOG “FLAPPER TYPE” CHECK VALVES

A. General Description: Flapper type with PVC Body, compression end fittings with Buna-N “O” ring and Buna-N flapper with PVC shields.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, equipment foundations, and conditions with Installer present, for compliance with requirements for installation and other conditions affecting performance of plumbing pumps. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Examine rough-in for plumbing piping systems to verify actual locations of piping connections prior to installation.

3.2 INSTALLATION

A. General: Comply with the manufacturer's written installation and alignment instructions.

B. Install pumps in locations and arrange to provide access for periodic maintenance, including removal of motors, impellers, couplings, and accessories.

C. Support pumps and piping separately so that the weight of the piping system does not rest on the pump.

D. Basins: Install sump pump basins in indicated locations and connect to drainage lines. Brace interior of basin in accordance with manufacturer's instructions to prevent distortion or collapse during concrete placement. Refer to Division 3 for concrete work. Set cover over basin and fasten to top flange of basin. Install so cover is flush with finished floor.

3.3 CONNECTIONS

A. General: Install valves that are same size as the piping connecting the pump.

B. Install discharge pipe sizes equal to or greater than the diameter of the pump nozzles. Sump pump discharge pipe material is specified in Division 22 Section “Storm Drainage Piping and Specialties”.

C. Electrical wiring and connections are specified in Division 26 section “Common Work Results for Electrical”.

D. Coordinate interlock of elevator pit high level and sump pump high level alarms with facility management system. Alarm wiring and alarm interlock with the facility management system are specified in Division 23 Section “Direct-Digital Control for HVAC”.

3.4 STARTUP

A. Final Checks Before Start-Up: Perform the following preventative maintenance operations and checks before start-up:

1. Lubricate oil-lubricated bearings.

2. Remove grease-lubricated bearing covers and flush the bearings with kerosene and thoroughly clean. Fill with new lubricant in accordance with the manufacturer's recommendations.

3. Disconnect coupling and check motor for proper rotation. Rotation shall match direction of rotation marked on pump casing.

4. Check that pump is free to rotate by hand. For pumps handling hot liquids, pump shall be free to rotate with the pump hot and cold. If the pump is bound or even drags slightly, do not operate the pump until the cause of the trouble is determined and corrected.

B. Starting procedure for pumps with shutoff power not exceeding the safe motor power:

1. Prime the pump, opening the suction valve, closing the drains, and prepare the pump for operation.

2. Open the valve in the cooling water supply to the bearings where applicable.

3. Open the sealing liquid supply valve if the pump is so fitted.

4. Open the warm-up valve of a pump handling hot liquids if the pump is not normally kept at operating temperature.

5. Open the recirculating line valve if the pump should not be operated against dead shutoff.

6. Start motor.

7. Open the discharge valve slowly.

8. Observe the leakage from the stuffing boxes and adjust the sealing liquid valve for proper flow to ensure the lubrication of the packing. Do not tighten the gland immediately, but let the packing run in before reducing the leakage through the stuffing boxes.

9. Check the general mechanical operation of the pump and motor.

10. Close the recirculating line valve once there is sufficient flow through the pump to prevent overheating.

C. If the pump is to be started against a closed check valve with the discharge gate valve open, the steps are the same except that the discharge gate valve is opened some time before the motor is started.

END OF SECTION

SECTION 223300 - ELECTRIC DOMESTIC WATER HEATERS

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section includes electric water heaters.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 22 Section "Common Work Results for Plumbing" for concrete equipment pads.

2. Division 22 Section "Basic Piping Materials and Methods" for pipe joining materials, unions, dielectric unions, dielectric flanges, dielectric flange kits and basic installation requirements.

3. Division 22 Section "Meters and Gauges for Plumbing Piping." for thermometers and their installation requirements.

4. Division 26 Section "Common Work Results for Electrical" required electrical devices.

5. Division 26 Section "Enclosed Switches and Circuit Breakers" for field-installed disconnects.

1.2 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

1. Product data including rated capacities of selected models, weights (shipping, installed, and operating), furnished specialties, and accessories, and indicating dimensions, required clearances, and methods of assembly of components, and piping and wiring connections.

2. Wiring diagrams from manufacturers detailing electrical requirements for electrical power supply wiring to water heaters. Include ladder-type wiring diagrams for interlock and control wiring required for final installation of water heaters and controls. Differentiate between portions of wiring that are factory installed and portions that are to be field installed.

3. Maintenance data for inclusion in Operating and Maintenance Manual specified in Division 1 and Division 22 Section "General Plumbing Requirements."

1.3 QUALITY ASSURANCE

A. UL Standards: Provide water heaters complying with the following:

1. UL 174, "Household Electric Storage Tank Water Heaters."

2. UL 778, "Motor Operated Water Pumps."

B. NSF Standards: Provide water heaters complying with NSF No. 5, "Standard for Hot Water Generating Equipment for Food Service Establishments using Spray Type Dishwashing Machines," and bearing NSF label.

C. Electrical Component Standard: Provide components complying with NFPA 70 "National Electrical Code."

D. Listing and Labeling: Provide water heaters that are listed and labeled.

1. The terms "listed" and "labeled" shall be as defined in the National Electrical Code, Article 100.

E. State Boiler Code Compliance: Provide rated water heaters, safety relief valve and accessories that comply with the state boiler code in effect.

F. ASHRAE Standards: Provide water heaters with performance efficiencies not less than prescribed in ASHRAE 90.1b, "Energy Conservation in New Building Design."

G. Design Concept: The drawings indicate types and capacities of water heaters and are based on specific descriptions and manufacturers indicated. Water heaters having equal performance characteristics by other manufacturers may be considered provided that deviations in capacities, dimensions, operation, or other characteristics are minor and do not change the design concept or intended performance as judged by the Architect. Burden of proof for equality of water heaters is on the proposer.

1.4 WARRANTY

A. Special Project Warranty: Submit a written warranty, executed by manufacturer, agreeing to repair or replace water heater units that fail in materials or workmanship within the specified warranty period. Failures include, but are not limited to, controls, tanks, and coils. This warranty shall be in addition to, and not a limitation of, other rights the Owner may have against the Contractor under the Contract Documents.

1. Commercial Electric Water Heaters:

a. Tank: Three years

b. Controls and Other Components: One year

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

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

1. Commercial Electric Water Heaters:

a. Lochinvar Water Heater Corp.

b. Rheem Mfg.

c. Ruud Mfg. Div.; Rheem Mfg.

d. A.O. Smith Water Products Co. Div.; A.O. Smith Corp.

e. State Industries, Inc.

2. Thermal Expansion Tanks

a. Armstrong Pumps, Inc.

b. Amtrol, Inc.

c. Bell & Gosset, ITT

d. Elbi

e. TACO, Inc.

f. Watts

g. Wessels Tank Co.

3. Vacuum Relief Valves

a. Apollo #37

b. Cash ACME #VR-801

c. Watts #N36

d. Wilkins #VR-10

4. Water Heater Drain Pans

a. Holdrite

b. Killarney Metals

c. Oatey

2.2 ELECTRIC WATER HEATERS

A. Description: Automatic, commercial, electric; with vertical, 150-psig-rated storage tank, integral controls, drain valve, and relief valve.

B. Insulation: Fiberglass or polyurethane foam, surrounding tank.

C. Jacket: Steel, with baked-on enamel finish.

D. Tank: Glass-lined steel with anode rods and drain valve.

E. Heating Elements: Screw-in or flanged bolt-in immersion type, in multiples as described on the drawings.

F. Controls: Adjustable surface mounted thermostats.

G. Safety Controls: Automatic, high-temperature-limit cutoff.

H. Temperature and Pressure Relief Valve: Lead free brass body meeting ANSI Z21.22.

2.3 THERMAL EXPANSION TANKS

A. Thermal Expansion Tanks: Provide size and number as indicated; construct of welded carbon steel listed for 150 psig working pressure, 200 deg F maximum operating temperature. Separate air charge from system water to maintain design expansion capacity, by means of a FDA approved butyl rubber diaphragm securely sealed into tank. Provide taps for pressure gauge and air charging fitting, and drain fitting. Support vertical tanks with steel legs or base.

2.4 VACUUM RELIEF VALVES

A. Lead free brass body meeting ANSI Z21.22 with silicon disc. Valve shall open at 0.5 inches HG vacuum and be rated for 200 psig working pressure and 250 F operating temperature.

2.5 WATER HEATER DRAIN PANS

A. Galvanized steel or aluminum with outside diameter minimum 2" greater than water heater diameter, with 3/4" screwed drain outlet.

PART 3 - EXECUTION

3.1 WATER HEATER INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. General: Set and connect units in accordance with manufacturer's written instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances. Orient so controls and devices needing servicing are accessible.

C. Install thermometers on water heater outlet piping. Thermometers and their installation requirements, are specified in Division 22 Section "Meters and Gauges for Plumbing Piping."

D. Vacuum Relief Valve: Install in cold water supply to each water heater downstream of the shutoff and check valves.

E. Water Heater Drain Pan: Install under water heater on wall or ceiling supports or resting on elevated floor slabs. Install drain pan drain line to discharge to an approved receptor with air gap.

3.2 EXPANSION TANK INSTALLATION

A. Install in-line expansion tanks in the vertical position. Install in-line expansion tank in the horizontal position when allowed by manufacturer and provided with required supports.

B. Install stand mounted expansion tanks on concrete equipment bases.

C. Charge expansion tank bladder with air to a pressure equal to the domestic water static pressure.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Sections of Division 22. The Drawings indicate general arrangement of piping, fittings, and specialties. The following are specific connection requirements:

1. Install piping adjacent to equipment arranged to allow servicing and maintenance.

2. Connect hot and cold water piping to units with shutoff valves and unions. Connect hot water circulating piping to unit with shutoff valve, check valve, and union. Extend relief valve discharge to closest floor drain.

a. Where water heater piping connections are dissimilar metals, install dielectric waterway fittings or dielectric unions for joints 2" and smaller and install dielectric flanges for joints 2-1/2" and larger. Dielectric waterway fittings, unions and flanges are specified in Division 22 Section "Basic Piping Materials and Methods."

b. Install vacuum relief valve in cold water inlet piping.

3. Install drain as indirect waste to spill into open drain or over floor drain.

a. Install drain valve at low point in water piping, for water heaters not having tank drain.

4. Install heat traps at inlet and outlet of each water heater storage tank. Heat trap shall be made of elbows and piping. Heat trap shall turn down to 12" below the outlet or inlet, run 12" horizontal and turn up to the cold water to the heater or hot water from the heater. Where multiple tanks are connected with a manifold, a single heat trap may be provided at the connection of the cold water supply to the cold water manifold together.

B. Electrical Connections:

1. Power wiring is specified in Division 26 Section "Common Work Results for Electrical"

2. Field-installed disconnects are specified in Division 26 Sections "Enclosed Switches and Circuit Breakers".

3. Grounding: Connect unit components to ground in accordance with the National Electrical Code.

3.4 FIELD QUALITY CONTROL

A. General: Provide the services of a factory-authorized service representative to test and inspect unit installation, provide start-up service, and demonstrate operation of equipment as specified below.

1. Test and adjust operating and safety controls. Replace damaged and malfunctioning controls and equipment.

3.5 STARTUP

A. Perform the following before start-up final checks:

1. Fill water heaters with water.

2. Piping systems test complete.

3. Check for piping connections leaks.

4. Test operation of safety controls and devices.

B. Perform the following start-up procedures:

1. Energize circuits.

2. Adjust operating controls.

3. Adjust hot water outlet temperature setting.

3.6 TRAINING

A. General: At a time mutually agreed upon between the Owner and Contractor, provide the services of a factory trained and authorized representative to train Owner's designated personnel for a minimum of two hours on the operation and maintenance of the equipment provided under this section.

B. Content: Training shall include but not be limited to:

1. Overview of the system and/or equipment as it relates to the facility as a whole.

2. Operation and maintenance procedures and schedules related to startup and shutdown, troubleshooting, servicing, preventive maintenance and appropriate operator intervention.

3. Review data included in the operation and maintenance manuals. Refer to Division 1 Section "Operating and Maintenance Data."

C. Certification: Contractor shall submit to the Engineer a certification letter stating that the Owner's designated representative has been trained as specified herein. Letter shall include date, time, attendees and subject of training. The certification letter shall be signed by the Contractor and the Owner's representative indicating agreement that the training has been provided.

D. Schedule: Schedule training with Owner with at least 7 days' advance notice.

END OF SECTION 223300

SECTION 223400 - FUEL FIRED DOMESTIC WATER HEATERS

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section includes commercial gas fired water heaters.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 3 Section "Concrete Work" for specifications on concrete and reinforcing materials and concrete placing requirements for equipment pads.

2. Division 22 Section "Common Work Results for Plumbing" for concrete equipment pads.

3. Division 22 Section "Basic Piping Materials and Methods" for flexible metal braid connectors, pipe joining materials, specialties, unions, dielectric unions, dielectric flanges, dielectric flange kits and basic installation requirements.

4. Division 22 Section "Meters and Gauges for Plumbing Piping." for thermometers and their installation requirements.

5. Division 22 Section "Natural Gas Piping" for natural gas equipment connections.

6. Division 26 Section "Common Work Results for Electrical" required electrical devices.

7. Division 26 Sections "Enclosed Switches and Circuit Breakers" for field-installed disconnects.

1.2 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

1. Product data including rated capacities of selected models, weights (shipping, installed, and operating), furnished specialties, and accessories, and indicating dimensions, required clearances, and methods of assembly of components, and piping and wiring connections.

2. Wiring diagrams from manufacturers detailing electrical requirements for electrical power supply wiring to water heaters. Include ladder-type wiring diagrams for interlock and control wiring required for final installation of water heaters and controls. Differentiate between portions of wiring that are factory installed and portions that are to be field installed.

3. Certificates of shop inspection and data report as required by provisions of the ASME Boiler and Pressure Vessel Code.

4. Maintenance data for inclusion in Operating and Maintenance Manual specified in Division 1 and Division 22 Section "General Plumbing Requirements."

1.3 QUALITY ASSURANCE

A. UL Standards: Provide water heaters complying with the following:

1. UL 778, "Motor Operated Water Pumps."

B. NSF Standards: Provide water heaters complying with NSF No. 5, "Standard for Hot Water Generating Equipment for Food Service Establishments using Spray Type Dishwashing Machines," and bearing NSF label.

C. Electrical Component Standard: Provide components complying with NFPA 70 "National Electrical Code."

D. Listing and Labeling: Provide water heaters that are listed and labeled.

1. The terms "listed" and "labeled" shall be as defined in the National Electrical Code, Article 100.

E. AGA Standards: Provide water heaters that bear the label of the American Gas Association.

F. ASME Code Compliance: Provide water heaters and safety relief valves that comply with ASME Boiler and Pressure Vessel Code and that bear the appropriate code symbols.

G. State Boiler Code Compliance: Provide rated water heaters, safety relief valve, gas train and accessories that comply with the state boiler code in effect.

H. ASHRAE Standards: Provide water heaters with performance efficiencies not less than prescribed in ASHRAE 90.1b, "Energy Conservation in New Building Design."

I. Design Concept: The drawings indicate types and capacities of water heaters and are based on specific descriptions and manufacturers indicated. Water heaters having equal performance characteristics by other manufacturers may be considered provided that deviations in capacities, dimensions, operation, or other characteristics are minor and do not change the design concept or intended performance as judged by the Architect. Burden of proof for equality of water heaters is on the proposer.

1.4 WARRANTY

A. Special Project Warranty: Submit a written warranty, executed by manufacturer, agreeing to repair or replace water heater units that fail in materials or workmanship within the specified warranty period. Failures include, but are not limited to, controls, tanks, coils, heat exchangers, and burners. This warranty shall be in addition to, and not a limitation of, other rights the Owner may have against the Contractor under the Contract Documents.

1. Commercial, Gas Fired, Storage Water Heaters:

a. Storage Tank: Three years.

b. Controls and Other Components: One year.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

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

1. Commercial Atmospheric Gas-Fired Water Heaters:

a. Bradford-White Corp.

b. Lochinvar Water Heater Corp.

c.

d. Rheem Mfg.

e. Teledyne Laars

f. Ruud Mfg. Div.; Rheem Mfg.A.O. Smith Water Products Co. Div.; A.O. Smith Corp.

g. State Industries, Inc.

2. Thermal Expansion Tanks

a. Armstrong Pumps, Inc.

b. Amtrol, Inc.

c. Bell & Gosset, ITT

d. Elbi

e. TACO, Inc.

a. Watts

b. Wessels Tank Co.

3. Vacuum Relief Valves

a. Apollo #37

b. Cash ACME #VR-801

c. Watts #N36

d. Wilkins #VR-10

2.2 ATMOSPHERIC GAS-FIRED WATER HEATERS

A. Description: Automatic, commercial, gas-fired; with vertical, 150-psig-rated storage tank, gas burner, integral controls, draft diverter, drain valve, gas regulator, and relief valve.

1. Fuel: Natural gas.

B. Insulation: Fiberglass, surrounding tank.

C. Jacket: Steel, with baked-on enamel finish.

D. Tank: Glass-lined steel, with anode rods and drain valve.

E. Safety Controls: Automatic gas shutoff device to shut off entire gas supply in event of excessive temperature in tank.

F. Controls: Adjustable surface mounted thermostat, intermittent electronic ignition and flue damper control.

G. Temperature and Pressure Relief Valve: Lead free brass body meeting ANSI Z21.22.

2.3 THERMAL EXPANSION TANKS

A. Thermal Expansion Tanks: Provide size and number as indicated; construct of welded carbon steel listed for 150 psig working pressure, 200 deg F maximum operating temperature. Separate air charge from system water to maintain design expansion capacity, by means of a FDA approved butyl rubber diaphragm securely sealed into tank. Provide taps for pressure gauge and air charging fitting, and drain fitting. Support vertical tanks with steel legs or base.

2.4 VACUUM RELIEF VALVES

A. Lead free brass body meeting ANSI Z21.22 with silicon disc. Valve shall open at 0.5 inches HG vacuum and be rated for 200 psig working pressure and 250 F operating temperature.

PART 3 - EXECUTION

3.1 WATER HEATER INSTALLATION

A. Install in accordance with manufacturer's installation instructions.

B. General: Install water heaters on concrete equipment bases. Set and connect units in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances. Orient so controls and devices needing servicing are accessible.

C. Install thermometers on water heater inlet and outlet piping. Thermometers are specified in Division 22 Section "Meters and Gauges for Plumbing Piping."

D. NFPA Compliance: Install gas-fired water heaters in compliance with NFPA 54, "National Fuel Gas Code."

E. Vacuum Relief Valve: Install in cold water supply to each water heater downstream of the shutoff and check valves.

F. Install condensate neutralization kit furnished with water heater condensate drain downstream of trap at condensate connection. Fill kit with water heater manufacturer recommended neutralization media.

3.2 CONCRETE EQUIPMENT BASES

A. Construct concrete equipment bases in accordance with Section "Basic Mechanical Materials and Methods" for setting of equipment.

3.3 EXPANSION TANK INSTALLATION

A. Install in-line expansion tanks in the vertical or horizontal position (where allowed by manufacturer). Where tanks are installed in horizontal position, provide supports per manufacturer requirements.

B. Install stand mounted expansion tanks on concrete equipment bases.

C. Charge expansion tank bladder with air to a pressure equal to the domestic water static pressure.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Sections of Division 22. The Drawings indicate general arrangement of piping, fittings, and specialties. The following are specific connection requirements:

1. Install piping adjacent to equipment arranged to allow servicing and maintenance.

2. Connect hot and cold water piping to units with shutoff valves and unions. Connect hot water circulating piping to unit with shutoff valve, check valve, and union. Extend relief valve discharge to closest floor drain.

    a. Where water heater piping connections are dissimilar metals, install dielectric waterway fittings or dielectric unions for joints 2" and smaller and dielectric flanges for joints 2-1/2" and larger. Dielectric waterway fittings, unions and flanges are specified in Division 22 Section "Basic Piping Materials and Methods."

    b. Install vacuum relief valve in cold water inlet piping.

3. Connect gas supply piping to burner with drip leg, tee, gas cock, and union; minimum size same as inlet connection. Arrange piping to allow unit servicing. Gas piping is specified in Division 22 Section "Natural Gas Piping".

    a. Install vent piping from gas train pressure regulators and valves to outside the building. Terminate vent piping with brass screened vent cap fitting. Do not combine vents except with approval of local authority.

b. Install gas pressure regulators where indicated.

4. Install drain as indirect waste to spill into open drain or over floor drain.

a. Install drain valve at low point in water piping, for water heaters not having tank drain.

5. Install heat traps at inlet and outlet of each water heater storage tank. Heat trap shall be made of elbows and piping. Heat trap shall turn down to 12" below the outlet or inlet, run 12" horizontal and turn up to the cold water to the heater or hot water from the heater. Where multiple tanks are connected with a manifold, a single heat trap may be provided at the connection of the cold water supply to the cold water manifold together.

B. Electrical Connections:

1. Power wiring is specified in Division 26 Section "Common Work Results for Electrical"

2. Field-installed disconnects are specified in Division 26 Sections "Enclosed Switches and Circuit Breakers".

3. Grounding: Connect unit components to ground in accordance with the National Electrical Code.

C. Vent Connections: Connect gas-fired water heater draft hood to the vent system. Unless otherwise indicated provide vent same size as outlet on heater. Comply with gas utility requirements.

1. Vents are specified in Division 23 Section "Breechings, Chimneys, and Stacks."

3.5 FIELD QUALITY CONTROL

A. General: Provide the services of a factory-authorized service representative to test and inspect unit installation, provide start-up service, and demonstrate operation of equipment as specified below.

1. Test and adjust operating and safety controls. Replace damaged and malfunctioning controls and equipment.

3.6 STARTUP

A. Perform the following before start-up final checks:

1. Fill water heaters with water.

2. Piping systems test complete.

3. Check for piping connections leaks.

4. Check for adequate combustion air.

5. Check for clear vent.

6. Test operation of safety controls and devices.

B. Perform the following start-up procedures:

1. Energize circuits.

2. Adjust operating controls.

3. Adjust hot water outlet temperature setting.

3.7 TRAINING

A. General: At a time mutually agreed upon between the Owner and Contractor, provide the services of a factory trained and authorized representative to train Owner's designated personnel for a minimum of two hours on the operation and maintenance of the equipment provided under this section.

B. Content: Training shall include but not be limited to:

1. Overview of the system and/or equipment as it relates to the facility as a whole.

2. Operation and maintenance procedures and schedules related to startup and shutdown, troubleshooting, servicing, preventive maintenance and appropriate operator intervention.

3. Review data included in the operation and maintenance manuals. Refer to Division 1 Section "Operating and Maintenance Data."

C. Certification: Contractor shall submit to the Engineer a certification letter stating that the Owner's designated representative has been trained as specified herein. Letter shall include date, time, attendees and subject of training. The certification letter shall be signed by the Contractor and the Owner's representative indicating agreement that the training has been provided.

D. Schedule: Schedule training with Owner with at least 7 days' advance notice.

END OF SECTION 223400

SECTION 224000 - PLUMBING FIXTURES

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section includes plumbing fixtures and trim, fittings, and accessories, appliances, appurtenances, equipment, and supports associated with plumbing fixtures.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 7 Section "Joint Sealers," for materials and methods for sealing between plumbing fixtures and interior walls.

2. Division 22 Section "General Duty Valves for Plumbing Piping" for valves used as supply stops.

1.2 DEFINITIONS

A. Accessible: Describes a plumbing fixture, building, facility, or portion thereof that can be approached, entered, and used by physically handicapped people.

Examples of accessory below are toilet seats, grab bars, and soap dishes.

B. Accessory: Device that adds effectiveness, convenience, or improved appearance to a fixture but is not essential to its operation.

C. Appliance: Device or machine designed and intended to perform a specific function.

D. Appurtenance: Device or assembly designed to perform some useful function when attached to or used with a fixture.

E. Equipment: Device used with plumbing fixtures or plumbing systems to perform a certain function for plumbing fixtures but that is not part of the fixture.

F. Fitting: Fitting installed on or attached to a fixture to control the flow of water into or out of the fixture.

G. Fixture: Installed receptor connected to the water distribution system, that receives and makes available potable water and discharges the used liquid or liquid-borne wastes directly or indirectly into the drainage system. The term "Fixture" means the actual receptor, except when used in a general application where terms "Fixture" and "Plumbing Fixture" include associated trim, fittings, accessories, appliances, appurtenances, support, and equipment.

H. Roughing-In: Installation of piping and support for the fixture prior to the actual installation of the fixture.

I. Support: Device normally concealed in building construction, for supporting and securing plumbing fixtures to walls and structural members. Supports for urinals, lavatories, and sinks are made in types suitable for fixture construction and the mounting required. Categories of supports are:

1. Carrier: Floor-mounted support for wall-mounted water closet, and support fixed to wall construction for wall-hung fixture.

2. Chair Carrier: Support for wall-hung fixture, having steel pipe uprights that transfer weight to the floor.

3. Chair Carrier, Heavy Duty: Support for wall-hung fixture, having rectangular steel uprights that transfer weight to the floor.

4. Reinforcement: Wood blocking or steel plate built into wall construction, for securing fixture to wall.

J. Trim: Hardware and miscellaneous parts, specific to a fixture and normally supplied with it required to complete fixture assembly and installation.

K. Lead Free: Refers to the wetted surface of pipe, fittings and fixtures in potable water systems that have a weighted average lead content ≤0.25% per Safe Drinking Water Act as amended January 4th 2011 Section 1417.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

1. Product data for each type of plumbing fixture specified, including fixture and trim, fittings, accessories, appliances, appurtenances, equipment, supports, construction details, dimensions of components, and finishes.

2. Wiring diagrams for field-installed wiring of electrically operated units.

3. Maintenance data for inclusion in Operating and Maintenance Manual specified in Division 1 and Division 22 Section "General Plumbing Requirements."

B. Submit third party certification that faucets and trim for domestic water distribution for drinking or cooking comply with NSF 61 Annex G and / or NSF 372. The following faucets and trim need not comply:

1. Electronic faucets

2. Service sink faucets

3. Flush valves

4. Shower valves and heads

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with requirements of ANSI Standard A117.1, "Buildings and Facilities -- Providing Accessibility and Usability for Physically Handicapped People," Public Law 90-480, "Architectural Barriers Act, 1968," with respect to plumbing fixtures for the physically handicapped and "Americans with Disabilities Act Accessibility Guidelines for Buildings 1991" with respect to plumbing fixtures for the physically handicapped.

B. Listing and Labeling: Provide electrically operated fixtures specified in this Section that are listed and labeled.

1. The terms "listed" and "labeled" shall be as defined in the National Electrical Code, Article 100.

C. Comply with NSF 61 Annex G and / or NSF 372 for wetted surfaces of faucets and trim containing no more than 0.25% lead by weight for domestic water distribution for drinking or cooking.

D. Design Concept: The drawings indicate types of plumbing fixtures and are based on the specific descriptions, manufacturers, models, and numbers indicated. Plumbing fixtures having equal performance characteristics by other manufacturers may be considered provided that deviations in dimensions, operation, color or finish, or other characteristics are minor and do not change the design concept or intended performance as judged by the Architect. Burden of proof for equality of plumbing fixtures is on the proposer.

1.5 SPARE PARTS

A. Deliver spare parts to Owner. Furnish spare parts described below matching products installed, packaged with protective covering for storage, and identified with labels clearly describing contents.

B. Faucet Washers and O-rings: Furnish quantity of identical units not less than 10 percent of amount of each installed.

C. Faucet Cartridges and O-rings: Furnish quantity of identical units not less than 5 percent of amount of each installed.

D. Flushometer Repair Kits: Furnish quantity of identical units not less than 10 percent of amount of each flushometer installed.

E. Provide individual metal boxes or a hinged-top wood or metal box having separate compartments for each type and size of above extra materials.

F. Water Closet Tank Repair Kits: Furnish quantity of identical flush valve units not less than 5 percent of amount of each type installed.

G. Toilet Seats: Furnish quantity of identical units not less than 5 percent of amount of each type toilet seat installed.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products in each category, by one of the following listed for that category:

1. Water Closets:

a. American Standard, Inc.

b. Crane Eljer; A Household International Co.

c. Kohler Co.

d. TOTO KIKI USA, Inc.

e. Universal-Rundle Corp.

2. Urinals:

a. American Standard, Inc.

b. Crane

c. Eljer; A Household International Co.

d. Kohler Co.

e. TOTO KIKI USA, Inc.

f. Universal-Rundle Corp.

3. Lavatories:

a. American Standard, Inc.

b. Crane

c. Eljer; A Household International Co.

d. Kohler Co.

e. Universal-Rundle Corp.

f. TOTO KIKI USA, Inc.

4. Sinks:

a. Elkay Manufacturing Co.

b. Just Manufacturing Co.

5. Service Sinks:

a. American Standard, Inc.

b. Kohler Co.

6. Mop Basins:

a. Fiat Products.

b. Florestone Products Co., Inc.

c. Josam

d. JF Smith

e. Stern-Williams Co., Inc.

f. Wade

g. Zurn

Drinking Fountains:

a. Elkay Manufacturing Co.

b. Halsey Taylor; A Household International Co.

c. Haws Drinking Faucet Co.

d. Most Dependable

e. Oasis

8. Water Coolers:

a. Elkay Manufacturing Co.

b. Halsey Taylor; A Household International Co.

c. Haws Drinking Faucet Co.

d. Most Dependable

e. Oasis

9. Wash Fountains:

a. Bradley Corp.

10. Outlet Boxes:

a. Guy Gray Manufacturing Co., Inc.

b. Symmons Industries, Inc.

c. Oatey Co.

11. Emergency Equipment:

a. Guardian Equipment.

12. Toilet Seats:

a. Bemis Mfg. Co.

b. Beneke Div.; Sanderson Plumbing Products, Inc.

c. Forbes-Wright Industries, Inc.: Church Products

d. Church Seat Co.

e. Olsonite Corp.

13. Flushometers – Piston Type:

a. Sloan Valve Co.

b. Toto Kikki, USA

c. Zurn Industries, Inc.; Flush Valve Operations.

14. Commercial/Industrial Cast-Brass Faucets:

a. American Standard, Inc.

b. Bradley

c. Chicago Faucet Co.

d. Delta-Commercial

e. Kohler Co.

f. Lawler

g. Sloan

h. Speakman Co.

i. Symmons

j. T & S Brass and Bronze Works, Inc.

15. Thermostatic Mixing Valve Bath/Shower Faucets:

a. Lawler Manufacturing Co., Inc.

b. Leonard Valve Co.

PROFLO is made by Grohe	Powers Process Controls; A Unit of Mark Controls Corp.

d. Speakman

e. Watts

16. Sensor-Operated Faucets and Devices:

a. American Standard

b. Bradley Corp.

c. Chicago

d. Delta

e. Kohler

f. Lawler

g. Sloan Valve Co.

h. Speakman Co.

i. Symmons

j. T&S Brass

17. Stop Valves & Supplies:

a. Brass Craft Subsidiary; Masco Co.

b. Engineered Brass Company

c. McGuire Manufacturing Co., Inc.

d. PROFLO

e. Watts Brass and Tubular

f. Zurn Industries

18. P-traps, Drains & Miscellaneous Fittings:

a. Brass Craft Subsidiary; Masco Co.

b. Dearborn Brass

c. Engineered Brass Company

d. McGuire Manufacturing Co., Inc.

e. PROFLO

f. Watts Brass and Tubular

g. Zurn Industries

19. Supports:

a. Josam Co.

b. Smith (Jay R.) Mfg. Co.

c. Wade Div.; Tyler Pipe.

d. Watts Drainage Products

e. Zurn Industries, Inc.; Hydromechanics Div.

f. Mifab Manufacturing, Inc.

20. Disposers:

a. General Electric Co.

b. Hotpoint; General Electric Co.

c. In-Sink-Erator Div.; Emerson Electric Co.

d. KitchenAid, Inc.

e. Thermador/Waste King; A Masco Co.

21. Insulation Kits

a. Brocar

b. McGuire

c. Plumberex

d. PROFLO

e. Trap-Wrap

f. Truebro, Inc.

2.2 PLUMBING FIXTURES, GENERAL

A. Provide plumbing fixtures and trim, fittings, other components, and supports as specified on the drawings and below:

2.3 FAUCETS

A. Faucets General: As described on the drawings.

1. Electronic faucets shall be of the same manufacturer as the water closet and urinal flush valves. All electronically controlled faucets shall be installed with check valves to prevent water mixing temperature crossover (hot-cold).

2.4 STOP VALVES & SUPPLIES

A. Supplies General: As described on the drawings.

1. Exposed piping and parts shall be polished chrome plated.

2.5 P-TRAPS, DRAINS AND MISCELLLANEOUS FITTINGS:

A. Fittings General: As described on the drawings, except as listed below.

1. Exposed piping and fittings shall be polished chrome plated.

2. Fittings installed concealed inside a plumbing fixture or within wall construction may be without chrome plate finish.

3. Fitting and faucet bodies for domestic water distribution shall be of lead free brass or lead free cast bronze.

B. Sink Continuous Wastes: Polished chrome-plated, tubular brass, 1-1/2 inches, 17 gauge, with brass nuts on slip inlets, and of configurations indicated.

C. Scullery sink Continuous Wastes: Polished chrome-plated, tubular brass, 2 inches, 17 gauge, with brass nuts on slip inlets, and of configurations indicated.

D. Escutcheons: Wall flange with set screw.

E. Deep Pattern Escutcheons: Wall flange with set screw or sheet steel wall flange with friction clips, of depth adequate to conceal protruding roughing-in fittings.

2.6 FLUSHOMETERS

A. Provide flushometers compatible with fixtures, with features and of consumption indicated As described on the drawings.

1. Exposed metal parts shall be polished chrome plated.

2. Flush valves installed within wall construction may be without chrome plate finish.

2.7 TOILET SEATS

A. General: As described on the drawings.

2.8 DISPOSERS

A. Disposers: As specified on the drawings.

2.9 PLUMBING FIXTURE SUPPORTS

A. Supports: ASME A112.6.1M, categories and types as required for wall-hanging fixtures specified, and wall reinforcement.

B. Support categories are:

1. Carriers: Supports for wall-hanging water closets and fixtures supported from wall construction. Water closet carriers shall have an additional faceplate and coupling when used for wide pipe spaces. Provide tiling frame or setting gauge with carriers for wall-hanging water closets.

2. Chair Carriers: Supports with steel pipe uprights for wall-hanging fixtures. Urinal chair carriers shall have bearing plates.

3. Chair Carriers, Heavy Duty: Supports with rectangular steel uprights for wall-hanging fixtures.

4. Reinforcement: 2-inch by 4-inch wood blocking between studs or 1/4-inch by 6-inch steel plates attached to studs, in wall construction, to secure floor-mounted and special fixtures to wall.

C. Support Types: Provide support of category specified, of type having features required to match fixture.

D. Provide supports specified as part of fixture description, in lieu of category and type requirements above.

2.10 INSULATION KITS

A. Insulation kits for lavatory and sink waste and supplies of vinyl plastic with reusable fasteners and openings for access to supply stop handles.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install fixtures, trim and supports in accordance with manufacturer's installation instructions.

3.2 APPLICATION

A. Install plumbing fixtures and specified components, in accordance with designations and locations indicated on Drawings.

B. Install supports for plumbing fixtures in accordance with categories indicated, and of type required:

1. Carriers for following fixtures:

a. Wall-hanging water closets.

b. Wall hanging lavatories

c. Wall hanging electric water coolers and drinking fountains.

d. Wall-hanging fixtures supported from wall construction.

2. Chair carriers for the following fixtures:

a. Wall-hanging lavatories and sinks.

b. Wall-hanging drinking fountains and electric water coolers.

3. Heavy-duty chair carriers for the following fixtures:

a. Accessible lavatories.

b. Fixtures where specified.

4. Reinforcement for the following fixtures:

   a. Floor-mounted lavatories required to be secured to wall.

   b. Floor-mounted sinks required to be secured to wall.

   c. Recessed, box-mounted electric water coolers.

   d. Wall mounted and mop sink faucets.

3.3 INSTALLATION OF PLUMBING FIXTURES

A. Install plumbing fixtures level and plumb, in accordance with fixture manufacturers' written installation instructions, roughing-in drawings, and referenced standards.

B. Install wall-hanging, back-outlet water closets with support manufacturer's tiling frame or setting gauge.

C. Fasten wall-hanging plumbing fixtures securely to supports attached to building substrate when supports are specified, and to building wall construction where no support is indicated.

D. Fasten floor-mounted fixtures and special fixtures having holes for securing fixture to wall construction, to reinforcement built into walls.

E. Fasten wall-mounted fittings to reinforcement built into walls.

F. Fasten counter-mounting-type plumbing fixtures to casework.

G. Secure supplies behind wall or within wall pipe space, providing rigid installation.

H. Set and mop basins in leveling bed of cement grout.

I. Install stop valve in an accessible location in each water supply to each fixture.

J. Install trap on fixture outlet except for fixtures having integral trap.

K. Install escutcheons at each wall, floor, and ceiling penetration in exposed finished locations and within cabinets and millwork. Use deep pattern escutcheons where required to conceal protruding pipe fittings.

L. Seal fixtures to walls, floors, and counters using a sanitary-type, one-part, mildew-resistant, silicone sealant in accordance with sealing requirements specified in Division 7 Section "Joint Sealers." Match sealant color to fixture color.

M. Install insulation kits on ADA compliant sink and lavatory waste, continuous wastes, hot and cold water supplies where indicated on the drawings and as required by the ADA.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other sections of Division 22. The Drawings indicate general arrangement of piping, fittings, and specialties. The following are specific connection requirements:

1. Install piping connections between plumbing fixtures and piping systems and plumbing equipment specified in other sections of Division 22.

2. Install piping connections indicated between appliances and equipment specified in other sections, direct connected to plumbing piping systems.

3.5 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Test fixtures to demonstrate proper operation upon completion of installation and after units are water pressurized. Replace malfunctioning fixtures and components, then retest. Repeat procedure until all units operate properly.

3.6 ADJUSTING AND CLEANING

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

B. Operate and adjust disposers, hot water dispensers, and controls. Replace damaged and malfunctioning units and controls.

C. Adjust water pressure at drinking fountains, electric water coolers, and faucets, shower valves, and flushometers having controls, to provide proper flow and stream.

D. Replace washers of leaking and dripping faucets and stops.

E. Clean fixtures, fittings, and spout and drain strainers with manufacturers' recommended cleaning methods and materials.

F. Adjust faucet wrist blade handles perpendicular to the spout while in the closed position.

G. Review the data in Operating and Maintenance Manuals. Refer to Division 1 Section "Project Closeout."

H. Set each shower valve temperature limit stop to 110ºF. Perform work after the shower head is installed and the domestic water heater is in operation. Allow the hot water to run for 5 minutes minimum or until temperature reaches equilibrium. Allow cold to run for 5 minutes minimum or until temperature reaches equilibrium. Provide the architect a report and schedule indicating the hot, cold and mixed maximum water temperature at each shower.

3.7 FIXTURE SCHEDULE

A. Provide plumbing fixtures as specified on the drawings.

B. Install rough-in for plumbing fixtures as scheduled on the drawings.

3.8 MOUNTING HEIGHTS SCHEDULE:

A. Refer to the architectural drawings for plumbing fixture mounting heights. Unless indicated otherwise, install plumbing fixtures with the mounting heights as listed below with final approval by the Architect:

FIXTURE	MOUNTING HEIGHT
Lavatory or Sink	
Standard Height	31" floor to rim
ADA Accessible	34" floor to rim
Child Height	24" floor to rim
Urinal	
Standard Height	24" floor to rim
ADA Accessible	17" floor to rim
Child Height	14" floor to rim
Water Closet	
Standard	15" floor to rim
ADA Accessible	17" to 19" floor to top of seat
Child Height	10" floor to rim
Water Cooler or Drinking Fountain	
Standard Height	41" floor to spout
ADA Accessible	36" floor to spout
Child height	30" floor to spout
Shower Valves	
Standard Height	48" men and 42" women floor to centerline
ADA Accessible	38" minimum to 48" maximum floor to centerline
Shower heads	
Standard Height	6'-6" men, 6'-0" women floor to centerline
Ice Maker Outlet Boxes	24" floor to center of box
Washing Machine Outlet Boxes	42" floor to rim
Janitor's Sink Faucet Fittings	42" floor to centerline
Hose Bibbs	36" AFF to centerline

Non Freeze Wall Hydrant	18" AFG to centerline

END OF SECTION 224000

SECTION 227000 - NATURAL GAS SYSTEMS

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section includes distribution piping systems for natural gas, liquid petroleum-gas and manufactured gas within the building and extending from the point of delivery to the connections with gas utilization devices. Piping materials and equipment specified in this Section include:

1. Pipes, fittings, and specialties.

2. Special duty valves.

3. Pressure regulators.

4. Service meters.

B. Contractors Option:

1. The Division 22 contractor may provide mechanically joined joints for natural gas systems to connect couplings, fittings, valves and related components as an option in lieu of, in whole or in part, welded, threaded or flanged piping methods. Mechanically joined natural gas systems where used shall be provided in compliance with specification Section 227011 "Mechanically Joined Natural Gas Systems".

C. This Section does not apply to liquid petroleum piping; industrial gas applications using such gases as acetylene and acetylenic compounds, hydrogen, ammonia, carbon monoxide, oxygen and nitrogen; gas piping, meters, gas pressure regulators and other appurtenances used by the serving gas supplier in distribution of gas.

D. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 22 Section "General plumbing Requirements," for trenching, excavation, backfill and compaction materials and methods for underground piping installations.

2. Division 7 Section "Joint Sealers," for materials and methods for sealing pipe penetrations through basement and foundation walls.

3. Division 9 Section "Painting," for materials and methods for painting pipe.

4. Division 12 Section "Laboratory Casework and Fixtures," for laboratory trim installed in the casework.

5. Division 22 Section "Common Work Results for Plumbing," for materials and methods for fire barrier penetrations and wall and floor penetrations.

6. Division 22 Section "Basic Piping Material and Methods," for materials and methods for strainers, unions, dielectric flanges and mechanical sleeve seals.

7. Division 22 Section "Hangers and Supports for Plumbing Piping," for materials and methods for hanging and supporting gas distribution piping.

8. Division 26 Section "Common Work Results for Electrical" required electrical devices.

E. Gas pressures for systems specified in this Section are limited to 5 psig.

F. Products furnished under this Section include gas meters and gas service piping, which will be provided by the utility company to the site. The following is the name and address of the utility company:
Company: Spire
Telephone number: (800) 582-1234

1.2 DEFINITIONS

A. Pipe sizes used in this Specification are Nominal Pipe Size (NPS).

B. Gas Distribution Piping: A pipe within the building which conveys gas from the point of delivery to the points of usage.

C. Gas Service Piping: The pipe from the gas main or other source of supply including the meter, regulating valve, or service valve to the gas distribution system of the building served.

D. Point of Delivery: The outlet of the service meter assembly, or the outlet of the service regulator (service shutoff valve when no meter is provided).

1.3 SUBMITTALS

A. Product data for each gas piping specialty and special duty valves. Include rated capacities of selected models, furnished specialties and accessories, and installation instructions.

B. Shop drawings detailing dimensions, required clearances, for connections to gas meter.

C. Coordination drawings for gas distribution piping systems in accordance with Division 22 Section "General Plumbing Requirements."

D. Maintenance data for gas specialties and special duty valves, for inclusion in operating and maintenance manual specified in Division 1 and Division 22 Section "General Plumbing Requirements."

E. Welders' qualification certificates, certifying that welders comply with the quality requirements specified under "Quality Assurance" below.

F. Test reports specified in Part 3 below.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Installation and replacement of gas piping, gas utilization equipment or accessories, and repair and servicing of equipment shall be performed only by a qualified installer. The term qualified is defined as experienced in such work (experienced shall mean having a minimum of 5 previous projects similar in size and scope to this project), familiar with precautions required, and has

complied with the requirements of the authority having jurisdiction. Upon request, submit evidence of such qualifications to the Architect.

B. Qualifications for Welding Processes and Operators: Comply with the requirements of ASME Boiler and Pressure Vessel Code, "Welding and Brazing Qualification."

C. Regulatory Requirements: Comply with the requirements of the following codes:

1. NFPA 54 - National Fuel Gas Code, for gas piping materials and components, gas piping installation and inspections, testing, and purging of gas piping systems.

2. 2018 International Fuel Gas Code

D. Local Gas Utility Requirements: Comply with local gas utility installation rules and regulations.

E. Pipe, pipe fittings and pipe specialties shall be manufactured in plants located in the United States or certified to meet the specified ASTM and ANSI standards.

1.5 SPARE PARTS

A. Valve Wrenches: Furnish to Owner, with receipt, 2 valve wrenches for each type of gas valve installed, requiring same.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide gas piping system products from one of the following:

Gas Cocks – 2" and Smaller:

a. Homestead # 601

b. Milliken #200M

c. RM Energy Systems # D125

2. Gas Cocks – 2-1/2" and Larger:

a. Homestead # 602

b. Milliken #200MF

c. RM Energy Systems "Hercules" # D126

3. Laboratory Gas Cocks

a. Chicago Faucet Company

b. T & S Brass

c. Zurn

4. Gas Pressure Regulators

a. American Meter Company

b. Fisher

c. Itron

d. Sensus

e. Maxitrol

5. Polyethylene to Steel Pipe Transition Fittings:

a. Perfection Corporation

b. R.W. Lyall

c. Central Plastics

6. Insect Screens

a. Northtown Pipe Protection Products "BUGSCRN Series"

2.2 PIPE AND TUBING MATERIALS

A. General: Refer to Part 3, Article "PIPE APPLICATIONS" for identification of systems where the specified pipe and fitting materials listed below are used.

B. Steel Pipe: ASTM A 53, Grade B, Schedule 40, (Type E electric-resistance welded or Type S seamless, black steel pipe, beveled ends).

2.3 FITTINGS

A. Malleable-Iron Threaded Fittings: ANSI B16.3, Class 150, standard pattern, for threaded joints. Threads shall conform to ANSI B1.20.1.

B. Forged Steel Flanges and Flanged Fittings: ASME B16.5, Class 150, butt weld ends, standard pattern with bolts, nuts and gaskets of material group 1.1.

C. Transition Fittings – Steel to Polyethylene: Factory assembled and pressure tested one piece design, with steel half of Schedule 40 steel pipe with beveled edge for welding and polyethylene half shall be of ample length for making welds. Steel pipe shall have epoxy protective coating.

2.4 JOINING MATERIALS

A. Joint Compound: Suitable for the gas being handled.

B. Gasket Material: Thickness, material, and type suitable for gas to be handled, and for design temperatures and pressures.

2.5 PIPING SPECIALTIES

A. Protective Coating: When piping will be in contact with material or atmosphere exerting a corrosive action, pipe and fittings shall be factory-coated with polyethylene tape, having the following properties:

1. overall thickness; 20 mils;

2. synthetic adhesive;

3. water vapor transmission rate, gallons per 100 square inch: 0.10 or less.

4. water absorption, percent: 0.02 or less.

B. Prime pipe and fittings with a compatible primer prior to application of tape.

C. Strike Plates: 16 gauge carbon steel, tested and listed by CSA International.

2.6 VALVES

A. Gas Cocks 2 Inch and Smaller: 175 psi, lubricated plug type, ASTM A126 Grade B semi-steel body, brass or semi-steel plug with full area rectangular port, straightaway pattern, square head, threaded ends.

B. Gas Cocks 2-1/2 Inch and Larger: 175 psi, lubricated plug type, ASTM A126 Grade B semi-steel body and plug with full area rectangular port, straightaway pattern, single gland, wrench operated, flanged ends.

Solenoid Valves: Aluminum body, 120 volts AC, 60 Hz, Class B continuous duty molded coil, NEMA 4 coil enclosure; electrically opened/normally closed with visual indication to indicate whether valve is open or closed; UL listed and labeled, FM approved for natural gas service.As specified on the drawings.

D. Gas Line Pressure Regulators: Single stage, steel jacketed, corrosion-resistant gas pressure regulators; with atmospheric vent, elevation compensator; internal relief vent, vent limiter for indoor installation, with threaded ends for 2 inch and smaller, flanged ends for 2-1/2 inch and larger; for inlet and outlet gas pressures, specific gravity, and volume flow as indicated on the drawings.

1. CSA listed for 2 PSI gas systems

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install pipe, fittings, valves and specialties in accordance with manufacturer's installation instructions.

3.2 PREPARATION

A. Precautions: Before turning off the gas to the premises, or section of piping, turn off all equipment valves. Perform a leakage test as specified in "FIELD QUALITY CONTROL" below, to determine that all equipment is turned off in the piping section to be affected.

B. Conform with the requirements in NFPA 54, for the prevention of accidental ignition.

3.3 PREPARATION FOUNDATION FOR UNDERGROUND GAS SERVICE PIPING

A. Pipe Beds for Pre-sleeved Vent Capable Semi-rigid Corrugated Stainless Steel Tubing, PE Pipe and PVC Pipe Conduit: Support pipe in trench with sand bags level and true to prevent sand, gravel or debris from interfering with the solvent cement or fusion process. After pressure testing is complete, gradually install bedding to maintain continuous pipe slope and prevent pipe deflection and then install subbase. Refer to Division 22 Section "General Plumbing Requirements" for bedding and subbase materials, excavation, trenching, backfill and compaction requirements and refer to ASTM D2321 "Underground Installation of Thermoplastic Pipe for Sewers and Gravity-flow Applications" for additional requirements.

3.4 PIPE APPLICATIONS

A. Install steel pipe with threaded joints and fittings for 2 inch and smaller, and with welded joints for 2-1/2 inch and larger.

3.5 PIPING INSTALLATION

A. General: Conform to the requirements of NFPA 54 - National Fuel Gas Code.

B. Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of piping systems. Design locations and arrangements of piping take into consideration pipe sizing, flow direction, slope of pipe, expansion, and other design considerations. So far as practical, install piping as indicated.

C. Concealed Locations: As specified below:

1. Inaccessible Above-Ceiling Locations: Install concealed gas piping in inaccessible above-ceiling spaces without valves or unions.

2. Accessible Above-Ceiling Locations: Gas piping may be installed in accessible above-ceiling spaces (subject to the approval of the authority having jurisdiction), whether or not such spaces are used as a plenum. Valves and unions shall not be located in such spaces used as a plenum.

3. In Floors: Install concealed gas piping in concrete floor slabs in an air-tight conduit constructed of Schedule 40 PVC with socket weld joints two pipe sizes larger than the gas pipe served. Extend conduit a minimum of 12" above finish floor and cap air tight at both ends. Vent conduit to the outside with a minimum 2" pipe and terminate with a screened vent cap.

4. Concrete or Masonry Walls: Do not install gas piping in masonry or concrete walls.

5. Prohibited Locations: Do not install gas piping in or through a circulating air duct, clothes chute, chimney or gas vent, ventilating duct, dumbwaiter or elevator shaft. This does not apply to accessible above-ceiling space specified above.

D. Fire Barrier Penetrations: Where pipes pass though fire-rated walls, partitions, ceilings, and floors, maintain the fire-rated integrity. Refer to Division 22 Section "Common Work Results for Plumbing" for special sealers and materials.

E. Elevated Floor Penetrations of Waterproof Membrane, Interior Penetrations of No-Fire Rated Walls and Concrete Slab on Grade Penetrations: Provide sleeves and seal pipes that pass through waterproof floors, non-fire rated walls, partitions and ceilings or concrete slab on grade. Refer to Division 22 Section "Basic Piping Materials and Methods" for special sealers and materials.

F. Underground Exterior Wall Penetrations: Seal pipe penetrations through underground exterior walls with sleeves and mechanical sleeve seals. Refer to Division 22 Section "Basic Piping Material and Methods" for additional information.

G. Dirt legs and Sediment Traps: Install a dirt leg at points where condensate and impurities may collect, at the outlet of the gas meter, as close to the inlet of each gas appliance or equipment as possible, and in a location readily accessible to permit cleaning and emptying.

1. Construct dirt legs and sediment traps using a tee fitting with the bottom outlet plugged or capped. Provide a 3" length of pipe and screwed cap for the dirt leg. Use line size pipe for dirt leg, refer to the drawings for sizes. Enter the tee with flow from the top and exit the tee from the side outlet. Install the dirt leg a minimum of 3-1/2" above the roof or floor readily accessible to permit cleaning and emptying.

2. Install line size gas cock, union and dirt leg at each equipment connection; refer to the drawings for sizes. Provide reducers at the equipment connection as required. Unions are specified in Division 22 section "Basic Piping Materials and Methods".

H. Use fittings for all changes in direction and all branch connections.

I. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.

J. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.

K. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.

L. Install horizontal piping as high as possible allowing for specified slope and coordination with other components. Install vertical piping tight to columns or walls. Allow sufficient space above removable ceiling panels to allow for panel removal.

M. Locate groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

N. Make reductions in pipe sizes using eccentric reducer fittings installed with the level side down.

O. Connect branch outlet pipes from the top or sides of horizontal lines, not from the bottom.

P. Install unions in pipes 2 inch and smaller, adjacent to each valve, and elsewhere as indicated. Unions are not required on flanged devices. Unions are specified in Section "Basic Piping Materials and Methods".

Q. Joints Containing Dissimilar Metals: Provide dielectric unions for 2" and smaller and dielectric flanges for piping 2-1/2" and larger. Dielectric unions and flanges are specified in Section "Basic Piping Materials and Methods".

R. Install flanges on valves, apparatus, and equipment having 2-1/2 inch and larger connections.

S. Anchor piping to ensure proper direction of expansion and contraction. Install expansion loops and joints as indicated on the Drawings and specified in Division 22 Section "Expansion Fittings and Loops for Plumbing Piping."

T. Paint Exposed Outdoor Gas Piping: Cleaning and painting of exposed outdoor gas piping is specified in Division 9 Section "Painting".

1. Final color per the architect.

U. Install plastic pipe underground with socket weld plastic joints. Use transition fittings for joining steel to plastic pipe. Installation and pipe bedding shall be per the manufacturer's published installation recommendations.

3.6 HANGERS AND SUPPORTS

A. General: Hanger, support, and anchor components and installation procedures conforming to MSS SP-58 and SP-69 are specified in Division 22 Section "Hangers and Supports for Plumbing Piping". Conform to the table below for maximum spacing of supports.

B. Pipe Attachments: Install the following:

1. Adjustable clevis hangers, MSS SP-69 Type 1, for steel pipe 2-1/2" and larger for individual horizontal runs.

2. Riser clamps, MSS SP-69 Type 8, for individual vertical runs.

3. Extension split ring pipe clamp, MSS SP-69 Type 12, for individual exposed runs on walls.

4. Engineered strut support system may be provided, at the contractor's option, in lieu of individual hangers for horizontal pipes as specified in Division 22 "Hangers and Supports for Plumbing Piping". Provide two piece straps for uninsulated pipe secured to the bare pipe and provide plastic galvanic isolators for bare copper tube.

5. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:

SIZE (NPS)	SPACING IN FEET	MIN. ROD SIZE IN INCHES
1/2" to 1"	7	3/8
1-1/4"	8	3/8
1-1/2"	9	3/8
2"	10	3/8
2-1/2"	11	1/2
3"	12	1/2
4"	14	5/8
6"	16	3/4

6. Support semi-rigid corrugated stainless steel tubing with the following maximum spacing:

SIZE (NPS)	HORIZONTAL SPACING IN FEET	VERTICAL SPACING IN FEET
3/8"	4	10
1/2"	6	10
3/4" to 2"	8	10

C. Support vertical piping at every floor.

D. Support gas piping within 12" of each elbow or tee and for gas piping 2-1/2" and larger at each valve or pressure regulator.

E. Support gas piping located on roof with pre-engineered roof supports, pre-engineered roof supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping". Conform to the table above for maximum spacing of supports. Support pipe at a minimum 7" above the roof.

F. Support semi-rigid corrugated stainless steel tubing located on the roof with strut/channel from support to support, running parallel beneath the pipe.

3.7 PIPE JOINT CONSTRUCTION

A. Welded Joints: Comply with the requirements in ASME Boiler and Pressure Vessel Code, Section IX.

B. Threaded Joints: Conform to ANSI B1.20.1, tapered pipe threads for field cut threads. Join pipe, fittings, and valves as follows:

1. Note the internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint. Refer to NFPA 54, for guide for number and length of threads for field threading steel pipe.

2. Align threads at point of assembly.

3. Apply thread compound for use with gas systems to the external pipe threads. Pipe thread tape is not accepted.

4. Assemble joint to appropriate thread depth. When using a wrench on valves place the wrench on the valve end into which the pipe is being threaded.

5. Damaged Threads: Do not use pipe with threads which are corroded, or damaged. If a weld opens during cutting or threading operations, that portion of pipe shall not be used.

C. Flanged Joints: Align flanges surfaces parallel. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly to appropriate torque specified by the bolt manufacturer.

D. Fusion Welded: Joints shall be made by a qualified and approved operator in accordance with Title 49, CFR, Part 192.283 and be made in accordance with pipe manufacturer's recommendations.

E. Semi-rigid Corrugated Stainless Steel Tubing: Joints shall be made by a qualified and approved operator in accordance with pipe manufacturer's recommendations.

3.8 VALVE APPLICATIONS

A. General: The Drawings indicate valve types, locations, and arrangements.

B. Shut-off duty: Use gas cocks specified in Part 2 above.

3.9 VALVE INSTALLATIONS

A. Install valves in accessible locations, protected from physical damage. Tag valves with a metal tag attached with a metal chain indicating the piping systems supplied.

B. Install line size gas cock at the outlet of the gas meter set or gas riser and install a line size union downstream of the gas cock outside of the building.

C. Installation of Gas Pressure Regulators:

1. Install a gas cock 10 pipe diameters upstream of each gas pressure regulator. Where two gas pressure regulators are installed in series in a single gas line, a manual valve is not required at the second regulator.

2. Install line pressure regulators a minimum of 10 pipe diameters upstream of each atmospheric or power burner equipment connection.

3. Install line pressure regulators a minimum of 10'-0" upstream of each condensing boiler or water heater connection.

4. Install gas pressure regulator relief devices so they can be readily operated to determine if the valve is free; so they can be tested to determine the pressure at which they will operate; and examined for leakage when in the closed position.

5. Install gas pressure regulators with listed vent limiters indoors where allowed by the AHJ. Install with regulator dome vertically upright and level.

6. Install gas pressure regulators located outside the building with the relief port facing down to prevent the entry of moisture with the relief port a minimum of 18" above the roof or finish grade. Remove vent limiter and provide with line size (same size as gas vent relief port) insect screen or gas relief vent and 1" long schedule 40 black steel nipple.

a. Where manufacturer does not allow the gas pressure regulator, use a different regulator from the acceptable manufacturer list. to be installed upside down, install gas pressure regulator with regulator dome in the horizontal or vertically upright with factory breather plug.

3.10 ELECTRICAL BONDING AND GROUNDING

A. Install above ground portions of gas piping systems, upstream from equipment shutoff valves electrically continuous and bonded to a grounding electrode in accordance with NFPA 70 - "National Electrical Code."

B. Do not use gas piping as a grounding electrode.

C. Conform to NFPA 70 - "National Electrical Code," for electrical connections between wiring and electrically operated control devices.

3.11 FIELD QUALITY CONTROL

A. Piping Tests: Inspect, test, and purge natural gas systems in accordance with NFPA 54, and local utility requirements.

END OF SECTION 227000

SECTION 227010 - MECHANICALLY JOINED NATURAL GAS PIPING SYSTEMS

1.1 SUMMARY

A. This Section includes mechanically joined fittings and valves for distribution piping systems for natural gas, within the building and extending from the point of delivery to the connections with gas utilization devices. Piping materials and equipment specified in this Section include:

1. Fittings.

B. This Section does not apply to liquid petroleum piping; industrial gas applications using such gases as acetylene and acetylenic compounds, hydrogen, ammonia, carbon monoxide, oxygen and nitrogen; gas piping, meters, gas pressure regulators and other appurtenances used by the serving gas supplier in distribution of gas.

C. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 22 Section "Natural Gas Systems," for valves, hangers, natural gas systems and installation requirements.

D. Gas pressures for systems specified in this Section are limited to 5 psig.

1.2 SUBMITTALS

A. Product data for each mechanically joined gas pipe fitting. Include rated capacities of selected models, furnished specialties and accessories, and installation instructions.

B. Maintenance data for mechanically joined gas pipe fittings, for inclusion in operating and maintenance manual specified in Division 1 and Division 22 Section "General Plumbing Requirements."

C. Installer qualification certificates, certifying that installers comply with the quality requirements specified under "Quality Assurance" below.

D. Test reports specified in Part 3 below.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: Installation of mechanically joined fittings shall be performed only by a qualified installer. The term qualified is defined as experienced in such work (experienced shall mean having a minimum of 5 previous projects similar in size and scope to this project), familiar with precautions required, and has complied with the requirements of the authority having jurisdiction. Upon request, submit evidence of such qualifications to the Architect.

B. Local Gas Utility Requirements: Installation of mechanically joined fittings shall comply with local gas utility installation rules and regulations.

C. Mechanically joined fittings shall be manufactured in plants located in the United States or certified to meet the specified ASTM and ANSI standards.

D. Obtain training from the mechanically joined fittings manufacturer for all workers that will be installing or handling the mechanically joined fittings.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide gas piping system products from one of the following:

1. Mechanically Joined Fittings:

a. Viega "Mega-Press G Fittings"

b. Apollo "PowerPress"

2.2 FITTINGS

A. Mechanically Joined Fittings: ½ inch through 4 inch meeting ANSI LC4-2012 /CSA 6.32-2012 2nd Edition with zinc/nickel coating, HNBR sealing element, 420 stainless steel grip ring, 304 stainless steel separator ring, and Smart Connect (SC) Feature that allows the joint to leak if not properly sealed. Fittings shall be for use with IPS schedule 10 thru schedule 40 carbon steel, or galvanized pipe meeting ASTM A53. Fittings shall have temperature and pressure rating of -40F to 180F at a maximum operating pressure of 125 psi.

2.3 VALVES

A. Mechanically Joined Gas Ball Valves: ½ inch through 2 inch carbon steel body meeting ASTM A216 with full port 316 stainless steel ball meeting ASTM A276, blowout-proof stem, with replaceable "Teflon" or "PTFE" seats and seals, solder ends and vinyl-covered steel handle. Provide with mechanically joined ends meeting ASTM LC4 with HNBR O-ring.

1. Apollo "PowerPress" # 89FHV4 series

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Install fittings and valves in accordance with manufacturer's installation instructions.

3.2 PREPARATION

A. Precautions: Before turning off the gas to the premises, or section of piping, turn off all equipment valves. Perform a leakage test as specified in "FIELD QUALITY CONTROL" below, to determine that all equipment is turned off in the piping section to be affected.

B. Conform with the requirements in NFPA 54, for the prevention of accidental ignition.

3.3 PIPE APPLICATIONS

A. Install above floor steel pipe with mechanically joined fittings for pipe 1/2 inch and larger up to 4".

3.4 PIPING INSTALLATION

A. Piping Installation requirements are specified in Division 22 Section "Natural Gas Systems".

3.5 PIPE JOINT CONSTRUCTION

A. Joint materials and installation requirements are specified in Division 22 Section "Natural Gas Systems".

B. Joints for Mechanically Joined Fittings: Comply with the manufacturer's installation instructions and Requirements:

1. Cut pipe ends at right angle (square) to the pipe.

2. Ream pipe ends with chamfer.

3. Remove paint, lacquer, grease, oil or dirt from the pipe end with an abrasive cloth, or with the "Ridgid MegaPress" pipe end prep tool.

4. Visually examine the fitting sealing element to ensure there is no damage.

5. Utilize a "Viega MegaPress Insertion Depth Inspection Gauge" to mark the pipe wall, with a felt tip pen, at the appropriate location, or insert the pipe fully into the fitting and mark the pipe wall at the face of the fitting.

6. Verify the pipe is fully inserted into the fitting prior to pressing the joint.

7. Install mechanically joined fittings using "Ridgid" MegaPress Tools.

3.6 VALVE APPLICATIONS

A. Valves are specified in Division 22 Section "Natural Gas Systems".

B. Valves can be installed with screwed joints for 2" and smaller and flanged joints for 2-1/2" and larger. Or, valves can be provided with mechanically joined fitting adapters and the joints installed as specified herein.

3.7 VALVE INSTALLATIONS

A. Valve installation requirements are specified in Division 22 Section "Natural Gas Systems".

3.8 FIELD QUALITY CONTROL

A. Field quality control requirements are specified in Division 22 Section "Natural Gas Systems".

B. Installing contractor shall schedule training session with the mechanically joined fittings manufacturer at project site for all workers that will be installing or handling mechanically joined fittings. Submit certification letter along with list of certified attendees to Architect within 30-days of mobilization. Include copy of certification letter with closeout documents. Mechanically joined fittings manufacturer shall provide certification training to the contractor without cost and without additional cost to the Owner.

C. Piping Tests: Inspect, test, and purge natural gas systems in accordance with NFPA 54, and local utility requirements.

D. Manufacturer's Piping Test: Provide two-step test process as follows:

1. Pressurize the system between 0.5 psi and 45 psi with air or dry nitrogen.

2. If the system does not hold pressure, walk the system and check for un-pressed fittings.

3. If un-pressed fittings are found, ensure the pipe is fully inserted into the fitting and properly marked prior to pressing the joint.

4. If failed joints are fond, cut out the failed fitting and replace with new as specified herein.

5. After appropriate repairs have been made, test the system per local code, not to exceed 200 psig.

END OF SECTION

SECTION 229000 - LABORATORY SAFETY DEVICE SYSTEM

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. Related Documents:

1. Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 1 Specifications and Section 16010, apply to this Section.

B. Section Includes:

1. Furnishing and installation of the Laboratory Safety Device System as shown on the Drawings as herein specified.

C. This project will be submitted for Leadership in Energy and Environmental Design (LEED) certification to the US Green Building Council (USGBC). Goal for this project is "Certified" 26 to 32 points. For additional information, refer to Division 1 Section 01352 - "LEED Requirements."

D. Related Sections:

1. Division 22 Section “Coordination” for basic requirements for electrical components that are an integral part of packaged system components.

2. Division 26 Section “Common Work Results for Electrical” required electrical devices.

3. Division 26 Sections "Enclosed Switches and Circuit Breakers" for field-installed disconnects.

4. Natural Gas Systems – Section 22700

5. Digital Control Equipment – Division 25

6. Any requirements for additional systems indicated by the plans and specifications.

E. Codes and Regulations:

1. NFPA 70, National Electrical Code.

2. NFPA 72, National Fire Alarm Code.

3. NFPA 90A, Installation of Air Conditioning and Ventilation Systems.

4. Americans with Disabilities Act.

5. Local and State Building Codes.

6. All requirements of the local authority having jurisdiction.

F. Warranty:

1. Provide a 1 year minimum warranty from date of acceptance of project.

1.2 SUBMITTALS:

A. Submittal procedures: See Division 23 Section “Coordination”.

B. Product Data:

1. Manufacturer

2. Model Number

3. Indicate all options and accessories

4. Wiring diagrams detailing wiring for power, signal, and control systems; differentiating between manufacturer-installed wiring and field-installed wiring.

5. Catalog data sheet with photographs

C. Submit complete submittal package within 30 calendar days after award of this work for approval. Equipment is not to be ordered without approval.

1.3 SCOPE OF WORK:

A. Plumbing:

1. It shall be the responsibility of the Plumbing Contractor to provide in his base bid all equipment, devices, and coordination for the Laboratory Safety Device System as outlined in the Drawings and Specifications. Each Utility Controller where shown on the Drawings and herein specified shall operate as an independent Control System.

B. Electrical:

1. It shall be the responsibility of the Electrical Contractor to provide in his base bid installation of LA controller and E-Series enclosure, all conduit systems, standard electrical boxes, operating power, and all low voltage control wiring for the Laboratory Safety Device System as outlined in the Drawings and Specifications. Each Utility Controller where shown on the Drawings and herein specified shall operate as an independent Control System.

PART 2 - PRODUCTS

2.1 ALL PRODUCTS AND DEVICES FOR A COMPLETE LABORATORY SAFETY DEVICE SYSTEM SHALL BE PROVIDED AS SHOWN ON DRAWINGS AND AS LISTED IN THE EQUIPMENT SCHEDULE OF THE SECTION.

A. Manufacturer:

1. ISIMET - Naples, TX – (903)897-0737 – No substitutions accepted

B. Equipment as scheduled on the drawings.

B. LA - Series control panel:

1. Where shown on Drawings, provide an LA Series Control Panel. LA Series shall control all natural gas and electrical utilities as detailed on drawings. Panel shall be flush mounted on the

wall inside the prep room as shown on drawings. Panel shall be equipped with switches for each utility and a time dial for the operation of the purge fan, an enabling key switch that restricts operation to the Instructor and a momentary panic button assembly. Control Panel shall be furnished under this section and provided to the Electrical Contractor for installation.

C. Solenoids:

1. At each science classroom and where shown on Drawings, provide a ISIMET 24-Vc fuel gas solenoid valve. Solenoid shall be integrated with LA Controller as shown on Drawings. Pipe sizes are as noted on drawings. Locate solenoid as shown on Drawings.

PART 3 - EXECUTION

3.1 INTEGRATION AND CONFIGURATION

A. Integration with other building systems:

1. CAUTION – Operation of emergency devices, including emergency showers and eyewashes, shall not be integrated with this system for either activation or deactivation.

B. System configuration:

1. LA Controllers shall be factory configured to the specified configurations and shall be capable of field adjustments to meet specific project modification requirements. Configurations shall be limited to specific placement of control cabling and jumpers at PC Board without requirement for additional modifications to equipment.

C. Classroom Utilities:

1. Each natural gas utility service with outlets at student work-stations shall be controlled by independent output circuit at the LA Controller. Control of services shall not be combined onto one output circuit unless indicated on Drawings. Services shall be activated by Controller panel switches and the engaging of the service enabling key. Activation of utility services shall be restricted to the Instructor by means of the enabling key switch.

D. Digital Control Equipment – (BAS)

1. Each Utility Control System shall be configured so that all controlled utilities and devices disengage at the end of the daily occupied period. Withdrawal of the low voltage control signal from the Energy Management Control System shall disable the Controller during the non-occupied “BAS” mode. Signal shall originate at points as shown on drawings. Verify that Controller is field configured to accept specified control signal. Controller shall be reenabled upon return of control signal. Controller output circuits shall only re-activate by engaging enabling key switch. Verify voltage of control signal prior to placing the unit into service. Provide for additional monitoring output circuit at Controller for integration with “BAS”.

2. Common Alarm System: Where indicated by the Drawings, configure each LA Controller for 24 VDC alarm to integrate with the Building Alarm System. Building Alarm System shall monitor the Controller for Panic. Controller shall accept fire alarm input signal from Building Alarm system for automatic shut-down. Integration with the Building Alarm System should be configured so that any fan activated by the Panic State will deactivate upon a Fire-Alarm signal from that system.

3. Where shown on Drawings, provide low voltage integration wiring to connection point for integration of the facility BAS system. Integration voltage shall be 24 VAC. Make connection of wiring and configure Controller to activate with specified control voltage.

E. Panic Reset:

1. Unless stated elsewhere on Drawings, the LA Controller shall be configured so that reset of Panic State may occur at service enabling key switch on wall panel.

3.2 INSTALLATION:

A. Install in accordance with manufacturer's recommendations and instructions.

B. Verify manufacturer's mounting heights to comply with ADA or other standards.

C. Furnish and install all devices as shown on Drawings and as specified herein. Where device is to be installed by other trades, furnish and then turn over to appropriate trade for installation.

D. Furnish, install and make final connections to monitoring and remote panic assembly panels as indicated on Drawings and specified herein. Furnish and install low voltage control wiring from Utility Controller to connection point of Energy Management Control System and Building Alarm. Final connection by others.

E. Plumbing:

1. Plumbing contractor shall furnish all equipment. Install and make final connections to all piping systems where indicated by Drawings and specifications. Provide to Electrical Contractor for installation all devices not requiring connections to utility piping systems. Install in accordance with SECTION 22700 – NATURAL GAS SYSTEMS.

F. Electrical:

1. Electrical Contractor shall furnish all conduit and wiring, making final wiring connections to all equipment as indicated by Drawings and specifications. Contractor shall install all devices not requiring connections to utility piping systems. Contractor shall be responsible for all system configurations, integration, test and start-up.

G. Conduit:

1. Unless otherwise specified for wiring systems, provide conduits for control and integration wiring from point of connection to each device to accessible point above ceiling. Provide separate conduit for each device that is controlled and integrated with Controller. Conduits for monitoring panels, arrays and panic assemblies shall be separate from line voltage, control wiring and integrated system wiring. Where system components are mounted along side the Controller within a common wall, install conduct for low voltage control wiring between the devices.

H. Wiring:

1. Operating Power:

a. Provide dedicated electrical service to each LA Controller. Verify wiring requirements with Manufacturer's requirements. Minimum 15 amp circuit.

2. Low Voltage Control Wiring:

a. Low voltage wiring shall be provided by temperature control contractor subject to Division 25.

b. Provide 24 VAC control wiring from LA Controller to each controlled utility or device. Make connections at controlled device and terminate at output terminal on Controller's control panel. Minimum wiring, 18 AWG, plenum rated cable. Provide cable with required conductors plus two spares.

3. Integrated Systems:

a. Provide low voltage wiring for integration to other systems as shown on Drawings. Verify voltage and wire sizes to comply with requirements of each system.

4. System Monitoring Panels and Arrays:

a. Provide 24 VAC control wiring from LA Controller to each monitoring panel or array. Make connections at monitoring device and terminate at output terminal on Controller's control panel. Minimum wiring, 22 AWG, plenum rated cable. Provide cable with required conductors plus two spares.

3.3 SYSTEM TEST AND START-UP

A. Prior to placing the LA Controller System into service, perform ALL Start-up procedures and Checklists as stated in Manufacturer's Operations and Maintenance Procedure literature.

1. Verify that all components and control devices comply with manufacturer's requirements and recommendations and that all devices and installations conform to Drawings and Specification requirements.

a. Verify that all controlled piping systems have been thoroughly cleaned.

b. Verify that all controlled devices and circuits are ON.

c. Verify that connections to all integrated systems are complete.

d. Verify that all monitoring systems respond to Panic.

e. Verify that remote panic assemblies activate the Panic State.

f. Verify that service to emergency showers and eyewashes are not affected by operation of system.

2. Upon completion of ALL Start-up tests, place the system into service. Complete all warranty registration documents. Submit originals with other project related closeout and O & M documentation. Review all operating procedures with a representative of the Owner. Provide all System keys to the Owner's representative.

END OF SECTION

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SECTION 230010 - GENERAL MECHANICAL REQUIREMENTS

PART 1 - GENERAL REQUIREMENTS

1.1 DESCRIPTION OF WORK

A. This Division requires the furnishing and installing of complete functioning systems, and each element thereof, as specified or indicated on the Drawings and Specifications or reasonably inferred; including every article, device or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the work include materials, labor, supervision, supplies, equipment, transportation, and utilities.

B. Division 23 of the Specifications and Drawings numbered with prefixes M, MP or ME, or MEP generally describe these systems, but the scope of the Mechanical work includes all such work indicated in the Contract Documents: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Mechanical, Plumbing and Electrical Drawings and Specifications; and Addenda.

C. The Drawings have been prepared diagrammatically intended to convey the scope of work, indicating the intended general arrangement of the equipment, fixtures, ductwork, piping, etc. without showing all the exact details as to elevations, offsets, control lines, and other installation requirements. The Contractor shall use the Drawings as a guide when laying out the work and shall verify that materials and equipment will fit into the designated spaces, and which, when installed per manufacturers requirements, will ensure a complete, coordinated, satisfactory and properly operating system.

1.2 QUALITY ASSURANCE

A. All work under this Division shall be executed in a thorough professional manner by competent and experienced workmen licensed to perform the Work specified.

B. All work shall be installed in strict conformance with manufacturers' requirements, recommendations, and installation instructions. Equipment and materials shall be installed in a neat and professional manner and shall be aligned, leveled, and adjusted for satisfactory operation.

C. Material and equipment shall be new, shall be of the best quality and design, shall be current model of the manufacturer, shall be free from defects and imperfections and shall have markings or a nameplate identifying the manufacturer and providing sufficient reference to establish quality, size and capacity. Material and equipment of the same type shall be made by the same manufacturer whenever practicable.

D. Unless specified otherwise, manufactured items shall have been installed and used, without modification, renovation, or repair for not less than one year prior to date of bidding for this project.

1.3 CODES, REFERENCES AND STANDARDS

A. Execute Work in accordance with the National Fire Protection Association and all Local, State, and National codes, ordinances and regulations in force governing the particular class of Work involved.

Obtain timely inspections by the constituted authorities, and upon final completion of the Work obtain and deliver to the Owner executed final certificates of acceptance from the Authority Having Jurisdiction.

B. Any conflict between these Specifications and accompanying Drawings and the applicable Local, State and Federal codes, ordinances and regulations shall be reported to the Architect in sufficient time, prior to the opening of Bids, to prepare the Supplementary Drawings and Specification Addenda required to resolve the conflict.

C. The governing codes are minimum requirements. Where these Drawings and Specifications exceed the code requirements, these Drawings and Specification shall prevail.

D. All material, manufacturing methods, handling, dimensions, method or installation and test procedure shall conform to but not be limited to the following industry standards and codes:

IBC	International Building Code
IMC	International Mechanical Code
IPC	International Plumbing Code
IFC	International Fire Code
IFGC	International Fuel Gas Code
ADA	American Disabilities Act
ADC	Air Diffusion Council
AMCA	Air Movement and Control Association, Inc.
ANSI	American National Standards Institute
AHRI	Air Conditioning, Heating and Refrigeration Institute
ASHRAE	American Society of Heating Refrigerating and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASSE	American Society of Sanitary Engineering
ASTM	American Society of Testing Materials
AWS	American Welding Society
AWWA	American Water Works Association
CISPI	Cast Iron Soil Pipe Institute
ETL	Electrical Testing Laboratories
HI	Hydraulic Institute
MSS	Manufacturer's Standardization Society of the Valve and Fitting Industry
NBFU	National Board of Fire Underwriters
NEC	National Electrical Code
NFPA	National Fire Protection Association
NEMA	National Electrical Manufactures' Association
OSHA	Occupational Safety and Health Act
PDI	Plumbing and Drainage Institute
SMACNA	Sheet Metal and Air Conditioning Contractors National Association, Inc.
UL	Underwriter's Laboratories

E. Contractor shall comply with rules and regulations of public utilities and municipal departments affected by connections of services.

F. All mechanical work shall be performed in compliance with applicable safety regulations, including OSHA regulations. Safety lights, guards, shoring and warning signs required for the performance of the mechanical work shall be provided by the Contractor.

1.4 DEFINITIONS

A. General:

1. Furnish: The term "furnish" is used to mean "supply and deliver to the project site, ready for unloading, unpacking, assembly, installation and similar operations."

2. Install: The term "install" is used to describe operations at the project site including the actual "unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations."

3. Provide: The term "provide" means "to furnish and install, complete and ready for the intended use."

4. Furnished by Owner or Furnished by Others: The item will be furnished by the Owner or Others. It is to be installed and connected under the requirements of this Division, complete and ready for operation, including items incidental to the Work, including services necessary for proper installation and operation. The installation shall be included under the guarantee required by this Division.

5. Engineer: Where referenced in this Division, "Engineer" is the Engineer of Record and the Design Professional for the Work under this Division, and is a Consultant to, and an authorized representative of, the Architect, as defined in the General and/or Supplementary Conditions. When used in this Division, it means increased involvement by, and obligations to, the Engineer, in addition to involvement by, and obligations to, the "Architect".

6. AHJ: The local code and/or inspection agency (Authority) Having Jurisdiction over the Work.

7. NRTL: Nationally Recognized Testing Laboratory, as defined and listed by OSHA in 29 CFR 1910.7 (e.g., UL, ETL, CSA, etc.), and acceptable to the Authority having Jurisdiction (AHJ) over this project. Nationally Recognized Testing Laboratories and standards listed are used only to represent the characteristics required and are not intended to restrict the use of other listed Manufacturers and models that meet the specified criteria.

8. Substitution: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor. Substitutions include Value Engineering proposals.

   a. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.

   b. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.

9. Value Engineering: A systematic method to improve the "value" of goods and services by using an examination of function. Value, as defined, is the ratio of function to cost. Value can therefore be increased by either improving the function or reducing the cost. The goal of VE is to achieve the desired function at the lowest overall cost consistent with required performance.

B. The terms "approved equal", "equivalent", or "equal" are used synonymously and shall mean "accepted by or acceptable to the Engineer as equivalent to the item or manufacturer specified". The term "approved" shall mean labeled, listed, or both, by an NRTL, and acceptable to the AHJ over this project.

C. The following definitions apply to excavation operations:

1. Additional Excavation: Where excavation has reached required subgrade elevations, if unsuitable bearing materials are encountered, continue excavation until suitable bearing materials are reached. The Contract Sum may be adjusted by an appropriate Contract Modification.

2. Bedding: Bedding as used in this section refers to the compacted sand or pea gravel installed in the bottom of a trench to immediately support and cover a pipe or duct.

3. Subbase: as used in this Section refers to the compacted soil layer used in pavement systems between the subgrade and the pavement base course material.

4. Subgrade: as used in this Section refers to the compacted soil immediately below the slab or pavement system.

5. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction from the Architect.

1.5 COORDINATION

A. The Contractor shall visit the site and ascertain the conditions to be encountered while installing the Work under this Division, verify all dimensions and locations before purchasing equipment or commencing work, and make due provision for same in the bid. Failure to comply with this requirement shall not be considered justification for omission, alteration, incorrect or faulty installation of Work under this Division or for additional compensation for Work covered by this Division.

B. The Contractor shall refer to Drawings of the other disciplines and to relevant equipment drawings and shop drawings to determine the extent of clear spaces. The Contractor shall make offsets required to clear equipment, beams and other structural members; and to facilitate concealing piping and ductwork in the manner anticipated in the design.

C. The Contractor shall confirm and coordinate the final location and routing of all mechanical, electrical, plumbing, fire protection, control and audio-visual systems with all architectural features, structural components, and other trades. The contractor shall locate equipment, components, ductwork, piping, conduit, and related accessories to maintain the desired ceiling heights as indicated on the architectural drawings. The contractor shall inform the architect of any areas where conflicts may prevent the indicated ceiling height from being maintained. The contractor shall not proceed with any installation in such areas until the architect has given written approval to proceed or has provided modified contract drawings or written instructions to resolve the apparent conflict.

D. The Contractor shall provide materials with trim which will fit properly the types of ceiling, wall, or floor finishes actually installed.

E. The Contractor shall maintain a foreman on the jobsite at all times to coordinate his work with other contractors and subcontractors so that various components of the mechanical systems will be installed at the proper time, will fit the available space, and will allow proper service access to the equipment.

Carry on the Work in such a manner that the Work of the other contractors and trades will not be handicapped, hindered, or delayed at any time.

F. Work of this Division shall progress according to the "Construction Schedule" as established by the Prime Contractor and his subcontractors and as approved by the Architect. Cooperate in establishing these schedules and perform the Work under this Division, in a timely manner in conformance with the construction schedule so as to ensure successful achievement of schedule dates.

1.6 MEASUREMENTS AND LAYOUTS

A. The drawings are schematic in nature, but show the various components of the systems approximately to scale and attempt to indicate how they are to be integrated with other parts of the building. Figured dimensions shall be taken in preference to scale dimensions. Determine exact locations by job measurements, by checking the requirements of other trades, and by reviewing the Contract Documents. The Contractor will be held responsible for errors which could have been avoided by proper checking and inspection.

1.7 SUBMITTALS

A. Refer to Division 01 and General Conditions for submittal requirements in addition to requirements specified herein.

B. Submittals and shop drawings shall not contain the firm name, logo, seal, or signature of the Engineer. They shall not be copies of the work product of the Engineer. If the Contractor desires to use elements of such product, the license agreement for transfer of information obtained from the Engineer must be used.

C. Assemble and submit for review manufacturer product literature for material and equipment to be furnished and/or installed under this Division. Literature shall include shop drawings, manufacturer product data, performance sheets, samples, and other submittals required by this Division as noted in Table 1 at the end of this Section. Provide the number of submittals required by Division 01; if hard-copy sets are provided, submit a minimum of seven (7) sets. General product catalog data not specifically noted to be part of the specified product will be rejected and returned without review.

D. Separate submittals according to individual specification sections. Only resubmit those sections requested for resubmittal.

E. Provide submittals in sufficient detail so as to demonstrate compliance with these Contract Documents and the design concept. Highlight, mark, list or indicate the materials, performance criteria and accessories that are being proposed. Illegible submittals will be rejected and returned without review.

F. Refer to individual Sections for additional submittal requirements.

G. Transmit submittals as early as required to support the project schedule. Allow two weeks for Engineer review time, plus to/from mailing time via the Architect, plus a duplication of this time for resubmittal if required. Transmit submittals as soon as possible after Notice to Proceed and before Mechanical construction starts.

H. Before transmitting submittals and material lists, verify that the equipment submitted is mutually compatible with and suitable for the intended use. Verify that the equipment will fit the available space

and maintain manufacturer recommended service clearances. If the size of equipment furnished makes necessary any change in location, or configuration, submit a shop drawing showing the proposed layout.

I. Submittals shall contain the following information:

1. The project name.

2. The applicable specification section and paragraph.

3. Equipment identification acronym as used on the drawings.

4. The submittal date.

5. The Contractor's stamp, which shall certify that the stamped drawings have been checked by the Contractor, comply with the Drawings and Specifications, and have been coordinated with other trades.

6. Submittals not so identified will be returned to the Contractor without action.

J. Refer to Division 01 for acceptance of electronic submittals for this project. For electronic submittals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 01. Contractor shall notify the Architect and Engineer that the submittals have been posted. If electronic submittal procedures are not defined in Division 01, Contractor shall include the website, user name and password information needed to access the submittals. For submittals sent by e-mail, Contractor shall copy the Architect and Engineer's designated representatives. Contractor shall allow for the Engineer review time as specified above in the construction schedule. Contractor shall submit only the documents required to purchase the materials and/or equipment in the submittal.

K. The checking and subsequent acceptance by the Engineer and/or Architect of submittals shall not relieve responsibility from the Contractor for (1) deviations from Drawings and Specifications; (2) errors in dimensions, details, sizes of equipment, or quantities; (3) omissions of components or fittings; and (4) not coordinating items with actual building conditions and adjacent work. Contractor shall request and secure written acceptance from the Engineer and Architect prior to implementing any deviation.

L. Provide welders' qualification certificates.

1.8 ELECTRONIC DRAWING FILES

A. In preparation of shop drawings or record drawings, Contractor may, at their option, obtain electronic drawing files in AutoCAD or DXF format from the Engineer for a shipping and handling fee of $200 for a drawing set up to 12 sheets and $15 per sheet for each additional sheet. Contact the Architect for Architect's written authorization. Contractor shall request and complete the Electronic File Release Agreement form from the Engineer. Send the form along with a check made payable to Henderson Engineers, Inc. Contractor shall indicate the desired shipping method and drawing format on the attached form. In addition to payment, Architect's written authorization and Engineer's release agreement form must be received before electronic drawing files will be sent.

1.9 SUBSTITUTIONS

A. Refer to Division 01 and General Conditions for Substitutions in addition to requirements specified herein.

B. Materials, products, equipment, and systems described in the Bidding Documents establish a standard of required function, dimension, appearance and quality to be met by the proposed substitution.

C. The base bid shall include only the products from manufacturers specifically named in the drawings and specifications.

D. Request for Substitution:

1. Complete and send the Substitution Request Form attached at the end of this section for each material, product, equipment, or system that is proposed to be substituted.

2. The burden of proof of the merit of the proposed substitution is upon the proposer.

3. Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner the following:

a. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.

b. Proposed substitution is consistent with the Contract Documents and will produce indicated results, including functional clearances, maintenance service, and sourcing of replacement parts.

c. Proposed substitution has received necessary approvals of authorities having jurisdiction.

d. Same warranty will be furnished for proposed substitution as for specified Work.

e. If accepted substitution fails to perform as required, Contractor shall replace substitute material or system with that originally specified and bear costs incurred thereby.

f. Coordination, installation and changes in the Work as necessary for accepted substitution will be complete in all respects.

E. Substitution Consideration:

1. No substitutions will be considered unless the Substitution Request Form is completed and attached with the appropriate substitution documentation.

2. No substitutions will be considered prior to receipt of Bids unless written request for approval to bid has been received by the Engineer at least ten (10) calendar days prior to the date for receipt of Bids.

3. If the proposed substitution is approved prior to receipt of Bids, such approval will be stated in an Addendum. Bidders shall not rely upon approvals made in any other manner. Verbal approval will not be given.

4. No substitutions will be considered after the Contract is awarded unless specifically provided in the Contract Documents.

1.10 OPERATION AND MAINTENANCE MANUALS

A. Refer to Division 01 and General Conditions for Operation and Maintenance Manuals in addition to requirements specified herein.

B. Submit manuals prior to requesting the final punch list and before all requests for Substantial Completion.

C. Instruct the Owner's permanent personnel in the proper operation of, startup and shutdown procedures and maintenance of the equipment and components of the systems installed under this Division.

D. Prior to Substantial Completion of the project, furnish to the Architect, for Engineer's review, and for the Owner's use, four (4) copies of Operation and Maintenance Manuals in labeled, hard-back three-ring binders, with cover, binding label, tabbed dividers and plastic insert folders for Record Drawings. Include local contacts, complete with address and telephone number, for equipment, apparatus, and system components furnished and installed under this Division of the specifications.

E. Each manual shall contain data listed in Table 5.

F. Refer to Division 01 for acceptance of electronic manuals for this project. For electronic manuals, Contractor shall submit the documents in accordance with this Section and the procedures specified in Division 01. Contractor shall notify the Architect and Engineer that the manuals have been posted. If electronic manual procedures are not defined in Division 01, Contractor shall include the website, user name and password information needed to access the manuals. For manuals sent by e-mail, Contractor shall copy the Architect and Engineer's designated representative.

1.11 SPARE PARTS

A. Provide to the Owner the spare parts specified in the individual sections in Division 23 of this specification. Refer to Table 2 at the end of this Section for a list of specification sections in Division 23 that contain spare parts requirements.

B. Owner or Owner's representative shall initial and date each section line in Table 2 when the specified spare parts for that section are received and shall sign at the bottom when all spare parts have been received.

1.12 RECORD DRAWINGS

A. Refer to Division 01 and General Conditions for Record Drawings in addition to requirements specified herein.

B. A set of work prints of the Contract Documents shall be kept on the jobsite during construction for the purpose of noting changes. During the course of construction, the Contractor shall indicate on these Documents changes made from the original Contract Documents. Particular attention shall be paid to those items which need to be located for servicing. Underground utilities shall be located by dimension from column lines.

C. At the completion of the project, the Contractor shall obtain, at their expense, reproducible copies of the final drawings and incorporate changes noted on the jobsite work prints onto these drawings. These changes shall be done by a skilled drafter. Each sheet shall be marked "Record Drawing", along with the date. These drawings shall be delivered to the Architect/Engineer.

1.13 TRAINING

A. Provide training as indicated in each specific section to demonstrate the systems to the owner. All features and functions shall be explained and the owner shall be instructed on proper operation and maintenance of the system including drain and freeze protection requirements during winter conditions. Schedule training with the Owner at least 7 days in advance after systems have been tested, balanced, and placed in proper working order but before final acceptance of the mechanical systems. Video record the training sessions in format as agreed to with the Owner. Provide three copies of each session to the Owner and obtain written receipt from the Owner. Provide a certificate to owner certifying demonstrations have been completed including the system demonstrated, dates demonstrations were performed, and names of personnel in attendance signed by Contractor and Owner.

1.14 PAINTING

A. Exposed ductwork and ferrous surfaces, including pipe, pipe hangers, equipment stands and supports [and exposed insulated piping] shall be painted by the Contractor using materials and methods as specified under Division 09 of the Specifications; colors shall be as selected by the Architect.

B. Factory finishes, shop priming and special finishes are specified in the individual equipment specification sections.

C. Where factory finishes are provided and no additional field painting is specified, marred or damaged surfaces shall be touched up or refinished so as to leave a smooth, uniform finish.

1.15 DELIVERY, STORAGE AND HANDLING

A. Refer to Division 01 and General Conditions for Delivery, Storage and Handling in addition to requirements specified herein.

B. Equipment and material shall be delivered to the job site in their original containers with labels intact, fully identified with manufacturer's name, model, model number, type, size, capacity and Underwriter's Laboratories, Inc. labels and other pertinent information necessary to identify the item.

C. Deliver, receive, handle and store equipment and materials at the job site in the designated area and in such a manner as to prevent equipment and materials from damage and loss. Store equipment and materials delivered to the site on pallets and cover with waterproof, tear resistant tarp or plastic or as required to keep equipment and materials dry. Follow manufacturer's recommendations, and at all times, take every precaution to properly protect equipment and material from damage, to include the erection of temporary shelters to adequately protect equipment and material stored at the Site. Equipment and/or material which become rusted or damaged shall be replaced or restored by the Contractor to a condition acceptable to the Architect.

D. The Contractor shall be responsible for the safe storage of his own tools, material and equipment.

1.16 GUARANTEES AND WARRANTIES

A. Refer to Division 01 and General Conditions for Guarantees and Warranties in addition to requirements specified herein.

B. Each system and element thereof shall be warranted against defects due to faulty workmanship, design or material for a period of 12 months from date of Substantial Completion, unless specific items are noted to carry a longer warranty in the Construction Documents or manufacturer's standard warranty. The Contractor shall remedy defects occurring within a period of one year from the date of Substantial Completion or as stated in the General Conditions.

C. The following additional items shall be guaranteed:

1. Piping shall be free from obstructions, holes or breaks of any nature.

2. Insulation shall be effective.

3. Proper circulation of fluid in each piping system.

D. The above guarantees shall include both labor and material; and repairs or replacements shall be made without additional cost to the Owner.

E. The remedial work shall be performed promptly, upon written notice from the Architect or Owner.

F. At the time of Substantial Completion, deliver to the Owner warranties with terms extending beyond the one year guarantee period, each warranty instrument being addressed to the Owner and stating the commencement date and term. Refer to Table 3 at the end of this section for a list of specification sections in Division 23 that contain special warranties.

1.17 TEMPORARY FACILITIES

A. Refer to Division 01 and General Conditions for Temporary Facilities requirements in addition to requirements specified herein.

B. Temporary Utilities: The types of services required include, but are not limited to, water, sewerage, surface drainage and gas. When connecting to existing franchised utilities for required services, comply with service companies' recommendations on materials and methods, or engage service companies to install services. Locate and relocate services (as necessary) to minimize interference with construction operations.

1. Provide the necessary backflow prevention devices where connecting to the potable water system. Protect water service from freezing by draining system or by providing adequate heat. Where non-potable water is used, mark each outlet with health hazard warning signs.

2. Sewer Sediment: Maintain sewers and temporary connecting sewers in a clean, non-clogged condition during construction period.

C. Construction Facilities: Provide facilities reasonably required to perform construction operations properly and adequately.

1. Enclosures: When temporary enclosures are required to ensure adequate workmanship, weather protection and ambient conditions required for the work, provide fire-retardant treated lumber and plywood; provide tarpaulins with UL label and flame spread of 15 or less; provide translucent type (nylon reinforced polyethylene) where daylighting of enclosed space would be beneficial for workmanship, and reduce use of temporary lighting.

2. Heating: Provide heat, as necessary, to protect work, materials and equipment from damage due to dampness and cold. In areas where building is occupied, maintain a temperature not less than 65 degrees Fahrenheit. Use steam, hot water, or gas from piped distribution system where available. Where steam, hot water or piped gas are not available, heat with self-contained LP gas or fuel oil heaters, bearing UL, FM or other approval labels appropriate for application. Vent fuel-burning heaters, and equip units with individual-space thermostatic controls. Use electric-resistance space heaters only where no other, more energy-efficient, type of heater is available and allowable.

1.18 PROJECT CONDITIONS

PART 2 - PRODUCTS AND MATERIALS

2.1 NOT USED

PART 3 - EXECUTION

3.1 PERMITS

A. Secure and pay for permits required in connection with the installation of the Mechanical Work. Arrange with the various utility companies for the installation and connection of required utilities for this facility and pay charges associated therewith including connection charges and inspection fees, except where these services or fees are designated to be provided by others.

3.2 EXISTING UTILITIES

A. Schedule and coordinate with the Utility Company, Owner and with the Engineer connection to, or relocation of, or discontinuation of normal utility services from existing utility lines. Premium time required for any such work shall be included in the bid.

B. Existing utilities damaged due to the operations of utility work for this project shall be repaired to the satisfaction of the Owner or Utility Company without additional cost.

C. Utilities shall not be left disconnected at the end of a work day or over a weekend unless authorized by representatives of the Owner or Engineer.

D. Repairs and restoration of utilities shall be made before workmen leave the project at the end of the workday in which the interruption takes place.

E. Contractor shall include in his bid the cost of furnishing temporary facilities to provide services during interruption of normal utility service.

3.3 CUTTING AND PATCHING

A. Cut walls, floors, ceilings, and other portions of the facility as required to install work under this Division.

B. Obtain permission from the Architect prior to cutting. Do not cut or disturb structural members without prior approval from the Architect and Structural Engineer.

C. For post-tension slabs, x-ray slab and closely coordinate all core drill locations with Architect and Structural Engineer prior to performing any work. Obtain approval from Architect and Structural Engineer for all core drills and penetrations at least four days prior to performing work.

D. Penetrations shall be made as small as possible while maintaining required clearances between the building element penetrated and the system component.

E. Patch around openings to match adjacent construction, including fire ratings, if applicable.

F. Repair and refinish areas disturbed by work to the condition of adjoining surfaces in a manner satisfactory to the Architect.

3.4 CLEANING

A. Dirt and refuse resulting from the performance of the work shall be removed from the premises as required to prevent accumulation. The Mechanical Contractor shall cooperate in maintaining reasonably clean premises at all times.

B. Immediately prior to the final inspection, the Mechanical Contractor shall clean material and equipment installed under the Mechanical Contract. Dirt, dust, plaster, stains, and foreign matter shall be removed from surfaces including components internal to equipment. Damaged finishes shall be touched-up and restored to their original condition.

3.5 SUBSTANTIAL COMPLETION REVIEW

A. Prior to requesting inspection for "CERTIFICATE OF SUBSTANTIAL COMPLETION", the Contractor shall complete the following items:

1. Submit complete Operation and Maintenance Manuals.

2. Submit complete Record Drawings.

3. Perform special inspections. Refer to Table 4 at the end of this section for a list of specification sections in Division 23 that contain special inspection requirements.

4. Start-up testing of systems.

5. Removal of temporary facilities from the site.

6. Comply with requirements for Substantial Completion in the "General Conditions".

B. The Contractor shall request in writing a review for Substantial Completion. The Contractor shall give the Architect/Engineer at least seven (7) days notice prior to the review.

C. The Contractor's written request shall state that the Contractor has complied with the requirements for Substantial Completion.

D. Upon receipt of a request for review, the Architect/Engineer will either proceed with the review or advise the Contractor of unfulfilled requirements.

E. If the Contractor requests a site visit for Substantial Completion review prior to completing the above mentioned items, He shall reimburse the Architect/Engineer for time and expenses incurred for the visit.

F. Upon completion of the review, the Architect/Engineer will prepare a "final list" of outstanding items to be completed or corrected for final acceptance.

G. Omissions on the "final list" shall not relieve the Contractor from the requirements of the Contract Documents.

H. Prior to requesting a final review, the Contractor shall submit a copy of the final list of items to be completed or corrected. He shall state in writing that each item has been completed, resolved for acceptance or the reason it has not been completed.

END OF SECTION

TABLE 1: MECHANICAL SPECIFICATION SHOP DRAWING SUBMITTAL REQUIREMENTS

SPECIFICATION NUMBER/TITLE		CODE DESIGNATION
230010	General Mechanical Requirements	NONE
230015	Electrical Coordination for Mechanical Equipment	NONE
230500	Common Work Results for HVAC	A, B, G, N
230510	Basic Piping Materials and Methods	B, G
230513	Common Motor Requirements for HVAC Equipment	B
230514	Variable Frequency Drives	A, B, C, E, F, H, K, Q
230516	Expansion Fittings and Loops for HVAC Piping	A, B, F
230519	Meters and Gauges for HVAC Piping	B, H
230523	General-Duty Valves for HVAC Piping	B
230529	Hangers and Supports for HVAC Piping and Equipment	B, F, G, H
230550	Vibration Isolation for HVAC	A, B, C, F, I
230553	Identification for HVAC Piping and Equipment	B, L, N
230593	Testing, Adjusting and Balancing For HVAC	H, J
230700	HVAC Insulation	B, L
230800	Commissioning of HVAC Systems	C, J
230913	Instrumentation and Control Devices for HVAC	A, B, C, D, E, F, N, O, Q
230914	Refrigerant Monitoring Systems	A, B, C, E, F, Q
230923	Direct-Digital Control for HVAC	A, B, C, D, E, F, J, K, L, N, O, Q
232113	Hydronic Piping	B, C, D, F, G, H, J
232114	Mechanically Joined Hydronic Piping Systems	B, C, F, G, H
232116	Hydronic Specialties	A, B, C, F, G, H
232123	Hydronic Pumps	A, B, C, E, F
232300	Refrigerant Piping	A, B, G
232500	HVAC Water Treatment	A, B, C, E, F, K, Q
232600	Nondestructive Pipe Testing	H, J
233113	Metal Ducts	A, B, D, G
233300	Air Duct Accessories	A, B, F, Q
233416	Centrifugal HVAC Fans	A, B, C, F, H
233423	HVAC Power Ventilators	A, B, C, F
233600	Air Terminal Units	A, B, C, E, F
233713	Diffusers, Registers, and Grilles	A, B, C, F, M, N, Q
233723	HVAC Gravity Ventilators	A, B, C, F, M
233813	Commercial Kitchen Hoods	A, B, C, D, E, F, G, J
235100	Breechings, Chimneys, and Stacks	A, B, F, G, H, I
235216	Condensing Boilers	A, B, C, E, F, H, Q
235323	Boiler Accessories	A, B, C, E, F, Q
236426	Rotary Screw Water Chillers	A, B, C, E, F, K, Q
237313	Modular Indoor Central-Station Air-Handling Units	A, B, C, E, F, H, Q
237433	Dedicated Outdoor Air Units	A, B, C, E, F, K, Q
238126	Split System Air Conditioners	A, B, C, E, F, K
238200	Terminal Heating and Cooling Units	A, B, C, E, F, L, M, Q
238500	Electric Heating Units	B, C, E, F, M

CODED LEGEND

A	Shop Drawings
B	Product Data
C	Performance Data, Capacities, Curves and Certificates
D	Coordination Drawings
E	Wiring Diagrams
F	Installation Instructions
G	Welder's Certificates
H	Certificates
I	Calculations
J	Test Reports
K	Special Warranties
L	Material Samples
M	Color Samples
N	Schedules
O	Equipment List
P	Material List
Q	Recommended Spare Parts List

TABLE 2: SPARE PARTS REQUIREMENTS FOR MECHANICAL EQUIPMENT

SECTION NUMBER		RECEIVED/DATE/INITIAL
230553	Identification for HVAC Piping and Equipment	_____
230914	Refrigerant Monitoring Systems	_____
232116	Hydronic Specialties	_____
232123	Hydronic Pumps	_____
232133	Hydronic Packaged Pumping Systems	_____
232500	HVAC Water Treatment	_____
233300	Air Duct Accessories	_____
233416	Centrifugal HVAC Fans	_____
233423	HVAC Power Ventilators	_____
233600	Air Terminal Units	_____
233713	Diffusers, Registers, and Grilles	_____
233813	Commercial Kitchen Hoods	_____
234100	Particulate Air Filtration	_____
237313	Modular Indoor Central-Station Air-Handling Units	_____
237333	Indirect-Fired Heating & Ventilating Units	_____
237339	Direct-Fired Heating & Ventilating Units	_____
237433	Dedicated Outdoor Air Units	_____
238126	Split System Air Conditioners	_____
238200	Terminal Heating and Cooling Units	_____

_____
Owner's Signature

TABLE 3: SPECIAL WARRANTY REQUIREMENTS FOR MECHANICAL EQUIPMENT

SECTION NUMBER		RECEIVED/DATE/INITIAL
230514	Variable Frequency Drives	_____
230923	Direct Digital Control for HVAC	_____
232116	Hydronic Specialties	_____
232133	Hydronic Packaged Pumping Systems	_____
232500	HVAC Water Treatment	_____
235216	Condensing Boilers	_____
236426	Rotary Screw Water Chillers	_____
237433	Dedicated Outdoor Air Units	_____
238126	Split Systems Air Conditioners	_____

TABLE 4: SPECIAL INSPECTION REQUIREMENTS FOR MECHANICAL EQUIPMENT

SECTION NUMBER		COMPLETED/DATE/INITIAL
230550	Vibration Isolation for HVAC	_____
235216	Condensing Boilers	_____

TABLE 5: MECHANICAL SPECIFICATION OPERATION AND MAINTENANCE SUBMITTAL REQUIREMENTS

SPECIFICATION NUMBER/TITLE		CODE DESIGNATION
230514	Variable Frequency Drives	B, C, D, E, G, H, I
230516	Expansion Fittings and Loops for HVAC Piping	A, B
230519	Meters and Gauges for HVAC Piping	B, G, I
230529	Hangers and Supports for HVAC Piping and Equipment	B
230548	Seismic Controls for Mechanical Systems	A, B, C
230550	Vibration Isolation for HVAC	A, B, C
230553	Identification for HVAC Piping and Equipment	B
230593	Testing, Adjusting and Balancing for HVAC	F
230700	HVAC Insulation	B
230800	Commissioning of HVAC Systems	F
230913	Instrumentation and Control Devices for HVAC	A, B, C, D, E, G, H, I
230914	Refrigerant Monitoring Systems	A, B, C, D, E, G, H, I
230915	Vehicle Emission Monitoring Systems	A, B, C, D, E, G, H, I
230921	Pneumatic Control Systems	A, B, D, H, G, I
230923	Direct-Digital Control for HVAC	A, B, C, D, E, F, G, H, I
230924	Small Building Control Panel	A, B, D, E, G, I
231113	Facility Fuel Oil Piping	A, B, C, D, G, I
232113	Hydronic Piping	A, B, C, F, G, H, I
232113.13	Underground Hydronic and Steam Piping	A, B, C, I
232114	Mechanically Joined Hydronic Piping Systems	A, B, C, G, H, I
232115	Ground Loop Heat Pump Piping	A, B, C, I
232116	Hydronic Specialties	A, B, C, I
232123	Hydronic Pumps	B, C, D, E, G, H, I
232133	Hydronic Packaged Pumping Equipment	B, C, D, E, G, H, I
232213	Steam and Condensate HVAC Piping	A, B, C, F, G, H, I
232216	Steam and Condensate Piping Specialties	A, B, C, I
232223	Steam Condensate Pumps	B, C, D, G, H, I
232300	Refrigerant Piping	A, B, C, I
232313	VRF Refrigerant Piping	A, B, F, I
232500	HVAC Water Treatment	B, C, D, E, G, H, I
232520	Pulsed Power Water Treatment System	A, B, C, D, E, F, G, I
232540	Silica Based Water Treatment System	A, B, C, D, E, F, G, I
233113	Metal Ducts	A, B
233116	Non-Metal Ducts	A, B
233117	Fabric Ducts	A, B
233300	Air Duct Accessories	B, H
233413	Axial HVAC Fans	B, C, G, I
233416	Centrifugal HVAC Fans	B, C, G, I
233423	HVAC Power Ventilators	B, C, G, I
233427	Laboratory Exhaust Fans	B, C, G, I
233433	Air Curtains	B, C, D, G, H, I
233600	Air Terminal Units	B, C, D, E, G, H, I
233713	Diffusers, Registers and Grilles	C, H
233723	HVAC Gravity Ventilators	C, H
233815	Grease Scrubbers	B, C, D, E, F, H, I
233813	Commercial Kitchen Hoods	A, B, C, D, E, G, H, I
234100	Particulate Air Filtration	B, C, D, G, H, I

234200	Ultraviolet Light Emitters	B, C, D, E, G, H, I
235100	Breechings, Chimneys And Stacks	A, B
235113	Draft Control Devices	A, B, C, D, E, G, H, I
235213	Electric Boilers	B, C, D, E, G, H, I
235216	Condensing Boilers	B, C, D, E, G, H, I
235223	Cast-Iron Boilers	B, C, D, E, G, H, I
235233.19	Finned Copper Water Tube Boilers	B, C, D, E, G, H, I
235233.22	Inclined Water-Tube Boilers	B, C, D, E, G, H, I
235233.25	Bent Tube Boilers	B, C, D, E, G, H, I
235239.13	Scotch Marine Boiler	B, C, D, E, G, H, I
235243	Firebox Boilers	B, C, D, E, G, H, I
235313	Boiler Feedwater Pumps	B, C, D, E, G, H, I
235316	Deaerators	B, C, D, E, G, H, I
235323	Boiler Accessories	B, C, D, E, G, H, I
235400	Furnaces	B, C, D, E, G, I
235500	Fuel-Fired Heaters	B, C, D, E, H, I
235700	Heat Exchangers for HVAC	B, C, G, H, I
236200	Packaged Compressor and Condensing Units	B, C, D, E, I
236313	Air-Cooled Refrigerant Condensers	B, C, D, E, G, H, I
236333	Evaporative Refrigerant Condensers	B, C, D, E, G, H, I
236416	Centrifugal Water Chillers	B, C, D, E, G, H, I
236419	Reciprocating Water Chillers	B, C, D, E, G, H, I
236423	Scroll Water Chillers	B, C, D, E, G, H, I
236426	Rotary Screw Water Chillers	B, C, D, E, G, H, I
236500	Cooling Towers	B, C, D, E, G, H, I
236533	Liquid Coolers	B, C, D, E, G, H, I
236534	Dry Coolers	B, C, D, E, G, H, I
237200	Air-To-Air Energy Recovery Equipment	B, C, D, E, H, I
237313	Modular Indoor Central Station Air Handling Units	B, C, D, H, G, I
237323	Custom Central Station Air Handling Units	B, C, D, H, G, I
237333	Indirect-Fired Heating & Ventilating Units	B, C, D, E, G, I
237339	Direct-Fired Heating & Ventilating Units	B, C, D, E, G, I
237413	Outdoor Packaged Heating and Cooling Units	B, C, D, E, G, H, I
237433	Dedicated Outdoor Air Units	B, C, D, E, G, H, I
237439	Indoor Packaged Heating and Cooling Units	B, C, D, E, G, H, I
237443	Evaporative Condensing Rooftop Units	B, C, D, E, G, H, I
238120	Evaporative Cooling Units	B, C, D, G, H, I
238123	Computer Room Air Conditioners	B, C, D, E, G, I
238127	Variable Refrigerant Flow (VRF) Split AC Systems	B, C, D, E, F, G, H, I
238146	Water-Source Unitary Heat Pumps	B, C, D, E, G, H, I
238149	Rooftop Heat Pump Units	B, C, D, E, G, H, I
238200	Terminal Heating and Cooling Units	B, C, D, H, I
238313	Electric Snow and Ice Melting System	A, B, G, I
238316	Radiant Hydronic Piping System	A, B, G, I
238325	Chilled Beams	B, C, E, G, I
238413	Humidifiers (Dispersion Type)	B, C, D, E, G, H, I
238414	Humidifiers (Immersion Type)	B, C, D, E, G, H, I
238415	Clean Steam Generators	B, C, D, G, H, I
238416	Mechanical Dehumidification Units	B, C, D, E, H, I
238417	Desiccant Wheel Units	B, C, D, G, H, I
238419	Swimming Pool Air Handling Units	B, C, D, E, G, H, I

238500	Electric Heating Units	B, C, D, E, I

CODED LEGEND

A	As-Built Drawings
B	Product Data
C	Performance Data, Capacities, Curves and Certificates
D	Wiring Diagrams
E	Operating Instructions
F	Test Reports
G	Warranties
H	Recommended Spare Parts List
I	Service and Maintenance Instructions

SUBSTITUTION REQUEST FORM

To Project Engineer: _____ Request # (GC Determined): _____

Project Name: _____

Project No/Phase: _____ Date: _____

Specification Title: _____

Section Number: _____ Page: _____ Article/Paragraph: _____

Proposed Substitution: _____

_____

Manufacturer: _____ Model No.: _____

Address: _____ Phone: _____

History: ☐ New product ☐ 1-4 years old ☐ 5-10 years old ☐ More than 10 years old

Differences between proposed substitution and specified Work: _____

_____

☐ Point-by-point comparative data attached – REQUIRED BY ENGINEER
Comparative data may include but not be limited to performance, certifications, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements. Include all information necessary for an evaluation.

Supporting Data Attached: ☐ Drawings ☐ Product Data ☐ Samples ☐ Tests ☐ Reports ☐ Other: _____

Reason for not providing specified item: _____

_____

Similar Installation:
Project: _____ Architect: _____

Address: _____ Owner: _____

_____ Date Installed: _____

Proposed substitution affects other parts of Work: ☐ No ☐ Yes; explain: _____

_____

_____

Substitution Certification Statement:

Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner that the:

A. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.
B. Proposed substitution is consistent with the Contract Documents and will produce indicated results.
C. Proposed substitution does not affect dimensions and functional clearances.
D. Proposed substitution has received necessary approvals of authorities having jurisdiction.
E. Same warranty will be furnished for proposed substitution as for specified Work.
F. Same maintenance service and source of replacement parts, as applicable, is available.
G. Proposed substitution will not adversely affect other trades or delay construction schedule.
H. Coordination, installation, and changes in the Work as necessary for accepted substitution will be complete in all respects.

Submitting Contractor	Date	Company

Manufacturer's Certification of Equal Quality:

I _____ represent the manufacturer of the Proposed Substitution item and hereby certify and warrant to Architect, Engineer, and Owner that the function and quality of the Proposed Substitution meets or exceeds the Specified Item.

Manufacturer's Representative	Date	Company

Engineer Review and Recommendation Section

Recommend Acceptance	☐ Yes	☐ No
Additional Comments:	☐ Attached	☐ None

Acceptance Section:

Contractor Acceptance Signature	Date	Company
Owner Acceptance Signature	Date	Company
Architect Acceptance Signature	Date	Company
Engineer Acceptance Signature	Date	Company

SECTION 230015 - ELECTRICAL COORDINATION FOR MECHANICAL EQUIPMENT

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section specifies the basic requirements for electrical components which are an integral part of packaged mechanical equipment. These components include, but are not limited to factory furnished motors, starters, and disconnect switches furnished as an integral part of packaged mechanical equipment.

B. Specific electrical requirements (i.e. horsepower and electrical characteristics) for mechanical equipment are scheduled on the Drawings.

C. System shall be complete and operational with power and control wiring provided to meet the design intent shown on the drawings and specified within the specification sections.

1.2 SUBMITTALS

A. No separate submittal is required. Submit product data for motors, starters, and other electrical components with submittal data required for the equipment for which it serves, as required by the individual equipment specification Sections.

1.3 QUALITY ASSURANCE

A. Electrical components and materials shall be UL labeled.

B. All electrical equipment provided and the wiring and installation of electrical equipment shall be in accordance with the requirements of this Section and Division 26.

PART 2 - PRODUCTS AND MATERIALS

2.1 GENERAL

A. The Contractors shall provide all motors, starters, disconnects, wire, conduit, etc. as specified in the Construction Documents. If, however, the Division 23 Contractor furnishes a piece of equipment requiring a different motor, starter, disconnect, wire size, etc. than what is shown and/or intended on the Construction Documents, this Contractor shall coordinate the requirements with any other Contractor and shall be responsible for any additional cost incurred by any other Contractor that is associated with installing the different equipment and related accessories for proper working condition.

B. Refer to Division 26, "COMMON WORK RESULTS FOR ELECTRICAL" for specification of motor connections.

C. Refer to Division 26, "ENCLOSED CONTROLLERS" for specification of motor starters.

D. Refer to Division 26, "ENCLOSED SWITCHES AND CIRCUIT BREAKERS" for specification of disconnect switches and enclosed circuit breakers.

PART 3 - EXECUTION

3.1 CONTRACTOR COORDINATION

A. Unless otherwise indicated, all motors, equipment, controls, etc. shall be furnished, set in place and wired in accordance with Table 1. Any items not listed but shown on the drawings shall be considered part of the Contract Documents and brought to the attention of the Architect.

B. The General Contractor is the central authority governing the total responsibility of all trade contractors. Therefore, deviations and clarifications of this schedule are permitted provided the General Contractor assumes responsibility to coordinate the trade contractors different than as indicated herein. If deviations or clarifications to this schedule are implemented, submit a record copy to the Engineer.

TABLE 1: ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT

ITEM	FURN BY	SET BY	POWER WIRING	CONTROL WIRING
Equipment motors	DIV23m	DIV23m	DIV26	---
Motor control centers	DIV26	DIV26	DIV26	DIV23t
Factory furnished motor starters contactors and disconnects	DIV23m	DIV23m	DIV26	DIV23t
Overload heaters	DIV23m	DIV26	---	---
Loose motor starters, disconnect switches, thermal overloads and heaters.	DIV26	DIV26	DIV26	DIV23t
Variable speed drives	DIV23m	DIV23m	DIV26	DIV23t
Manual operating multi-speed switches	DIV23m	DIV26	DIV26	DIV23t
Control relays	DIV23t	DIV23t	DIV26	DIV23t
Thermostats (low voltage)	DIV23t	DIV23t	---	DIV23t
Thermostats (line voltage)	DIV23m	DIV23m	DIV26	---
Time switches (for mechanical equipment)	DIV23t	DIV23t	DIV26	DIV23t
Control power transformers	DIV23t	DIV23t	DIV26	DIV23t
Control power transformers furnished with equipment	DIV23m	DIV23m	DIV26	DIV23t
Temperature control panels (housing controllers)	DIV23t	DIV23t	DIV26	DIV23t
Building controllers, advanced application controllers, and application specific controllers	DIV23t	DIV23t	DIV23t	DIV23t
Motor and solenoid operated valves	DIV23t	DIV23m	DIV23t	DIV23t
Presssure independent control valves	DIV23t	DIV23m	DIV23t	DIV23t
Damper operators, PE & switches	DIV23t	DIV23t	DIV23t	DIV23t
Smoke dampers and combination fire/smoke dampers	DIV23m	DIV23m	DIV26	DIV28
Smoke dampers for smoke control system	DIV23t	DIV23m	DIV26	DIV23t/28
Duct Smoke detectors	DIV28	DIV23m	DIV28	DIV28
Refrigeration equipment and controls	DIV23m	DIV23m	DIV26	DIV23t
Pushbutton stations and connections	DIV23m	DIV23m	DIV26	DIV23t
Interlocks between chiller control panel and pump(s)	---	---	---	DIV23m
Interlocks between air handling units and exhaust fans	---	---	---	DIV23m
Interlocks between HVAC fans and damper operators	---	---	DIV26	DIV23t
Interlocks between kitchen exhaust hood(s) and make-up air unit(s)	---	---	---	DIV23m

DIV23m = Mechanical Contractor DIV23t = Temperature Controls Sub-Contractor
DIV26 = Electrical Contractor
DIV28 = Electronic Safety and Security

END OF SECTION

SECTION 230500 - COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section includes limited scope general construction materials and methods for application with mechanical installations as follows:

1. Access panels and doors in walls, ceilings, and floors for access to mechanical materials and equipment.
2. Mechanical equipment nameplate data.
3. Concrete for bases and housekeeping pads.
4. Non-shrink grout for equipment installations.
5. Sleeves for mechanical penetrations.
6. Drip Pans with detection.
7. Miscellaneous metals for support of mechanical materials and equipment.
8. Wood grounds, nailers, blocking, fasteners, and anchorage for support of mechanical materials and equipment.
9. Joint sealers for sealing around mechanical materials and equipment.
10. Sealing penetrations through noise critical spaces.
11. Plenum insulation for enclosure of combustible items located within fire-rated plenums.
12. Firestopping

B. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 07 Section "Penetration Firestopping" for material and methods for firestopping systems.
2. Division 23 Section "Basic Piping Materials and Methods," for materials and methods for mechanical sleeve seals.
3. Division 23 Section "Direct Digital Controls for HVAC" for integration with building automation system of leak detection system "Water Present" alarm.
4. Division 26 Section "Common Work Results for Electrical" required electrical devices.
5. Division 26 Sections "Enclosed Switches and Circuit Breakers" for field-installed disconnects.

1.2 SUBMITTALS

A. General: Submit the following in accordance with Division 01 and Division 23 Section General Mechanical Requirements.

1. Product data for the following products:

a. Access panels and doors.

b. Joint sealers.

c. Through and membrane-penetration firestopping systems.

d. Plenum insulation.

2. Shop drawings detailing fabrication and installation for metal fabrications, and wood supports and anchorage for mechanical materials and equipment.

3. Welder certificates, signed by Contractor, certifying that welders comply with requirements specified under "Quality Assurance" article of this Section.

4. Schedules indicating proposed methods and sequence of operations for selective demolition prior to commencement of Work. Include coordination for shut-off of utility services and details for dust and noise control.

a. Coordinate sequencing with construction phasing and Owner occupancy specified in Division 01 Section "Summary of Work."

5. Through and Membrane Penetration Firestopping Systems Product Schedule: Submit a schedule for each piping system penetration that includes UL listing, location, wall or floor rating and installation drawing for each penetration fire stop system.

a. Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping condition, submit illustration, with modifications marked, approved by penetration firestopping manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

1.3 QUALITY ASSURANCE

A. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel."

1. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

B. Fire-Resistance Ratings: Where a fire-resistance classification is indicated, provide access door assembly with panel door, frame, hinge, and latch from manufacturer listed in the UL "Building Materials Directory" for rating shown.

1. Provide UL Label on each fire-rated access door.

C. Through and Membrane Penetration Firestopping Systems Installer Qualifications: A firm experienced in installing penetration firestopping systems similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its penetration firestopping system products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.

1.4 NOISE CRITICAL SPACES

A. Many areas of the building, referred to as "noise-critical spaces", require special attention (special acoustical provisions and restrictions). The table below designates the noise-critical spaces; noise levels due to equipment, ductwork, grilles, registers, terminal devices, diffusers, etc., shall permit attaining sound pressure levels in all 8 octave bands in occupied spaces conforming to RC levels per ASHRAE handbook as indicated.

Space	RC Levels
Stage	25
Sound/Lighting Control Rooms	25
A/V Spaces	25
Drama Theatre	25
Music Teaching Studios	25
Teleconference Rooms	25
Meeting/Banquet Rooms	30
Conference Rooms	30

PART 2 - PRODUCTS AND MATERIALS

2.1 ACCESS TO EQUIPMENT

A. Manufacturers:

1. Bar-Co., Inc.
2. Elmdor Stoneman.
3. JL Industries
4. Jay R. Smith Mfg. Co.
5. Karp Associates, Inc.
6. Milcor
7. Nystrom Building Products
8. Wade
9. Zurn

B. Access Doors:

1. Steel Access Doors and Frames: Factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation. Joints and seams shall be continuously welded steel, with welds ground smooth and flush with adjacent surfaces.

2. Frames: 16-gauge steel, with a 1-inch-wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile, or wood paneling.

   a. For installation in masonry, concrete, ceramic tile, or wood paneling: 1-inch-wideexposed perimeter flange and adjustable metal masonry anchors.

   b. For installation in gypsum wallboard or plaster: perforated flanges with wallboard bead.

   c. For installation in full-bed plaster applications: galvanized, expanded metal lath and exposed casing bead, welded to perimeter of frame.

3. Flush Panel Doors: 14-gauge sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees; factory-applied prime paint.

   a. Fire-Rated Units: Insulated flush panel doors, with continuous piano hinge and self-closing mechanism.

4. Locking Devices: Flush, screwdriver-operated cam locks.

5. Locking Devices: Where indicated on the drawings or where access panels are installed in locations accessible to the public, provide 5-pin or 5-disc type cylinder locks, individually keyed; provide 2 keys.

2.2 MECHANICAL EQUIPMENT NAMEPLATE DATA

A. For each piece of power operated mechanical equipment, provide a permanent operational data nameplate indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliance's, and similar essential data. Locate nameplates in an accessible location.

2.3 CONCRETE EQUIPMENT BASES/HOUSEKEEPING PADS

A. Provide concrete equipment bases and housekeeping pads for various pieces of floor mounted mechanical equipment. Concrete equipment bases/housekeeping pads shall generally conform to the shape of the piece of equipment it serves with a minimum 4" margin around the equipment and supports.

B. Form concrete equipment bases and housekeeping pads using framing lumber or steel channel with form release agent. Chamfer top edges and corners. Trowel tops and sides of each base/pad to a smooth finish, equal to that of the floors.

C. Concrete equipment bases and housekeeping pads shall be made of a minimum 28 day, 4000 psi concrete conforming to American Concrete Institute Standard Building Code for Reinforced Concrete (ACI 318-99) and the latest applicable recommendations of the ACI standard practice manual. Concrete shall be

composed of cement conforming to ASTM C 150 Type I, aggregate conforming to ASTM C33, and potable water. All exposed exterior concrete shall contain 5 to 7 percent air entrainment.

D. Unless otherwise specified or shown on the structural drawings, reinforce equipment bases and housekeeping pads with No. 4 reinforcing bars conforming to ASTM A 615 or 6x6 – W2.9 x W2.9 welded wire mesh conforming to ASTM A185. Reinforcing bars shall be placed 24" on center with a minimum of two bars each direction.

E. Provide galvanized anchor bolts for all equipment placed on concrete equipment bases and housekeeping pads or on concrete slabs. Anchor bolts size, number and placement shall be as recommended by the Manufacturer of the equipment.

F. Concrete equipment bases and housekeeping pads shall have height as specified on the drawings or minimum height if not specified in accordance with the following table:

Equipment	Minimum Height
Air Handling Units w/TSP less than or equal to 3.5", Boilers (See Note 1)	3-1/2"
Chillers, Condensate Pumps, Pumps up to 30 HP, Air Handling Units w/TSP greater than 3.5" (See Note 1)	5-1/2"

NOTES:

1. Height of equipment bases applies to equipment installed on slab-on-grade. For equipment installed on floors above grade and/or roof, reference the drawings.

2.4 PENETRATIONS

A. Sleeves:

1. Steel Sleeves: Schedule 40 galvanized, welded steel pipe, ASTM A-53 grade A or 12 gauge (0.1084 inches) welded galvanized steel formed to a true circle concentric to the pipe.

2. Sheet-Metal Sleeves: 10 gauge (0.1382 inches), galvanized steel, round tube closed with welded longitudinal joint.

B. Frames for rectangular openings attached to forms and of a maximum dimension established by the Architect. For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, provide 18 gauge (0.052 inches) welded galvanized steel. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, provide 10 gauge (0.1382 inches) welded galvanized steel. Notify the General Contractor or Architect before installing any box openings not shown on the Architectural or Structural Drawings.

2.5 DRIP PANS

A. Leak Detection System: Rope style leak sensor and controller capable of connecting to a building automation system with audible and visual alarms for leak detection and cable failure in all drip pans unless otherwise noted on drawings. Provide with factory 24V DC power supply with power plug, sensing cables, and accessories.

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

    a. RLE Technologies #LD1000

2.6 MISCELLANEOUS METALS

A. Steel plates, shapes, bars, and bar grating: ASTM A 36.

B. Cold-Formed Steel Tubing: ASTM A 500.

C. Hot-Rolled Steel Tubing: ASTM A 501.

D. Steel Pipe: ASTM A 53, Schedule 40, welded.

E. Fasteners: Zinc-coated, type, grade, and class as required.

2.7 MISCELLANEOUS LUMBER

A. Framing Materials: Standard Grade, light-framing-size lumber of any species. Number 3 Common or Standard Grade boards complying with WCLIB or AWPA rules, or Number 3 boards complying with SPIB rules. Lumber shall be preservative treated in accordance with AWPB LP-2, and kiln dried to a moisture content of not more than 19 percent.

B. Construction Panels: Plywood panels; APA C-D PLUGGED INT, with exterior glue; thickness as indicated, or if not indicated, not less that 15/32 inches.

2.8 JOINT SEALERS

A. General: Joint sealers, joint fillers, and other related materials compatible with each other and with joint substrates under conditions of service and application.

B. Colors: As selected by the Architect from manufacturer's standard colors.

C. Nonacid Curing Sealer: One-part, nonacid-curing, silicone sealant complying with ASTM C920, Type S, Grade NS, Class 25, for uses in non-traffic areas for masonry, glass, aluminum, and other substrates recommended by the sealant manufacturer.

1. Manufacturers:

    a. Dow Corning, Dowsil 790.

    b. Dow Corning, Dowsil 795.

    c. GE, Silglaze II SCS 2350.

    d. GE, Silpruf SCS 2000.

    e. Owens Corning, Energy Complete.

f. Pecora, 864 NST.

g. Tremco, Spectrem 1.

h. Tremco, Spectrem 2.

D. High Humidity Sealer: One-part, mildew-resistant, silicone sealant complying with ASTM C920, Type S, Grade NS, Class 25, for uses in non-traffic areas for glass, aluminum, and nonporous joint substrates; formulated with fungicide; intended for sealing interior joints with nonporous substrates; and subject to in-service exposure to conditions of high humidity and temperature extremes.

1. Manufacturers:

a. Dow Corning, Dowsil 786.

b. GE, Momentum SCS1700.

c. Pecora, 898 Silicone NST.

E. Hybrid Joint Sealer: One-part, non-sag, paintable complying with ASTM C920, Type S, Grade NS, Class 50, recommended for exposed applications on interior and exterior locations involving joint movement of not more than plus or minus 50 percent.

1. Manufacturers:

a. BASF, MasterSeal NP 100.

b. Pecora, DyanTrol I-XL.

c. Tremco, Dymonic FC.

F. Acrylic Latex Joint Sealer: One-part, non-sag, mildew-resistant, paintable acrylic latex or siliconized acrylic latex, complying with ASTM C834, Type OP, Grade NF, recommended for exposed applications on interior and protected exterior locations involving joint movement of not more than plus or minus 5 percent.

1. Manufacturers:

a. Pecora, AC-20

b. Sherwin Williams 950A

c. Tremco, Tremflex 834

2.9 ACOUSTICAL SEALANTS

A. General: Penetrations by ducts, pipes and conduit through surfaces that are around and between noise critical spaces shall be sleeved, packed and sealed airtight with foam rod, non-hardening sealant and/or packing material as described herein.

B. Foam Rod: Foam backer rod shall be closed cell polyethylene suitable for use as a backing for non-hardening sealant.

C. Non-Hardening Sealant: Sealant for penetrations shall be non-hardening. Permanently flexible, approved firestop putty may be used in lieu of the sealant on foam rod in noise critical walls that are also fire rated.

D. Packing Material: Mineral fiber; non-combustible; resistant to water, mildew and vermin. Expanding resilient foams manufactured for this purpose are an acceptable alternative only if the material density is at least 15 pcf (40 kg/m3).

E. Acoustical Joint Sealant: Manufacturer's standard non-sag, paintable, non-staining latex sealant complying with ASTM C834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E90. Meeting ASTM E84 for a smoke flame spread index of less than 25 / 50.

F. Manufacturers:

1. Pecora, AC-20 FTR.

2. Pecora, AIS-919.

3. USG, SHEETROCK Acoustical Sealant.

2.10 PLENUM INSULATION

A. General: Combustible materials including, but not limited to, plastic pipe and plastic-coated cables that do not meet the minimum combustibility requirements of the applicable building codes may be installed in fire-rated plenums when enclosed within high-temperature insulation blanket where approved by the authority having jurisdiction.

B. Material: FyreWrap 0.5 Plenum Insulation, ETS Schaefer Plenumshield Blanket, Thermal Ceramics PlenumWrap+, or equivalent utilizing light weight, high temperature blanket enhanced for biosolubility. The encapsulating material shall be aluminum foil with fiberglass reinforcing scrim covering.

C. Certification: Plenum insulation shall have an encapsulated flame spread rating less than 25 and a smoke developed rating of less than 50. The product shall be UL 1887 (Modified) listed, certified by ASTM E-136 for Non-combustibility and ASTM E-84/UL 723 for Surface Burning Characteristics.

D. Physical Properties: Plenum insulation shall be single 1" minimum layer with a density of 2 to 6 pounds per cubic foot.

2.11 FIRESTOPPING

A. Sealants and accessories shall have fire-resistance ratings indicated, as established by testing identical assemblies in accordance with UL 2079 or ASTM E814, or other NRTL acceptable to AHJ.

B. Manufacturers:

1. 3M Corp., Fire Barrier Sealant.
2. Hilti.
3. Owens Corning, Firestopping Insulation.
4. Pecora, AC-20 FTR.
5. RectorSeal.
6. Specified Technologies Inc., Firestop.
7. USG SHEETROCK Firecode Compound.
8. Tremco, Tremstop Fyre-Sil.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install products in accordance with manufacturer's instructions.

3.2 INSTALLATION OF ACCESS DOORS

A. Provide access doors for all concealed equipment and duct and piping accessories that require service where indicated or as required, except where above lay-in ceilings. Refer to Section "Identification for HVAC Piping and Equipment" for labeling of access doors.

B. Access doors shall be adequately sized for the devices served with a minimum size of 18 inches x 18 inches, furnished by the respective Contractor or Subcontractor and installed by the General Contractor.

C. Access doors must be of the proper construction for type of construction where installed.

D. The exact location of all access doors shall be verified with the Architect prior to installation.

E. Set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.

F. Adjust hardware and panels after installation for proper operation.

3.3 ERECTION OF METAL SUPPORTS AND ANCHORAGE

A. Cut, fit, and place miscellaneous metal fabrications accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

B. Field Welding: Comply with AWS "Structural Welding Code."

3.4 ERECTION OF WOOD SUPPORTS AND ANCHORAGE

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorage accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

B. Select fastener sizes that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.5 PREPARATION FOR JOINT SEALERS

A. Surface Cleaning for Joint Sealers: Clean surfaces of joints immediately before applying joint sealers to comply with recommendations of joint sealer manufacturer.

B. Apply joint sealer primer to substrates as recommended by joint sealer manufacturer. Protect adjacent areas from spillage and migration of primers, using masking tape. Remove tape immediately after tooling without disturbing joint seal.

3.6 APPLICATION OF JOINT SEALERS

A. General: Comply with joint sealer manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.

1. Comply with recommendations of ASTM C 962 for use of elastomeric joint sealants.

2. Comply with recommendations of ASTM C 790 for use of acrylic-emulsion joint sealants.

B. Tooling: Immediately after sealant application and prior to time shinning or curing begins, tool sealants to form smooth, uniform beads; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

3.7 PENETRATIONS:

A. New Construction:

1. Coordinate with Divisions 03 and 04 for installation of sleeves and sleeve seals integrally in cast-in-place, precast, and masonry walls and horizontal slabs where indicated on the Drawings or as required to support piping or ductwork penetrations.

B. Construction in Existing Facilities:

1. Saw cut or core drill existing walls and slabs to install sleeves and sleeve seals in existing facilities. Do not cut or drill any walls or slabs without first coordinating with, and receiving approval from, the Architect, Owner, or both. Seal sleeves and sleeve seals into concrete walls or slabs with a waterproof non-shrink grout acceptable to the Architect.

C. Provide sleeves and/or box frames for openings in all concrete and masonry construction and fire or smoke partitions, for all mechanical work that passes through such construction; Coordinate with other trades and Divisions to dimension and lay out all such openings.

D. The General Contractor will provide only those openings specifically indicated on the Architectural or Structural Drawings as being provided under the General Contractor's work.

E. The cutting of new or existing construction shall not be permitted except by written approval of the Architect.

F. Floor sleeves shall be fitted with means for attachment to forms and shall be of length to extend at least two inches above the floor level.

G. All sleeves shall be of ample size to allow for movement of conduit, duct or pipe and insulation through the sleeves without damage to the insulation.

H. Cut sleeves to length for mounting flush with both surfaces of walls.

I. Extend sleeves installed in floors 2 inches above finished floor level.

J. Seal space outside of sleeves with grout for penetrations of concrete and masonry.

K. Seal space outside of sleeves with approved joint compound for penetrations of gypsum board assemblies.

L. All openings sleeved through underground exterior walls shall be sealed with mechanical sleeve seals as specified in Division 23 Section "Basic Piping Materials and Methods".

3.8 DRIP PANS

A. Provide drip pans in locations indicated on drawings.

B. Provide drip pans for piping or equipment installed over electrical panels in variance with the drawings. Obtain approval from the Architect prior to installation.

C. Provide drip pans, only with written approval obtained prior to installation, installed beneath piping above electrical rooms, telecom rooms, data rooms, servers or any other protected area not clearly indicated by drawings.

D. Provide drip pan supports every 4'-0".

E. Install leak detection rope in a zig-zag pattern covering entire length and width of the drip pan. Secure rope to pan per manufacturers recommendations.

F. Mount leak detection controller on wall adjacent to exit of the room above which the drip pan is located unless otherwise indicated on drawings indicated on drawings.

G. Coordinate disconnect and power supply for leak detection system and 120V dedicated receptacle adjacent to controller with Division 26. Power wiring and receptacles are specified in Division 26 Section "Common Work Results for Electrical". Disconnects are specified in Division 26 Section "Enclosed Switches and Circuit Breakers"

H. Place flood detector in the lowest location in the drip pan. Interlock detector with the HVAC equipment per manufacturer's recommendations.

I. Wire flood detector to remote alarm, Diversitech Universal Alarm or equivalent. Coordinate location of the remote alarm with building owner prior to installation.

J. Coordinate interlock of "Water Present" alarm and "Cable Fault" alarm with building automation system. Refer to Division 23 Section "Direct Digital Controls for HVAC" for integration with building automation system and low voltage power wiring.

3.9 ACOUSTICAL PENETRATIONS

A. General: There shall be no direct contact of Sheet Metal or piping with shaft walls, floor slabs and/or partitions. All openings around pipes and ducts in the structure surrounding the mechanical equipment and surrounding noise-critical spaces shall be sealed, packed with caulking for the full depth of the penetration, as described herein.. This includes all slab penetrations and penetrations of noise critical walls.

B. Duct Penetrations: Where each duct passes through a wall, floor or ceiling of a noise critical space, there shall be a clear annular space of 1 inch between the duct and structure. After all of the ductwork is installed, the Contractor shall check the clearance, pack the voids full depth with packing material and caulk both ends with non-hardening sealant backed by foam rod or permanently flexible firestop material. Where there is not sufficient access space to pack around all sides of a duct (for example, at the underside of a slab), place a short stub duct in the wall, pack and caulk around it and then attach the inlet and outlet ducts to each end.

C. HVAC Piping:

1. Provide a steel sleeve cast or grouted into the structure. The internal diameter of the sleeve shall be 2 inches larger than the external diameter of the pipe passing through it. After all of the piping is installed in that area, verify the specified clearance and correct it, if necessary, to within 1/2 inch. Pack the void full depth with packing material sealed at both ends, 1 inch deep, with non-hardening sealant backed by foam rod.

2. Provide factory fabricated split seal clamp around the pipe filled with closed-cell neoprene sponge insulation, thickness as required to match adjacent insulation, minimum 3/4 inch. Cast or grout the sleeve into the structure. Provide fiberglass insulation if the pipe is subject to temperatures greater than 225 degrees F. Provide Mason Industries Type SWS or approved equal.

3.10 PLENUM INSULATION

A. General: Plenum insulation shall be installed as a single layer encapsulation applied directly on the surface of combustible items within fire-rated plenums where permitted by the local authority having jurisdiction

B. Overlap: Provide a minimum 1" perimeter and longitudinal overlap at all seams and joints. Seal all cut edges with aluminum foil tape. There shall be no exposed fiber.

C. Secure Attachment: Securely attach insulation using stainless steel tie wire or banding at locations and intervals as recommended by the manufacturer. The entire installation shall comply with the manufacturer's written installation instructions.

D. Approval: Plenum insulation shall not be installed where not allowed by local authority having jurisdiction. Do not install combustible material within fire-rated plenums where the use of plenum insulation is not approved.

END OF SECTION

SECTION 230510 - BASIC PIPING MATERIALS AND METHODS

PART 1 - GENERAL REQUIREMENTS

1.1 SECTION INCLUDES

A. Joining materials.

B. Escutcheons.

C. Nipples.

D. Unions.

E. Dielectric waterway fittings.

F. Dielectric flanges and flange kits.

G. Mechanical sleeve seals.

H. Pipe roof curbs.

1.2 RELATED SECTIONS

A. Division 23 Section "Common Work Results for HVAC," for materials and methods for sleeve materials.

B. Division 26 Sections "Common Work Results for Electrical" and "Enclosed Controllers" for power-supply wiring including field-installed disconnects and required electrical devices.

1.3 SUBMITTALS

A. Refer to Division 01 and Division 23 Section "General Mechanical Requirements" for administrative and procedural requirements for submittals.

B. Product Data, including, rated capacities of selected models, weights (shipping, installed, and operating), furnished specialties and accessories, and installation instructions.

C. Quality Control Submittals: Submit welders' certificates specified in Quality Assurance below.

D. Piping Schedule: Submit a piping schedule that states the material being proposed for each piping system in the project including manufacturer, pipe sizes, type, grade, schedule, and ASTM standard and connection method(s).

E. Submit a schedule of dissimilar metal joints and dielectric flanges, flange kits, unions, or waterway fittings. Include proposed product, joint type materials, and connection method to isolate dissimilar metals. Refer to the individual Division 23 piping system specification sections for piping materials and fittings relative to that particular system and additional requirements.

F. Submit certification that fittings and specialties are manufactured in plants located in the United States or certified that they comply with applicable ANSI and ASTM standards.

1.4 QUALITY ASSURANCE

A. Welder's Qualifications: All welders shall be qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications.

B. Welding procedures and testing shall comply with ANSI Standard B31.9 - Standard Code for Building Services Piping, and The American Welding Society, Welding Handbook.

C. Soldering and Brazing procedures shall conform to ANSI B9.1 Standard Safety Code for Mechanical Refrigeration.

D. Pipe specialties and fittings shall be manufactured in plants located in the United States or certified to meet the specified ASTM and ANSI standards.

PART 2 - PRODUCTS AND MATERIALS

2.1 PIPE AND FITTINGS

A. Refer to the individual piping system specification sections in Division 23 for specifications on piping and fittings relative to that particular system.

2.2 JOINING MATERIALS

A. Refer to individual Division 23 Piping Sections for special joining materials not listed below.

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

C. Welding Materials: AWS D10.12; Comply with Section II, Part C, ASME Boiler and Pressure Vessel Code for welding materials appropriate for the wall thickness and chemical analysis of the pipe being welded.

D. Brazing Materials: AWS A5.8; Comply with SFA-5.8, Section II, ASME Boiler and Pressure Vessel Code for brazing filler metal materials appropriate for the materials being joined.

E. Soldering Materials: ASTM B32; Refer to individual piping system specifications for solder appropriate for each respective system.

F. Gaskets for Flanged Joints: ASME B16.21; Gasket material shall be full-faced for cast-iron flanges and raised-face for steel flanges. Select material, thickness, and type to suit the service of the piping system in which installed and which conform to their respective ANSI Standard (A21.11, B16.20, or B16.21). Provide materials that will not be detrimentally affected by the chemical and thermal conditions of the fluid being carried.

2.3 ESCUTCHEONS

A. Manufacturers:

1. AWI Manufacturing.
2. Keeney Manufacturing Company.
3. Wal-Rich Corp.
4. Jones Stephens Corp.
5. Approved equal.

B. Chrome-plated, stamped-steel, hinged, split-ring escutcheon, with set screw. Inside diameter shall closely fit pipe outside diameter, or outside of pipe insulation where pipe is insulated. Outside diameter shall completely cover the opening in floors, walls, or ceilings.

2.4 NIPPLES

A. Steel: ASTM A733, made of ASTM A53, Schedule 40, black steel; Type S seamless for pipe sizes 2 inch and smaller, Type E electric-resistance welded for pipe sizes 2-1/2 inch and larger.

2.5 UNIONS:

A. Manufacturers:

1. Anvil International.
2. Hart Industries.
3. Mueller Streamline Co.
4. Victaulic Company of America.
5. Watts Regulator Co.
6. Approved equal.

B. Hexagonal stock, with ball-and-socket joints, metal-to-metal bronze seating surfaces; female threaded ends.

1. Malleable-iron: ASME B16.39, class as specified in section "Hydronic Piping" for the piping system used.

2. Bronze: ASME B16.15, cast bronze body meeting ASTM B62, class as specified in section "Hydronic Piping" for the piping system used.

2.6 MECHANICAL SLEEVE SEALS

A. Manufacturers:

1. Thunderline/Link Seal.

2. Calpico, Inc.

3. Metraflex Co.

4. Approved equal.

B. Sleeves: Refer to Division 23 Section "Common Work Results for HVAC" for sleeve materials.

C. Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

2.7 PIPE ROOF CURBS

A. Manufacturers:

1. AES Industries.

2. Custom Curb, Inc.

3. Pate Company.

4. Thybar.

B. Provide factory-fabricated, pipe roof curbs with the following features:

1. Factory installed treated wood nailer.

2. Welded, 18 gauge galvanized steel shell, base plate and flashing.

3. 1-1/2 inch thick, 3 pound rigid insulation.

4. Fully mitered 3-inch raised cant.

5. Cover of weather-resistant, weather-proof material.

6. Pipe collar of weather-resistant material with stainless steel pipe clamps.

PART 3 - EXECUTION

3.1 PREPARATION

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

B. Remove scale, slag, dirt, and debris for both inside and outside of piping and fittings before assembly.

3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated. Refer to individual system specifications for requirements for coordination drawing submittals.

C. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.

D. Install piping free of sags and bends and with ample space between piping to permit proper insulation applications.

E. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated on the Drawings.

F. Install horizontal piping as high as possible allowing for specified slope and coordination with other components. Install vertical piping tight to columns or walls. Provide space to permit insulation applications, with 1 inch clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.

G. Locate groups of pipes parallel to each other, spaced to permit applying full insulation and servicing of valves.

H. Support piping from structure. Do not support piping from ceilings, equipment, ductwork, conduit and other non-structural elements.

I. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, 3/4 inch ball valve, and short 3/4 inch threaded nipple and cap.

J. Verify final equipment locations for roughing in.

K. Use fittings for all changes in direction and all branch connections.

L. Remake leaking joints using new materials.

M. Install components with pressure rating equal to or greater than system operating pressure.

N. Piping Protection:

1. Protect piping during construction period, to avoid clogging with dirt and debris, and to prevent damage from traffic and construction work.

2. Place plugs in ends of uncompleted piping at end of day or whenever work stops.

O. Penetrations:

1. Mechanical penetrations occur when piping or ductwork penetrate concrete slabs, concrete or masonry walls, or fire / smoke rated floor and wall assemblies. Reference Division 23 Section "Common Work Results for HVAC" for additional penetration requirements.

2. Above Grade Concrete or Masonry Penetrations:

a. Provide sleeves for pipes passing through above grade concrete or masonry walls, concrete floor or roof slabs. Sleeves are not required for core drilled holes in existing masonry walls, concrete floors or roofs.

1) Provide Schedule 40 galvanized steel pipe for sleeves smaller than 6 inches in diameter.

2) Provide galvanized sheet metal for sleeves 6 inches in diameter and larger, thickness shall be 10 gauge (0.1382 inches).

3) Provide welded galvanized sheet metal for rectangular sleeves with the following minimum metal thickness:

a) For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 18 gauge (0.052 inches).

b) For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 10 gauge (0.1382 inches).

4) Schedule 40 PVC pipe sleeves are acceptable for use in areas without return air plenums.

b. Extend pipe insulation for insulated pipe through floor, wall and roof penetrations, including fire rated walls and floors. The vapor barrier shall be maintained. Size sleeve for a minimum of 1 inch annular clear space between inside of sleeve and outside of insulation.

c. Seal elevated floor, exterior wall and roof penetrations watertight and weathertight with non-shrink, non-hardening commercial sealant. Pack with mineral wool and seal both ends with minimum of 1/2 inch of sealant.

3. Above Ground, Exterior Wall Penetrations:

    a. Seal annular space between sleeve and pipe or duct, using joint sealant appropriate for size, depth, and location of joint. Pack with mineral wool and seal both ends with minimum of 1/2 inch of waterproof sealant. Refer to Division 07 Section "Joint Sealants" for materials and installation.

    b. Extend pipe insulation for insulated pipe through sleeve. The vapor barrier shall be maintained. Size sleeve for a minimum of 1 inch annular clear space between inside of sleeve and outside of insulation.

4. Concrete Slab on Grade Penetrations:

    a. Provide schedule 40 PVC pipe sleeves for vertical pressure pipe passing through concrete slab on grade. Sleeves shall be one nominal pipe size larger than the pipe served and two pipe sizes larger than pipe served for ductile iron pipes with restraining rods. Seal water-tight with silicone caulk.

    b. Provide 1/2 inch thick cellular foam insulation around perimeter of non-pressure pipe passing thru concrete slab on grade. Insulation shall extend to 2 inches above and below the concrete slab.

5. Interior Penetrations of Non-Fire-Rated Walls:

    a. Seal annular space between sleeve and pipe or duct, using joint sealant appropriate for size, depth, and location of joint. Pack with mineral wool and seal both ends with minimum of 1/2 inch of sealant. Refer to Division 07 Section "Joint Sealants" for materials and installation.

    b. Extend pipe insulation for insulated pipe through sleeve. The vapor barrier shall be maintained. Size sleeve for a minimum of 1 inch annular clear space between inside of sleeve and outside of insulation.

6. Fire / Smoke Rated Floor and Wall Assemblies:

    a. Seal around penetrations of fire rated assemblies to maintain fire resistance rating of fire-rated assemblies. Coordinate fire ratings and locations with the architectural drawings. Install sealants in compliance with the manufacturer's UL listing. Refer to Division 07 Section "Penetration Firestopping" for special sealers and materials.

7. Acoustical Barrier Penetrations:

    a. Where a pipe passes through a wall, ceiling or floor slab of a noise critical space, a steel sleeve shall be cast or grouted into the structure. Refer to Section "Common Work Results for HVAC" for noise critical spaces. The internal diameter of the sleeve shall be minimum of 2 inches larger than the external diameter of the pipe. After the piping is installed, the Contractor shall check the clearance and correct it to within 1/2-inch. Contractor shall pack the void full depth with glass/mineral fiber insulation and seal at both ends, 1-inch deep, with sealant backed by foam rod.

b. Penetration of sound isolating ceilings by sprinkler pipes and heads shall be sleeved and sealed and shall have no rigid connections between them.

3.3 JOINTS

A. Steel Pipe Joints:

1. Pipe 2 Inch and Smaller:

a. Thread pipe with tapered pipe threads in accordance with ANSI B2.1. Cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Apply pipe joint lubricant or sealant suitable for the service for which the pipe is intended on the male threads at each joint and tighten joint to leave not more than 3 threads exposed.

2. Pipe Larger Than 2 Inch:

a. Weld pipe joints (except for exterior water service pipe) in accordance with ASME Code for Pressure Piping, B31.

b. Install flanges on all valves, apparatus, and equipment. Weld pipe flanges to pipe ends in accordance with ASME B31.9 Code for Building Services Piping. Clean flange faces and install gaskets. Tighten bolts to torque specified by manufacturer of flange and flange bolts, to provide uniform compression of gaskets.

B. Non-ferrous Pipe Joints:

1. Brazed and Soldered Joints: For copper tube and fitting joints, braze joints in accordance with ANSI B31.9 - Standard Code for Building Services Piping and ANSI B9.1 - Standard Safety Code for Mechanical Refrigeration.

2. Thoroughly clean tube surface and inside surface of the cup of the fittings, using very fine emery cloth, prior to making soldered or brazed joints. Wipe tube and fittings clean and apply flux. Flux shall not be used as the sole means for cleaning tube and fitting surfaces.

C. Joints for other piping materials are specified within the respective piping system Sections.

3.4 DIELECTRIC WATERWAY FITTINGS

A. Install dielectric waterway fittings for piping 2 inch and smaller for copper or brass pipe connections to carbon steel equipment connections.

3.5 DIELECTRIC FLANGES AND FLANGE KITS

A. Install dielectric flanges for piping 2-1/2 inch and larger to connect piping materials of dissimilar metals in dry piping systems (gas, compressed air, vacuum) for the following conditions:

1. Copper or brass connected to carbon steel, stainless steel, cast or ductile iron.

B. Install dielectric flanges for piping 2-1/2 inch and larger to connect piping materials of dissimilar metals in wet piping systems (water, steam) for the following conditions:

1. Copper or brass connected to carbon steel, stainless steel, cast or ductile iron.

2. Install waterway fittings where installation is concealed. Do not install dielectric flanges in concealed spaces.

C. Provide brass nipples between the equipment connection and dielectric flange for screwed connections. Provide an iron flange for the equipment side and a bronze flange for the copper or brass piping side of the joint.

D. Provide a bronze flange for the copper or brass piping connection to a cast iron, ductile iron or steel flange.

E. Provide full face gasket with pressure rating equal to system served.

F. At each bolt provide steel washers, thermoplastic washers, and bolt isolation sleeves or thermoplastic combination washers and bolt sleeves.

G. PIPE FIELD QUALITY CONTROL

1. Testing: Refer to individual piping system specification sections.

END OF SECTION 230510

SECTION 230513 - COMMON MOTOR REQUIREMENT FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. General construction and requirements.

B. Applications.

C. Single phase electric motors.

D. Three phase electric motors.

E. Electronically Commutated Motors (ECM).

F. Capacitors.

1.2 REFERENCE STANDARDS

A. ABMA STD 9 – Load Ratings and Fatigue Life for Ball Bearings; most recent edition.

B. IEEE 112 – IEEE Standard Test Procedure for Polyphase Induction Motors and Generators; most recent edition.

C. NEMA MG 1 – Motors and Generators; most recent edition.

D. NFPA 70 – National Electrical Code; most recent edition adopted by the Authority Having Jurisdiction, including all applicable amendments and supplements.

1.3 SUBMITTALS

A. Conform with the submittal procedures in Division 01.

B. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements. Provide nameplate data and ratings, mounting arrangements, size and location of winding termination lugs, overload relays, conduit entry, grounding lug, and coatings.

C. Test Reports: Indicate test results verifying nominal efficiency and power factor for three phase motors larger than 1/2 horsepower.

D. Manufacturer's Installation Instructions: Indicate setting, mechanical connections, lubrication, and wiring instructions.

E. Operation Data: Include instructions for safe operating procedures.

F. Maintenance Data: Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.5 DELIVERY STORAGE AND HANDLING.

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

1.6 WARRANTY

A. Provide five year manufacturer warranty for motors larger than 20 horsepower.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

A. Baldor Electric Company.

B. General Electric.

C. Gould.

D. Marathon.

E. Regal-Beloit Corporation (Century).

F. Westinghouse

2.2 GENERAL CONSTRUCTION AND REQUIREMENTS

A. Electrical Service: All motors shall be supplied in accordance with the following voltage and phase unless noted otherwise on the Drawings.

1. Motors less than 1/2 HP: 115 volts, single phase, 60 Hz.

2. Motors 1/2 HP and Larger: Voltage as scheduled, three phase, 60 Hz.

B. Construction:

1. Open drip-proof except where noted otherwise.

2. Design for continuous operation in 104 degrees F environment.

3. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type. Provide built-in thermal overload protection and, where indicated, provide internal sensing device suitable for signaling and stopping motor at starter.

4. Motors3/4 HP and above: Energy Efficient Type.

5. Provide "Quiet" rating on motors located in occupied spaces of building.

C. Explosion-Proof Motors: UL approved and labeled for hazard classification, with over temperature protection.

D. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.

E. Wiring Terminations:

1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.

2. For fractional horsepower motors where connection is made directly, provide flexible conduit connection in end frame. Maximum length of flexible conduit shall be five feet.

2.3 APPLICATIONS

A. Exception: Motors less than 250 Watts, for intermittent service may be the equipment manufacturer's standard and need not comply with these specifications.

B. Single phase motors for shaft mounted fans or blowers: Permanent split capacitor type.

C. Single phase motors for fans, pumps, blowers and air compressors: Capacitor start type.

D. Single phase motors for fans less than 1 hp and greater than 1/12 hp: Electronically commutated type.

E. Motors located in exterior locations, air cooled condensers, humidifiers and explosion proof environments: Totally enclosed fan cooled type.

2.4 SINGLE PHASE POWER - PERMANENT-SPLIT CAPACITOR MOTORS

A. Starting Torque: Exceeding one fourth of full load torque.

B. Starting Current: Up to six times full load current.

C. Multiple Speed: Through tapped windings.

D. Open Drip-proof: Class A (50 degrees C temperature rise) insulation, minimum 1.35 Service Factor, prelubricated sleeve or ball bearings, automatic reset overload protector.

2.5 SINGLE PHASE POWER - CAPACITOR START MOTORS

A. Starting Torque: Three times full load torque.

B. Starting Current: Less than five times full load current.

C. Pull-up Torque: Up to 350 percent of full load torque.

D. Breakdown Torque: Approximately 250 percent of full load torque.

E. Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.

F. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor minimum 1.35, prelubricated ball bearings.

G. Totally enclosed fan cooled Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

2.6 THREE PHASE POWER - SQUIRREL CAGE MOTORS

A. Starting Torque: Between 1 and 1-1/2 times full load torque.

B. Starting Current: Six times full load current.

C. Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics except Design C where required for high starting torque.

D. Design, Construction, Testing, and Performance: Conform to NEMA MG 1 for Design B motors.

E. Insulation System: NEMA Class B or better.

F. Drip-proof Enclosure: NEMA Service Factor.

G. All motors controlled by variable frequency controllers shall have a 1.15 Service Factor.

H. Testing Procedure: In accordance with IEEE 112. Load test motors to determine free from electrical or mechanical defects in compliance with performance data.

I. Motor Frames: NEMA 48 Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.

J. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors imbedded in motor windings and epoxy encapsulated solid state control relay for wiring into motor starter; refer to Division 26 - Motor Controlling Equipment.

K. Bearings: Grease lubricated anti-friction ball or roller bearings with housings equipped with plugged provision for relubrication, rated for minimum AFBMA 9, L-10 life of 100,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Where belt or other drives produce lateral or axial thrust in motor, provide bearings designed to resist thrust loading. Stamp bearing sizes on nameplate.

L. Sound Power Levels: To NEMA MG 1.

M. All totally enclosed motors shall be fan cooled type. Non-ventilated type motors are not acceptable.

N. Motors controlled by variable frequency drives:

1. Rated for voltage peaks and minimum rise times in accordance with NEMA MG1, Part 31.

2. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.

3. Inverter-Duty Motors: Class B temperature rise; Class F insulation.

4. Grounding: Provide shaft grounding system equal to AEGIS SGR Bearing Protection Ring, Inpro/Seal Current Diverter Ring (CDR) or approved equal. Install system in accordance with manufacturer's recommendations.

5. Motor Overload Relay: When a single drive is used to supply power to multiple motors, provide a solid state 3-phase adjustable overload relay between the drive and each motor.

a. Relay shall have manual reset.

b. Provide alarm contact with automatic reset overloads.

O. Part Winding Start, Where Indicated: Use part of winding to reduce locked rotor starting current to approximately 60 percent of full winding locked rotor current while providing approximately 50 percent of full winding locked rotor torque.

P. Weatherproof Epoxy Sealed Motors: Epoxy seal windings using vacuum and pressure with rotor and starter surfaces protected with epoxy enamel; bearings double shielded with waterproof non-washing grease.

Q. Nominal Efficiency: Motors shall have minimum NEMA premium efficiency at full load and rated voltage when tested in accordance with IEEE 112.

R. Nominal Power Factor: As scheduled at full load and rated voltage when tested in accordance with IEEE 112.

2.7 ELECTRONICALLY COMMUTATED MOTORS (ECM)

A. Minimum efficiency: 70 percent when rated in accordance with NEMA Standard MG 1 at full load rating conditions.

B. Motor shall be permanently lubricated with heavy-duty ball bearings to match the equipment load and prewired to the specific voltage and phase.

C. Internal motor circuitry shall convert AC power supplied to the equipment to DC power to operate the motor.

D. Motor shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by either a potentiometer dial mounted on the motor or by a 0-10 VDC signal.

2.8 CAPACITORS

A. Furnish capacitors for power factor correction as specified herein on motors furnished under Division 23 that are not connected to variable frequency drives. KVAR size shall be as required to correct motor power factor to 90 percent or better and shall be installed on all motors 1 horsepower and larger, that have an uncorrected power factor of less than 85 percent at rated load.

B. Features:

1. Individual unit cells.

2. All welded steel housing.

3. Each capacitor internally fused.

4. Non-flammable synthetic liquid impregnated.

5. Craft tissue insulation.

6. Aluminum foil electrodes.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install securely on firm foundation.

C. Check line voltage and phase and ensure agreement with nameplate.

3.2 NEMA OPEN MOTOR SERVICE FACTOR SCHEDULE

HP	3600 RPM	1800 RPM	1200 RPM	900 RPM
1/6-1/3	1.35	1.35	1.35	1.35
1/2	1.25	1.25	1.25	1.15
3/4	1.25	1.25	1.15	1.15
1	1.25	1.15	1.15	1.15
1.5-150	1.15	1.15	1.15	1.15

3.3 PERFORMANCE SCHEDULE: THREE PHASE - OPEN DRIP-PROOF

HP	RPM(Sync)	NEMA Frame	Minimum Percent Efficiency	Minimum Power Factor
1	1200	145T	80	72
1-1/2	1200	182T	85	73
2	1200	184T	85.5	75
3	1200	213T	86.5	60
5	1200	215T	87.5	65
7-1/2	1200	254T	90	73
10	1200	256T	90.2	74
15	1200	284T	90.2	77
20	1200	286T	92	78
25	1200	324T	92	74
30	1200	326T	92.4	78
40	1200	364T	93	77
50	1200	365T	93	79
60	1200	404T	93.6	82
75	1200	405T	95	80
100	1200	444T	95	80
125	1200	444T	95	84
1	1800	143T	82.5	84
1-1/2	1800	145T	85	85
2	1800	145T	85	85
3	1800	182T	86.5	86
5	1800	184T	87.5	87
7-1/2	1800	213T	90	86
10	1800	215T	90	85
15	1800	256T	91	85
20	1800	256T	92	86
25	1800	284T	92	85
30	1800	286T	92.4	88
40	1800	324T	93	83
50	1800	326T	93	85
60	1800	364T	93.6	88
75	1800	365T	95	88
100	1800	404T	95	83
125	1800	405T	95	86

150	1800	444T	95	85
200	1800	445T	95	85
1-1/2	3600	143T	85	85
2	3600	145T	85	87
3	3600	145T	85	85
5	3600	182T	85.5	86
7-1/2	3600	184T	90	88
10	3600	213T	90	86
15	3600	215T	90	89
20	3600	254T	92	89
25	3600	256T	92	92
30	3600	284T	92	91
40	3600	286T	92	92
50	3600	324T	92.4	89
60	3600	326T	93	91
75	3600	364T	95	88
100	3600	365T	95	88

3.4 PERFORMANCE SCHEDULE: THREE PHASE-ENERGY EFFICIENT, TOTALLY ENCLOSED, FAN COOLED

HP	RPM(Sync)	NEMA Frame	Minimum Percent Efficiency	Minimum Power Factor
1	1200	145T	80	72
1-1/2	1200	182T	85.5	65
2	1200	184T	86.5	68
3	1200	213T	87.5	63
5	1200	215T	87.5	66
7-1/2	1200	254T	90	68
10	1200	256T	90	75
15	1200	284T	90.2	72
20	1200	286T	92	76
25	1200	324T	92	71
30	1200	326T	92	79
40	1200	364T	93	78
50	1200	365T	93	81
60	1200	404T	93.6	83
75	1200	405T	95	80
100	1200	444T	95	83
125	1200	445T	95	85
1	1800	143T	82.5	84
1-1/2	1800	145T	85	85
2	1800	145T	85	85
3	1800	182T	87.5	83
5	1800	184T	87.5	83
7-1/2	1800	213T	90	85
10	1800	215T	90	84

15	1800	254T	92	86
20	1800	256T	92	85
25	1800	284T	92.4	84
30	1800	286T	92.4	86
40	1800	324T	93	83
50	1800	326T	93	85
60	1800	364T	93.6	87
75	1800	365T	95	87
100	1800	405T	955	86
125	1800	444T	955	87
150	1800	445T	95	88
200	1800	447T	95	87
1-1/2	3600	143T	85	85
2	3600	145T	85	87
3	3600	182T	85.5	87
5	3600	184T	87.5	88
7-1/2	3600	213T	90	86
10	3600	215T	90	86
15	3600	254T	90.2	91
20	3600	256T	92	89
25	3600	284T	92	92
30	3600	286T	92	92
40	3600	324T	92	91
50	3600	326T	92.4	92
60	3600	364T	93	93
75	3600	365T	95	91
100	3600	405T	95	92

END OF SECTION 230513

SECTION 230514 - VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. Variable speed drives shall be furnished for those units so indicated on the drawings. All variable speed drives provided under this section shall be by the same manufacturer.

B. Type of variable speed drive specified in this Section include the following:

1. Pulse Width Modulated

1.2 QUALITY ASSURANCE

A. Testing: The variable speed drive, all components and subassemblies shall be factory tested. The variable speed drive shall be tested and cycled under motor load.

B. Reliability: A complete description of supplier's Quality Assurance and Testing program shall be provided.

1. Component Testing: All power semiconductors and integrated circuits shall be 100% tested.

2. Computerized ATE Testing: Computerized Automated Testing Equipment (ATE) testing shall be used to evaluate functional performance of printed circuit boards. Printed circuit boards shall receive a thermal stress test where temperatures are cycled between 0°C and 65°C and receive electrical power-on and power-off cycle tests.

3. Burn In: All VFD's shall be tested/run in the equivalent of a NEMA 3R enclosure and burned in at rated ambient (40°C) with a fully loaded motor.

1.3 CODES AND STANDARDS:

A. The VFD shall meet the following standards.

1. Institute of Electrical and Electronic Engineers (IEEE)

a. Standard 519-2014 IEEE Recommended Practice and Requirements for Harmonic Control in Electric Power Systems

2. Nationally recognized testing lab such as UL or ETL

a. UL 508C (Variable frequency drive)

b. UL 508A (Bypass)

3. NEMA – ICS 7.0, AC Adjustable Speed Drives

1.4 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

1. Product Data: Submit manufacturer's technical product data for variable speed drive including dimensions, capacities, component performance data, ratings, features, motor electrical characteristics, over current protection rating, gages and finishes of material, and installation instructions.

2. Shop Drawings: Submit assembly-type shop drawings including unit dimensions, required clearances, control description, construction details, and field connection details.

3. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to variable speed drives. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

4. Maintenance Data: Submit maintenance instructions, including instructions for adjustments, troubleshooting, operation, testing and spare parts lists. Include this data, product data, shop drawings, and wiring diagrams in maintenance manuals; in accordance with requirements of Division 1 and Division 23 Section "General Mechanical Requirements."

5. Harmonic Analysis Report: Provide project-specific calculations and manufacturer's statement of compliance with IEEE 519.

1.5 WARRANTY

A. Provide warranty including on site parts and labor for minimum 36 months from date of shipment.

PART 2 - PRODUCTS AND MATERIALS

2.1 GENERAL:

A. Provide factory assembled and factory tested variable speed drives as indicated, of sizes and capabilities as scheduled, and as specified herein.

2.2 MANUFACTURERS:

A. Subject to compliance with requirements, manufacturers offering variable speed drives which may be incorporated in the work are limited to the following:

1. ABB.

2. Danfoss.

3. Eaton/Cutler-Hammer.

4. JCI

5. Square D, a division of Schneider Electric.

6. Yaskawa Electric America.

2.3 VARIABLE FREQUENCY DRIVES

A. The VFD shall provide the following design features as standard:

1. Input Section: Full wave rectification shall be achieved with input diodes in a conventional bridge configuration and shall be used to supply voltage to the DC bus. Drive shall be provided with dual DC bus chokes or AC line reactors, as required, for a total input impedance of 5% or better.

2. Output Section: The inverter shall use power transistors to provide three phase output power to the motor.

3. Input Displacement Power Factor: The input displacement power factor shall be 0.97 or higher at all operating speeds and loads.

4. Microprocessor Logic: The VFD shall be microprocessor based and utilize digital input for all parameter adjustments. Use of potentiometers for parameter adjustment is not acceptable.

5. Auto Restart: The VFD shall automatically attempt to restart after a malfunction or an interruption of power. The number of attempted restarts shall be customer selectable (0 to 5). If the drive reaches the limit of restarts without successfully restarting and running for a customer selectable length of time (60 to 600 seconds), the restart circuit shall lockout and shall provide contact annunciation. Delay between attempts to restart shall be customer selectable from 3 to 300 seconds.

6. Current Limit: A current limit circuit shall be provided to limit motor current to a preset adjustable maximum level by reducing the drive operating speed or acceleration rate when the limit is reached. Range of adjustment shall be from 50 to 110%.

7. Digital Output Displays and Input Parameter Programming: The VFD shall include a digital display and digital input programming capability on the main logic board. The display shall be programmable for indication of output speed in rpm, frequency, and percent of base speed, motor amps, output motor volts, and output load. The display shall also function as a first fault indicator.

8. Critical Frequency Avoidance (Frequency Jump Points): The VFD shall provide selectable frequency jump pointsto be used to avoid critical resonance frequencies of the mechanical system.

9. Input Signal Follower: The input signal follower circuit shall have selectable differential inputs and accept an electrical speed command from an external source rated at 4-20 mA or 0-10Vdc. The input follower circuit shall be capable of operating directly or inversely proportional to the listed speed commands.

10. Motor Overload Protection: Electronic motor protection shall be provided which is capable of predicting motor winding temperature based on inputting specific parameters including motor design type (TEFC, ODP, or other) and speed range. The protection shall provide an orderly

shutdown should the motor's thermal capabilities be exceeded. This protection also eliminates the requirement for motor overload relays on single motor applications when a bypass is not used.

11. Open Collector Outputs: The VFD shall include three (3) open collector outputs to indicate drive run, drive fault, and drive ready.

12. Output Signals: The VFD shall include analog output signals for output load, output speed, instantaneous kw and motor voltage. The signals shall be 4-20 ma or 0-10 Vdc @ 1 mA.

13. Stop Mode Functions: The VFD stopping mode functions shall be selectable for coast-to-rest or stopping at programmed deceleration rate.

14. V/Hz Profiles: The VFD shall provide selectable V/Hz profiles.

15. Loss of Control Signal: The VFD shall revert to the last speed on loss of input control signal. Owner shall be able to field select a preset speed for the VFD to run when control signal is lost, if preferred. In either case, an open collector output shall be selected to indicate loss of control signal for remote indication purposes.

B. The VFD supplier shall provide the same design/technology to cover the HP range for all VFD's.

C. Output Ratings: The VFD shall operate within the following ratings:

1. Frequency range: 1-120 Hz

2. Overload rating: 110% for one minute

D. Motor Performance: The VFD shall provide 3% speed regulation.

E. Input Power: The VFD shall operate within (+5%/-10%) of the nominal rated voltage.

F. Set-up Adjustments: Standard setup adjustments shall include:

1. Minimum speed: 0 to 100%

2. Maximum speed: 0 to 100%

3. Linear accel: 0.5 to 600 seconds

4. Linear decel: 0.5 to 600 seconds

5. Maximum output voltage: Adjustable

6. V/Hz: Adjustable with selectable profiles

7. Current limit: 50 to 110%

G. Environmental Ratings: The VFD shall operate within the following parameters without the requirement for derating:

1. Operating temperature: 0°C to 40°C

2. Altitude: Up to 1000m (3300 ft.)

3. Humidity: 95% non-condensing

H. Enclosure: Refer to VFD schedule or drawings for enclosure type. At minimum, the enclosure shall be suitable for environment installed. Finned heatsinks and/or cooling fans shall be provided as necessary for proper heat dissipation.

I. Protective Features: The VFD shall be designed to meet the following specifications and operate within the following parameters:

1. AC Input Overcurrent Protection: The VFD's power circuit shall be isolated internally with respect to ground and provided with a 100,000 AIC interrupting rated input circuit breaker. As an alternate to the circuit breaker, fuses may be used to accomplish the 100,000 A interrupting rating.

2. Logic Common: The power unit's logic common shall be at ground potential.

3. Phase Loss Protection: Phase loss protection shall be provided to prevent single phasing.

4. Power Loss Ride-Through: The VFD shall be capable of continued operation during an intermittent loss of power. Opening of the VFD's input and/or output line switches while operating shall not result in damage to the power circuit components.

5. Short Circuit and Ground Fault Protection: The VFD shall have an instantaneous electronic trip circuit to protect the VFD from output line-to-line and line-to-ground short circuits. The VFD must be capable of withstanding short circuits at nominal rated voltage plus 10%(i.e., 480V rated drive + 10% = 528V short circuit voltage). The VFD shall be capable of providing 110% motor current intermittently. The VFD shall include an instantaneous overcurrent trip and shall not restart after electronic overcurrent trip until reset through the run/stop circuit, or unless the auto restart function has been enabled.

6. Transient and Surge Voltage Protection: Transient and surge voltage protection shall be provided through the use of Metal Oxide Varistors (MOVs). The VFD shall withstand a 6000 volt, 80 joule surge voltage when tested in accordance with UL 1449 with the test circuit adjusted for a 2100 amp peak 8x20 us short circuit discharge current pulse.

7. Rotating Motor Start: The VFD shall be able to start into a motor rotating in either direction and at any speed, and accelerate to set speed without any time delay, tripping or component loss.

8. DV/DT Filters: Dv/dt filters shall be provided per the VFD schedule, or if recommended by the VFD manufacturer to ensure that the VFD is applied correctly and to maintain the manufacturer's full warranty.

J. Maintainability

1. All control circuit voltages (12VAC, 24VDC, 160VDC and 120VAC) shall be physically and electrically isolated from power circuit voltages (200 to 600VAC, 600VDC) to ensure safety to maintenance personnel.

2. The VFD shall be furnished with an alphanumeric diagnostic display with fault indications to include the following: bus overvoltage, bus undervoltage, overcurrent, overtemperature, ground fault, and timed overload.

3. VFD shall be capable of starting and operating without a motor connected for ease of service.

4. All setup and operating parameters shall be stored in nonvolatile memory. The static memory module shall be to be removed and installed in replacement logic boards with all setup and operating parameters intact requiring no adjustment of replacement boards.

K. Communications

1. The VFD shall have an RS-485 port as standard. The standard protocols shall be BACnet, Modbus, Johnson Controls N2 bus, and Siemens Building Technologies FLN. Optional protocols for LonWorks, Profibus, Ethernet, and DeviceNet shall be available. Each individual drive shall have the protocol in the base VFD. The use of third party gateways and multiplexers is not acceptable. All protocols shall be "certified" by the governing authority. Use of non-certified protocols is not allowed.

2. Serial communication capabilities shall include, but not be limited to; run-stop control, speed set adjustment, proportional/integral/derivative PID control adjustments, current limit, accel/decel time adjustments, and lock and unlock the keypad. The drive shall have the capability of allowing the building management system to monitor feedback such as process variable feedback, output speed / frequency, current (in amps), % torque, power (kW), kilowatt hours (resettable), operating hours (resettable), and drive temperature. The building management system shall also be capable of monitoring the VFD relay output status, digital input status, and all analog input and analog output values. All diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote VFD fault reset shall be possible. The following additional status indications and settings shall be transmitted over the serial communications bus – keypad "Hand" or "Auto" selected, bypass selected, the ability to change the PID setpoint, and the ability to force the unit to bypass (if bypass is specified). The building management system shall also be able to monitor if the motor is running in the VFD mode or bypass mode (if bypass is specified) over serial communications. A minimum of 15 field parameters shall be capable of being monitored.

3. The VFD shall allow the building management system to control the drive's digital and analog outputs via the serial interface. This control shall be independent of any VFD function. For example, the analog outputs may be used for modulating chilled water valves or cooling tower bypass valves. The drive's digital (relay) outputs may be used to actuate a damper, open a valve or control any other device that requires a maintained contact for operation. In addition, all of the drive's digital and analog inputs shall be capable of being monitored by the building management system.

4. The VFD shall include an independent PID loop for customer use. The independent PID loop may be used for cooling tower bypass value control, chilled water value control, etc. Both the VFD control PID loop and the independent PID loop shall continue functioning even if the serial communications connection is lost. The VFD shall keep the last good set-point command and last good DO & AO commands in memory in the event the serial communications connection is lost.

L. Required Optional Features

1. Operator Panel: A door-mounted Softouch Operator Panel shall be included with the following features:

   a. Shall digitally display motor speed, load, amps, and output volts. (and controller setpoint and system pressure when setpoint controller is included).

   b. Shall have indication for drive run, drive ready, drive fault, plus operator function/status indication such as auto speed reference, and auto restart.

   c. Shall provide selection for Hand/Off/Auto control. In Hand mode, the VFD shall be started and stopped from the operator's panel. In the Auto mode, the VFD shall be started and stopped by remote contact closure. In the Off mode, the VFD shall be locked out.

   d. Shall provide selection for Manual/Auto Speed Reference. In the Manual Reference mode, the VFD speed reference shall be set from the operator's panel. In the Auto Reference mode, the VFD speed reference shall be set by the external source instrument signal. Selecting between Manual and Auto speed reference shall have no bearing on the Hand/Off/Auto start/stop selector, or vice versa.

   e. Shall name all parameters in English, not codes or numbers.

   f. Keypad shall include electronic lock-out feature to prevent unauthorized personnel from parameter access.

   g. Shall store from three to six drive faults in a history batch file in the order they occur to simplify trouble-shooting. This file will automatically be updated should new faults occur.

2. Input Overcurrent Protection Device: The operating mechanism shall be designed so that the door can be padlocked in the "OFF" position.

3. Elapsed Time Meter: Meter shall provide indication of how long the drive has been running.

4. Firestat/Freezestat: VFDs for air system fans requiring shutoff from safety devices per sequences of operation shall provide terminals for connecting normally closed remote safety devices. This emergency shutdown shall operate in any mode of operation.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which variable speed drive is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to installer.

3.2 INSTALLATION

A. General: Install systems and materials in accordance with manufacturer's instruction.

B. Maintain minimum clearance of 12 inches on each side and 36 inches in front of the variable speed drive.

C. Install variable speed drive in the vertical position.

D. Provide separate conduits for input and output power cables.

E. Provide separate conduits for control cables and the output cables to the motor.

F. Install power and control cabling in separate conduits.

G. Provide dedicated conduits for power cables to the motors.

H. Load Side Disconnects: Provide a disconnect switch on the load side of the VFD near the motor for ease of service and safety. Disconnect switch shall be lockable in the open position when the VFD is not within sight of the motor. Operating the switch with the VFD running shall not cause any component failure. In dual motor applications, VFD shall be able to operate either motor with the other motor disconnected without requiring jumpers, parameter modifications, or other adjustments. As part of start-up, VFD supplier shall certify all load side disconnects can be opened or closed with drive running at full speed without damage to the drive.

1. When a separate disconnect is provided at the motor, provide auxiliary contact in the disconnect switch that will shut down the variable speed drive when the disconnect switch is turned off.

3.3 START UP

A. All units shall be started up at the jobsite by a factory trained and authorized representative.

3.4 TRAINING

A. General: At a time mutually agreed upon between the Owner and Contractor, provide the services of a factory trained and authorized representative to train Owner's designated personnel for a minimum of four hours on the operation and maintenance of the equipment provided under this section.

B. Content: Training shall include but not be limited to:

1. Overview of the system and/or equipment as it relates to the facility as a whole.

2. Operation and maintenance procedures and schedules related to startup and shutdown, troubleshooting, servicing, preventive maintenance and appropriate operator intervention.

3. Review data included in the operation and maintenance manuals. Refer to Division 1 Section "Operating and Maintenance Data."

C. Certification: Contractor shall submit to the Engineer a certification letter written by the Contractor stating that the Owner's designated representative has been trained as specified herein. Letter shall include date, time, attendees and subject of training. The certification letter shall be signed by the Contractor and the Owner's representative indicating agreement that the training has been provided. Copies of the startup report shall be attached to the certification letter.

D. Schedule: Schedule training with Owner with at least 14 days' advance notice.

END OF SECTION

SECTION 230519 - METERS AND GAUGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Pressure gauges and fittings.

B. Thermometers and thermometer wells.

C. Test plugs.

1.2 REFERENCE STANDARDS

A. - Pressure Gauges and Gauge Attachments; 2013.

B. ASME MFC-3M - Measurement of Fluid Flow in Pipes Using Orifice, Nozzle and Venturi; 2007.

C. ASTM E1 - Standard Specification for ASTM Liquid-in-Glass Thermometers; 2014.

D. ASTM E77 - Standard Test Method for Inspection and Verification of Thermometers; 2014.

E. AWWA C700 - Cold-Water Meters -- Displacement Type, Metal Alloy Main Case; 2015.

F. AWWA C701 - Cold-Water Meters -- Turbine Type, for Customer Service; 2012.

G. AWWA C702 - Cold-Water Meters -- Compound Type; 2010.

H. AWWA M6 - Water Meters -- Selection, Installation, Testing, and Maintenance; 2012.

I. UL 393 - Indicating Pressure Gauges for Fire-Protection Service; Current Edition, Including All Revisions.

J. UL 404 - Gauges, Indicating Pressure, for Compressed Gas Service; Current Edition, Including All Revisions.

1.3 SUBMITTALS

A. Submit in accordance with conditions of Contract and Division 01 submittal procedures.

B. Product Data: Provide schedule that indicates the following for each manufactured component:

1. Model or figure number.

2. Use.

3. Rating.

4. Operating range.

5. Total range.

6. Calibrated performance curves, certified where indicated.

7. Figure number.

8. Location.

9. Accessories.

C. Product Certificates: Signed by manufacturer certifying accuracy under specified operating conditions and product compliance with specified requirements.

D. Samples: Submit two of each type of instrument specified.

E. Project Record Documents: Record actual locations of components and instrumentation.

F. Operation and Maintenance Data: Furnish data for each manufactured component for inclusion in operating and maintenance manual.

G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1. Extra Pressure Gauges: One of each type and size.

1.4 FIELD CONDITIONS

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

PART 2 - PRODUCTS

2.1 PRESSURE GAUGES

A. Manufacturers:

1. Ametek, U.S. Gauge Div.

2. Ashcroft Dresser Industries Instrument Div.

3. Dwyer Instruments, Inc.

4. H.O. Trerice Co.

5. Marsh Instrument Co., Unit of General Signal.

6. Marshalltown Instruments, Inc.

7. Miljoco Corp.

8. Weiss Instruments, Inc.

9. Weksler Glass Thermometer Corp.

10. WIKA Instruments Corp.

11. Winters Instruments.

B. Description: ASME B40.100, UL 393, rotary brass movement, white with black markings and black pointer.

C. Case: Drawn steel, cast aluminum, or stainless steel with phosphor bronze bourdon tube and front or rear recalibration adjustment. Provide silicone fluid damping where required by Part 3.

D. Size: 4-1/2 inch diameter.

E. Lens: Clear glass.

F. Stem: Brass for separable socket, length to suit installation.

G. Scale: Progressive, satin-faced, non-reflective aluminum, permanently etched markings.

H. Accuracy: Plus or minus 1 percent of range span.

I. Liquid-Filled: Provide liquid filled gauges where specified in Part 3 of this section.

2.2 PRESSURE GAUGE TAPPINGS

A. Manufacturers: Same as pressure gauge manufacturers.

B. Gauge Cock: Tee or lever handle, brass, rated for system pressure.

C. Needle Valve: Brass, 1/4 inch NPT, rated for system pressure.

D. Pulsation Damper: Pressure snubber, brass with 1/4 inch threaded connections, corrosion-resistant porous metal disc. Disc material shall be suitable for fluid served and rated pressure.

E. Syphon: Brass, 1/4-inch NPT angle or straight pattern.

2.3 STEM TYPE THERMOMETERS

A. Manufacturers:

1. Dwyer Instruments, Inc.

2. H.O. Trerice Co.

3. Marsh Instruments, Inc.

4. Miljoco Corp.

5. Weiss Instruments, Inc.

6. Weksler Glass Thermometer Corp.

7. Winters Instruments.

B. Thermometers - Adjustable Angle:

1. Description: Red- or blue-appearing non-toxic liquid in glass tube; ASTM E1.

2. Adjustable Joint: Finish to match case with positive locking device; adjustable 360 degrees in horizontal plane, 180 degrees in vertical plane.

3. Case: Cast aluminum with enamel finish.

4. Size: 9 inch scale.

5. Window: Clear Lexan.

6. Stem: Brass, copper-plated steel, or aluminum for separable socket, length to suit installation.

7. Scale: Progressive, satin-faced, non-reflective aluminum, with permanently etched markings.

8. Accuracy: Plus or minus 1 percent of range span or plus or minus 1 scale division to maximum of 1.5 percent of range span.

9. Calibration: Degrees F.

2.4 DIAL THERMOMETERS

A. Thermometer – Direct Mount, Bimetal Actuated:

1. Manufacturers:

a. Ashcroft Dresser Industries Instruments Div.

b. H.O. Trerice Co.

c. Marshalltown Instruments, Inc.

d. Miljoco Corp.

e. Tel-Tru Manufacturing Co., Inc.

f. Weiss Instruments, Inc.

g. Weksler Glass Thermometer Corp.

h. Winters Instruments.

2. Description: Dial type, ASTM E1 bimetallic helix actuated with silicone fluid damping, white with black markings and black pointer.

3. Adjustable joint: Finish to match case with positive locking device; adjustable 360 degrees in horizontal plane, 180 degrees in vertical plane.

4. Case: Stainless steel with front or rear recalibration.

5. Size: 5 inch diameter dial.

6. Lens: Clear glass, hermetically sealed.

7. Stem: Stainless steel for separable socket. Length to suit installation.

8. Scale: Progressive, satin-faced, non-reflective aluminum, permanently etched markings.

9. Accuracy: Plus or minus 1 percent of range span or plus or minus 1 scale division to maximum of 1.5 percent of range span.

10. Calibration: Degrees F.

B. Thermometers – Direct Mount, Vapor Actuated:

2. Manufacturers:

a. Ashcroft Dresser Industries Instruments Div.

b. H.O. Trerice Co.

c. Miljoco Corp.

d. Weiss Instruments, Inc.

e. Weksler Glass Thermometer Corp.

f. Winters Instruments.

2. Description: Dial type vapor or liquid actuated; ASTM E1; copper bulb, copper or phosphor bronze bourdon tube, white with black markings and black pointer.

3. Adjustable joint: Finish to match case with positive locking device; adjustable 360 degrees in horizontal plane, 180 degrees in vertical plane.

4. Case: Drawn steel, cast aluminum, or stainless steel.

5. Size: 4-1/2 inch diameter dial.

6. Lens: Clear glass.

7. Stem: Brass, copper-plated steel, or aluminum for separable socket. Length to suit installation.

8. Scale: Progressive, satin-faced, non-reflective aluminum, permanently etched markings.

9. Accuracy: Plus or minus 1 percent of range span or plus or minus 1 scale division to maximum of 1.5 percent of range span.

10. Calibration: Degrees F.

C. Thermometers – Remote Reading:

3. Manufacturers:

a. Ashcroft Dresser Industries Instruments Div.

b. H.O. Trerice Co.

c. Miljoco Corp.

d. Tel-Tru Manufacturing Co., Inc.

e. Weiss Instruments, Inc.

f. Weksler Glass Thermometer Corp.

g. Winters Instruments.

2. Description: Dial type vapor or liquid actuated; ASTM E1; white with black markings and black pointer.

3. Case: Drawn steel, cast aluminum, or stainless steel.

4. Size: 4-1/2 inch diameter dial.

5. Lens: Clear glass.

6. Bulb: Copper for separable socket for liquids, averaging element for air.

7. Scale: Progressive, satin-faced, non-reflective aluminum, permanently etched markings.

8. Capillary: Copper or bronze double-braided capillary for separable socket. Length to suit installation, minimum 5 feet.

9. Accuracy: Plus or minus 1 percent of range span or plus or minus 1 scale division to maximum of 1.5 percent of range span.

10. Calibration: Degrees F.

2.5 THERMOMETER SUPPORTS

A. Thermowell Socket: ASTM A536 ductile iron, brass, or stainless steel, compatible with adjacent piping to eliminate dielectric corrosion, with separable socket for thermometer stems and 2 inch extension for insulated piping, pressure rated to match piping system design pressure, with cap and chain.

B. Flange: 3 inch outside diameter reversible flange, designed to fasten to sheet metal air ducts, with brass perforated stem.

2.6 TEST PLUGS

A. Manufacturers:

1. Flow Design, Inc.

2. MG Piping Products Co.

3. Peterson Equipment Co., Inc.

4. Sisco, A Spedco, Inc. Co.

5. Watts Regulator.

B. Test Plug: 1/2 inch nickel-plated brass fitting, rated for 500 psig, extension for insulation, and threaded cap with retention chain for receiving 1/8 inch outside diameter pressure or temperature probe.

C. Core Material:

1. Neoprene core for temperatures up to 200 degrees F.

2. Nordel core for temperatures up to 350 degrees F.

3. Viton core for temperatures up to 400 degrees F.

D. Test Kit: Carrying case, internally padded and fitted containing one 2-1/2 inch diameter pressure gauge, one gauge adapter with 1/8 inch probes, two 1 inch bimetal dial thermometers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install flow meters in a readily accessible location.

C. Install flow meters with isolating valves on inlet and outlet.

D. Install differential pressure-type flow elements with minimum straight lengths of pipe upstream and downstream from element in accordance with manufacturer's instructions.

E. Gas Meters: Furnish gas meter to Division 22 contractor for installation.

F. Install in-line BTU meters in piping where indicated in the hydronic supply line. Install thermal well in return line for remote sensor.

G. Install remote mounted BTU meters on wall or bracket in an accessible location.

H. Provide one pressure gauge per pump, installing taps before strainers and on suction and discharge of pump. Pipe to gauge.

I. Install pressure gauges with pulsation dampers. Provide gauge cock to isolate each gauge. Provide siphon on gauges in steam systems. Extend nipples and siphons to allow clearance from insulation.

J. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inch for installation of thermometer sockets. Ensure sockets allow clearance from insulation.

K. Install thermometers in air duct systems on flanges.

L. Install thermometer sockets adjacent to controls system thermostat, transmitter, or sensor sockets. Refer to Section 23 09 43. Where thermometers are provided on local panels, duct or pipe mounted thermometers are not required.

M. Locate duct mounted thermometers minimum 10 feet downstream of mixing dampers, coils, or other devices causing air turbulence.

N. Coil and conceal excess capillary on remote element instruments.

O. Provide instruments with scale ranges selected according to service with largest appropriate scale.

P. Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.

Q. Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.

R. Locate test plugs adjacent thermometers and thermometer sockets.

3.2 SCHEDULE

A. Pressure Gages, Location and Scale Range:

1. Location: Install device at inlet and outlet of each of the following:

a. Headers to central equipment.

b. Pumps. Provide silicone damping gauge.

c. Boilers.

d. Chillers.

e. After major coils. Reference details on plans.

f. Expansion tanks.

g. Pressure reducing valves.

2. Scale Range:

a. Vacuum: 30 inches Hg to 15 psig.

b. All fluids: 2 times operating pressure.

B. Pressure Gage Tappings, Location:

1. Control valves 3/4 inch & larger – inlets and outlets.

2. Major coils – inlets and outlets.

3. Chiller – inlets and outlets.

4. Boiler – inlets and outlets.

C. Stem Type Thermometers, Location and Scale Range:

1. Location: Install device at inlet and outlet of each of the following:

a. Headers to central equipment.

b. Heat exchangers.

c. Boilers.

d. Chillers.

e. After major coils. Reference details on plans.

2. Scale Range:

a. Hot Water: 30 to 300 degrees F with 2-degree scale divisions

b. Chilled Water: 0 to 100 degrees F with 2-degree scale divisions.

D. Thermometer Sockets, Location:

1. Control valves 1 inch & larger - inlets and outlets.

2. Reheat coils - inlets and outlets.

3. Cabinet heaters - inlets and outlets.

4. Unit heaters - inlets and outlets.

E. Dial Thermometers, Location and Scale Range:

1. Each supply air zone, minus 32 to 150 degrees F.

2. Outside air, minus 32 to 150 degrees F.

3. Return air, minus 32 to 150 degrees F.

4. Mixed air, minus 32 to 150 degrees F.

END OF SECTION 230519

SECTION 230523 - GENERAL DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Applications.

1. General duty valves common to most mechanical piping systems.

2. Special purpose valves are specified in individual piping system specifications.

B. General requirements.

C. Globe valves.

D. Ball valves.

E. Butterfly valves.

F. Gate valves.

1.2 ABBREVIATIONS AND ACRONYMS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene diene monomer rubber.

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

D. NRS: Nonrising stem.

E. OS&Y: Outside screw and yoke.

F. PTFE: Polytetrafluoroethylene.

G. RS: Rising stem.

H. TFE: Tetrafluoroethylene.

1.3 SUBMITTALS

A. Submit in accordance with conditions of Contract and Division 01 submittal procedures.

B. Product Data: Provide data on valves including manufacturers catalog information. Submit performance ratings, pressure and temperature classifications, valve design, body material, seating

materials, trim material, dimensions, clearances, rough-in details, weights, support requirements, and piping connections.

C. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

D. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts listings.

E. Maintenance Materials: Furnish Owner with one wrench for every five plug valves, in each size of square plug valve head.

1.4 QUALITY ASSURANCE

A. Manufacturer:

1. Obtain valves for each valve type from a single manufacturer.

2. Company must specialize in manufacturing products specified in this section, with not less than three years of documented experience.

3. Subject to compliance requirements, provide products from one of the manufacturers listed in Valve Schedule in Part 3.

B. Valves shall be certified to meet the specified ASTM, ASME, ANSI, and MSS standards in Part 2 Products, and as follows:

1. ASME B31.9 for building services piping.

2. ASME B31.1 for power piping.

C. Welding Materials and Procedures: Conform to .

1.5 DELIVERY, STORAGE, AND HANDLING

A. 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. Protect valve piping connections such as grooves, weld ends, threads, and flange faces.

4. Adjust globe, gate, and angle valves to the closed position to avoid clattering.

5. Secure check valves in either the closed position or open position.

6. Adjust butterfly valves to closed or partially closed position.

B. Use the following precautions during storage:

1. Maintain valve end protection and protect flanges and specialties from dirt.
    a. Provide temporary inlet and outlet caps.
    b. Maintain caps in place until installation.
2. Store valves in shipping containers and maintain in place until installation.
    a. Store valves indoors in dry environment.
    b. Store valves off the ground in watertight enclosures when indoor storage is not an option.

C. Exercise the following precautions for handling:

1. Avoid the use of operating handles or stems as rigging or lifting points.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products from one of the manufacturers listed in the Valve Schedule in Part 3.

2.2 APPLICATIONS

A. Provide the following valves for the applications if not indicated on Drawings:

1. Throttling (Hydronic): Butterfly, Ball, and Globe.
2. Isolation (Hydronic): Butterfly, Gate, Ball, and Globe.

B. Substitutions of valves with higher CWP classes or SWP ratings for same valve types are permitted when specified CWP ratings or SWP classes are not available.

C. Required Valve End Connections for Non-Wafer Types:

1. Steel Pipe:
    a. 2 NPS and Smaller: Threaded ends.
    b. 2-1/2 NPS and Larger: Grooved or flanged ends.
2. Copper Tube:
    a. 2 NPS and Smaller: Threaded or solder-joint valve ends.
        1) Exception: Solder ends not acceptable for hot water or steam pipe.
    b. 2-1/2 NPS and Larger: Grooved or flanged ends.

3. Steam and Steam Condensate Pipe: Solder and grooved ends not acceptable.

D. Chilled Water Valves:

1. 2 NPS and Smaller:

a. Minimum Class: 125.

b. Body: Bronze.

c. Allowable Valve Types:

1) Ball: Two piece.

2) Lift check.

3) Swing check.

4) Wafer plate-type check.

5) Gate.

6) Globe.

2. 2-1/2 NPS and Larger:

a. Minimum Class: 125.

b. Body: Cast iron, except as noted below.

c. Allowable Valve Types:

1) Ball: 2-1/2 inch to 3 inch: Three piece, bronze, carbon steel, or stainless steel body.

2) Butterfly: Ductile iron body.

3) Lift check.

4) Swing check.

5) Wafer plate-type check.

6) Gate.

7) Globe.

E. Heating Hot Water Valves:

1. 2 NPS and Smaller:

a. Minimum Class: 125.

b. Body: Bronze.

c. Allowable Valve Types:

1) Ball: Two piece.

2) Lift check.

3) Swing check.

4) Wafer plate-type check.

5) Gate.

6) Globe.

2. 2-1/2 NPS and Larger:

a. Minimum Class: 125.

b. Body: Cast iron, except as noted below.

c. Allowable Valve Types:

1) Ball: 2-1/2 inch to 3 inch: Three piece, bronze, carbon steel, or stainless steel body.

2) Butterfly: Ductile iron body.

3) Lift check.

4) Swing check.

5) Wafer plate-type check.

6) Gate.

7) Globe.

2.3 GENERAL REQUIREMENTS

A. Valve Pressure and Temperature Ratings: No less than rating indicated; as required for system pressures and temperatures.

B. Valve Sizes: Match upstream piping unless otherwise indicated.

C. Valve Stem Design:

1. Rising stem or rising outside screw and yoke stems.

2. Non-rising stem valves may be used on water systems where headroom prevents full extension of rising stems.

D. Valve Actuator Types:

1. Gear Actuator: Quarter-turn valves 8 NPS and larger.

2. Handwheels: Valves other than quarter-turn types.

3. Hand Lever: Quarter-turn valves 6 NPS and smaller, vinyl-covered.

E. Valves in Insulated Piping: Provide stem extensions so valve operator extends a minimum of 1/2 inches outside of the insulation and the following features:

1. Gate Valves: Rising stem.

2. Ball Valves: 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: Extended neck.

4. Memory Stops: Fully adjustable after insulation is installed.

F. Valve-End Connections:

1. Threaded End Valves: ASME B1.20.1.

2. Flanges: ASME B16.1 for cast iron.

3. Pipe Flanges and Flanged Fittings 1/2 NPS through 24 NPS: ASME B16.5 for steel, ASME B16.24 for bronze.

4. Solder Joint Connections: ANSI B16.18.

5. Grooved End Connections: AWWA C606.

G. General ASME Compliance:

1. Ferrous Valve Dimensions and Design Criteria: ASME B16.10 and ASME B16.34.

2. Power Piping Valves: ASME B31.1.

3. Building Services Piping Valves: ASME B31.9.

H. Bronze Valves:

1. Fabricate from dezincification resistant material.

2. Copper alloys containing more than 15 percent zinc are not permitted.

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

J. Source Limitations: Obtain each valve type from a single manufacturer.

2.4 BRONZE GLOBE VALVES

A. Class 125, 200 psig CWP:

1. Comply with MSS SP-80, Type 2, nonmetallic disc to metal seat.
2. Body: Bronze; ASTM B62, with integral seat and screw in bonnet.
3. Ends: Threaded or solder joint.
4. Stem and Disc: Bronze stem, PTFE disc.
5. Packing: Asbestos free, brass gland.
6. Operator: Malleable iron handwheel.

B. Class 150, 300 psig CWP:

1. Comply with MSS SP-80, Type 2, nonmetallic disc to metal seat.
2. Body: Bronze; ASTM B62, with integral seat and union bonnet.
3. Ends: Threaded or solder joint.
4. Stem and Disc: Bronze stem, PTFE disc.
5. Packing: Asbestos free, brass gland.
6. Operator: Malleable iron handwheel.

2.5 IRON GLOBE VALVES

A. Class 125, 200 psig CWP and Class 250, 500 psig CWP:

1. Comply with MSS SP-85, Type 1.
2. Body: Gray iron; ASTM A126, with bolted bonnet.
3. Ends: Grooved or flanged.
4. Trim: Bronze.
5. Packing and Gasket: Asbestos free, two-piece backing gland assembly.
6. Operator: Handwheel or chainwheel.

2.6 BRONZE BALL VALVES

A. Two Piece, Class 150, for valves 2 inch and smaller:

1. Comply with MSS SP-110.
2. CWP Rating: 600 psi.
3. Body: Bronze, ASTM B584.
4. Trim: Bronze.
5. Ends: Threaded or solder joint.
6. Seats and Seals: PTFE.
7. Stem: Blowout-proof.
8. Ball: Full port, ASTM A276 Type 316 stainless steel.
9. Operator: Vinyl-covered steel handle.

B. Three Piece, Class 150, for valves 2-1/2 inch to 3 inch:

1. Comply with MSS SP-110.
2. SWP Rating: 150 psig.
3. CWP Rating: 600 psig.
4. Body: Bronze, ASTM B584.
5. Trim: Bronze.
6. Ends: Threaded or solder joint.
7. Seats and Seals: PTFE.
8. Stem: Blowout-proof.
9. Ball: Full port, ASTM A276 Type 316 stainless steel.
10. Operator: Vinyl-covered steel handle.
11.

2.7 IRON BUTTERFLY VALVES

A. Lug type: Bi-directional dead-end service without downstream flange.

1. Comply with MSS SP-67, Type I.
2. CWP Rating: 200 psig and 250 psig.
3. Body Material: ASTM A536 ductile iron.

4. Stem: One or two-piece stainless steel.

5. Seat and Seal: EPDM.

6. Disc: Aluminum-bronze, stainless steel, or one-piece Nylon-coated ductile iron.

7. Operator:

   a. Size 2-1/2 through 6 inches: Lever operator, 10 position minimum, with locks and stops.

   b. Size 8 inch and larger: Gear type with position indicator.

2.8 BRONZE GATE VALVES

A. Class 125:

1. Comply with MSS SP-80, Type I.

2. CWP Rating: 200 psig.

3. Body: Bronze, ASTM B62 with integral seat and screwed bonnet.

4. Trim: Bronze.

5. Ends: Threaded or solder joint.

6. Stem: Bronze, RS type. NRS type where exceptions apply.

7. Disc: Solid wedge; bronze.

8. Packing: Asbestos free, brass.

8. Operator: Malleable iron handwheel.

B. Class 150:

1. Comply with MSS SP-80, Type I.

2. CWP Rating: 300 psig.

3. Body: Bronze, ASTM B61 with integral seat and union-ring bonnet.

4. Trim: Bronze.

5. Ends: Threaded.

6. Stem: Bronze, RS type. NRS type where exceptions apply.

7. Disc: Solid wedge; bronze.

8. Packing: Asbestos free, brass.

9. Operator: Malleable iron handwheel.

C. Class 300:

1. Comply with MSS SP-80, Type I.

2. CWP Rating: 600 psig.

3. Body: Bronze, ASTM B61 with integral seat and union-ring bonnet.

4. Trim: Bronze.

5. Ends: Threaded.

6. Stem: Bronze, RS type. NRS type where exceptions apply.

7. Disc: Solid wedge; bronze with stainless steel seat ring.

8. Packing: Asbestos free.

9. Operator: Malleable iron handwheel.

2.9 IRON GATE VALVES

A. Class 125:

1. Comply with MSS SP-70, Type I.

2. 2-1/2 NPS to 12 NPS, CWP Rating: 200 psig.

3. 14 NPS to 24 NPS, CWP Rating: 150 psig.

4. Body: Cast iron, ASTM A126 Class B with bolted bonnet.

5. Ends: Flanged.

6. Trim: Bronze.

7. Stem: OS&Y, RS type, NRS type where exceptions apply.

8. Disc: Solid wedge.

9. Packing and Gasket: Asbestos free, 2-piece packing gland assembly.

10. Operator: Malleable iron handwheel.

B. Class 250:

1. Comply with MSS SP-70, Type I.

2. 2-1/2 NPS to 12 NPS, CWP Rating: 500 psig.

3. 14 NPS to 24 NPS, CWP Rating: 300 psig.

4. Body: Cast iron, ASTM A126 Class B with bolted bonnet.

5. Ends: Flanged.

6. Trim: Bronze.

7. Stem: OS&Y, RS type. NRS type where exceptions apply.

8. Disc: Solid wedge.

9. Packing and Gasket: Asbestos free, 2-piece packing gland assembly.

10. Operator: Malleable iron handwheel.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Discard all packing materials and verify that valve interior, including threads and flanges are completely clean without signs of damage or degradation that could result in leakage.

B. Verify valve parts to be fully operational in all positions from closed to fully open.

C. Confirm gasket material to be suitable for the service, to be of correct size, and without defects that could compromise effectiveness.

D. If valve is determined to be defective, replace with new valve.

3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Locate valves for easy access. Provide access doors and fire rated access doors as required.

C. Provide unions or flanges with valves to facilitate equipment removal and maintenance while maintaining system operation and full accessibility for servicing.

D. Install shut-off duty valves at each branch connection to supply mains, at supply connection to each piece of equipment, and elsewhere as indicated.

E. Install throttling duty valves at each branch connection to return mains, at return connections to each piece of equipment, elsewhere as indicated.

F. Install three-valve bypass around each pressure reducing valve using throttling-type valves.

G. Provide separate valve support as required and locate valve with stem at or above center of piping, maintaining unimpeded stem movement.

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

I. Where valve support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.

J. Valves with soldered end connections:

1. Use solder with a melting point as follows:

a. Below 840 degrees F for gate, globe, and check valves.

b. Below 421 degrees F for ball valves.

K. Install check valves where necessary to maintain direction of flow as follows:

1. Lift Check: Install with stem plumb and vertical.

2. Swing Check: Install horizontal maintaining hinge pin level.

3. Orient plate-type into horizontal or vertical position, between flanges.

L. Provide chainwheels on operators for valves 2-1/2 NPS and larger where located 72 inches or more above finished floor in mechanical rooms, terminating 60 NPS above finished floor.

3.3 FIELD QUALITY CONTROL

A. Tests: After piping systems have been tested and put into service, but before final adjusting and balancing, inspect valves for leaks. Adjust or replace packing to stop leak; replace valves if leak persists.

3.4 ADJUSTING AND CLEANING

A. Cleaning: Clean mill scale, grease, and protective coatings from exterior of valves and prepare valves to receive finish painting or insulation.

B. Inspect valves for leaks after piping systems have been tested and put into service, but before final adjusting and balancing. Adjust or replace packing, as required, on valves with leaks. Replace valve if leak persists.

3.5 VALVE SCHEDULE

A. Bronze Globe Valves, Class 125:

MANUFACTURER	THREADED NRS	THREADED RS	SOLDER RS
Apollo	--	120T	120S
Crane	--	5TF	--
Hammond	--	--	--
Jenkins	--	--	--
Milwaukee	--	--	--
Nibco	--	T-211-Y	S-211-Y

Stockham	B-13T	--	B-14T

B. Bronze Globe Valves, Class 150:

MANUFACTURER	THREADED NRS	THREADED RS	SOLDER RS
Apollo	--	122T	--
Crane	--	7TF	1310
Hammond	--	IB413T	IB423
Jenkins	--	106BJ	--
Milwaukee	--	590T	1590T
Nibco	--	T-235-Y	S-235-Y
Powell	150	--	--
Stockham	--	B-22T	--

C. Iron Globe Valves:

MANUFACTURER	CLASS 125 STRAIGHT BODY	CLASS 125 ANGLE BODY	CLASS 250 STRAIGHT BODY
Apollo	711F	--	721F
Bray	DG	--	--
Crane	351	353	21E
Hammond	IR116	IB463	IR313
Jenkins	2342J	2344J	162J
Milwaukee	F2981A	--	F2983-M
Nibco	F-718-B	F-818-B	F-768-B
Powell	241	--	--
Stockham	G-512	G-515	F-532

D. Bronze Ball Valves – 2 inch and smaller, Class 150:

1. Model for chrome plated brass ball indicated. Furnish SS ball if specified in Part 2.

MANUFACTURER	THREADED ENDS	SOLDER ENDS
Apollo	77C-100	77C-200
Bray	S51	--
Hammond	8301A	8311A
Milwaukee	BA-400	BA-450
Nibco	T-585-70	S-585-70
Watts	LFB6080G2	LFB6081G2

E. Bronze Ball Valves - 2-1/2 inch to 3 inch, Class 150:

1. Model for chrome plated brass ball indicated. Furnish SS ball if specified in Part 2.

MANUFACTURER	THREADED ENDS	SOLDER ENDS
Apollo	82-100	82-200
Bray	5000/6000	--
Hammond	8604	8614
Milwaukee	BA-300	BA-350

Nibco	T-595-Y	S-595-Y

F. Iron Butterfly Valves, 200 psig CWP:

MANUFACTURER	SERIES
Apollo	LD141
Bray	30/31
Crane Center Line	44
Keystone	222
Nibco	LD-2000
Stockham	LD-712 & 722
Watts	BF-03
Milwaukee	ML
Hammond	6411

G. Iron Butterfly Valves, 250 psig CWP:

MANUFACTURER	SERIES
Bray	31H
Keystone	Paraseal
Nibco	LD-3000

H. Bronze Gate Valves, Class 125:

MANUFACTURER	THREADED NRS	THREADED RS	SOLDER NRS	SOLDER RS
Apollo	102T	101T	102S	101S
Crane	438	428	--	--
Hammond	IB645	IB640	IB647	IB635
Jenkins	992AJ	990AJ	993AJ	991AJ
Milwaukee	105	148	115	149
Nibco	T113	T111	S113	S111
Powell	507	500	--	--
Stockham	B-103	B-100	B-104	B-108

I. Bronze Gate Valves, Class 150:

MANUFACTURER	THREADED NRS	THREADED RS	SOLDER NRS	SOLDER RS
Apollo	106T	107T	--	--
Crane	437	431	1324	1334
Hammond	IB638	IB629	--	IB648
Jenkins	2310J	47CUJ	--	--
Milwaukee	1141	1151	--	1169
Nibco	T-136	T-134	S-136	S-134
Powell	2712	2714	--	--
Stockham	B-128	B-120	--	B-124

J. Bronze Gate Valves, Class 300:

MANUFACTURER	THREADED	THREADED

	NRS	RS
Apollo	--	111T
Crane	636E	634E
Hammond	IB656	IB654
Jenkins	2282J	2280UJ
Milwaukee	1186	1184
Nibco	T-176-SS	T-174-SS
Powell	--	2377
Stockham	B-147	B-145

K. Iron Gate Valves, Class 125:

MANUFACTURER	OS&Y RS	NRS
Apollo	611F	610F
Crane	465-1/2	461
Hammond	IR1140	IR1138
Jenkins	651A	326
Milwaukee	F2885A	F-2882A
Nibco	F617-O	F619
Powell	1793	1787
Stockham	G-623	G-612

L. Iron Gate Valves, Class 250:

MANUFACTURER	OS&Y RS	NRS
Apollo	621F	620F
Crane	7-1/2E	3E
Hammond	IR-330	--
Jenkins	204J	203J
Milwaukee	F2894A	--
Nibco	F-667-0	F-669
Powell	1797	--
Stockham	F-667	--

END OF SECTION 230523

SECTION 230529 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Support and attachment components.

B. Horizontal piping hangers and supports.

C. Saddles and shields.

D. Vertical piping clamps.

E. Anchors and fasteners.

F. Miscellaneous materials.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.

2. Coordinate the work with other trades to provide additional framing and materials required for installation.

3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.

4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.

5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:

1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured.

1.3 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for each type of hanger and support. Include a hanger and support schedule showing manufacturer's figure number, size,

location, and features for each hanger and support. Submit style and type to Structural Engineer for approval prior to installation.

B. Product Certificates: Signed by the manufacturer of hangers and supports certifying the products meet the specified requirements.

C. Welder Certificates: Signed by Contractor certifying that welders comply with requirements specified under "Quality Assurance" Article.

D. Maintenance Data: For inclusion in Operating and Maintenance manual specified in Division 01 and Division 23 Section "General Mechanical Requirements."

E. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution. Include dimensions, weights, required clearances, and method of assembly.

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

F. Installer's Qualifications: Include evidence of compliance with specified requirements.

G. 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.

1.4 QUALITY ASSURANCE

A. Comply with applicable building code.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Installer Qualifications for Field-Welding:

1. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel."

2. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

3. Qualify welding processes and welding operators in accordance with ASME BPVC Section IX, "Welding and Brazing Qualifications."

D. Flame/Smoke Ratings: Provide hangers and supports with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by UL 723 or ASTM E84 (NFPA 255) method.

E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.5 DELIVERY, STORAGE, AND HANDLING

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

PART 2 - PRODUCTS AND MATERIALS

1.1 SUPPORT AND ATTACHMENT COMPONENTS

A. General Requirements:

1. Comply with MSS SP-58.

2. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of work.

3. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.

4. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported. Include consideration for vibration, equipment operation, and shock loads where applicable.

5. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.

6. Materials: Products and materials listed in this specification are based on indoor, dry locations. Use corrosion resistant materials suitable for the environment where installed.

a. Indoor Dry Locations: Carbon steel, galvanized steel, zinc-plated steel or approved equivalent where installed for piping and equipment that will not have a factory-applied or field-applied finish, unless otherwise indicated.

a. Indoor Damp or Wet Locations: Galvanized steel, painted steel, Type 304 stainless steel, or aluminum.

b. Outdoor Locations: Type 304 stainless steel, galvanized steel, aluminum, or approved equivalent.

c. Dielectrics Barriers: Provide dielectric barriers between metallic supports and metallic piping and associated items of dissimilar type. Acceptable barriers include rubber, or copper-plated coatings where attachments are in direct contact with copper.

d. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.

e. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.

f. Stainless Steel: Type 304 in accordance with ASTM A240.

B. Metal Channel (Strut) Framing Systems:

1. Manufacturers:

a. Cooper B-Line.

b. Ferguson Enterprises/FNW.

c. PHD Manufacturing.

d. Thomas & Betts Corporation.

e. Unistrut, a brand of Atkore International Inc.

f. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.

2. Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.

3. Comply with MSS SP-69, Type 59, MSS SP-89, and . Welds shall comply with AWS D1.1.

4. Channel Material:

a. Indoor Dry Locations: Use painted steel, zinc-plated steel, or galvanized steel.

b. Outdoor and Damp or Wet Indoor Locations: Use stainless steel, aluminum, or galvanized steel.

c. All nuts, brackets, and clamps shall have the same finish as the channel.

5. Minimum Channel Thickness: Steel sheet, 14 gage, 0.0747 inch.

6. Minimum Channel Dimensions: 1-5/8 inch width by 13/16 inch height with factory-punched attachment holes.

7. Provide plastic galvanic isolators for connecting bare copper pipe for use with pre-engineered support strut system where indicated.

C. Hanger Rods:

1. Threaded zinc-plated steel, threaded both ends or continuously threaded, unless otherwise indicated.

2. Minimum Size: Reference piping specification sections for rod thicknesses.

3. Threaded Rods: Threaded rods are not allowed for floor supports except when the maximum length of the rod is less than 12". Threaded rod sizes shall be the same size diameter as specified for pipe hanger rods based upon pipe size being supported. Refer to system piping specification sections for rod size requirements.

D. Wire Rope Pipe Hanging Systems:

1. Manufacturers:

a. Gripple with no substitutions.

2. General: Wire rope hanger system shall have a minimum 5 to 1 safety factor based upon the applied working load being supported.

3. Source Limitations: Furnish associated fittings, accessories, and hardware produced by a single manufacturer.

4. Cast-in-place Concrete Insert: Pressed steel body with sintered steel wedge, 302 stainless steel spring and UV stabilized homopolymer polypropylene end cap. Model: Gripple Spider Hanging Kit.

5. Swivel Toggle Insert: Single assembly attached to wire rope cable, manufactured from plated carbon steel toggle, pins, and shackles; swivel insert engineered to be compatible with concrete insert.

6. Wire Rope: High tensile steel wire rope, to ASTM A1023, Class A zinc coating; minimum 7 by 7 cross-sectional thread construction; having a tensile strength of 256,000 psi; No.3 wire size minimum.

7. Adjustable Fastener: Mild steel (type UG2), bright zinc plated, one-channel body; encasing a series of Type 302 stainless-steel springs with serrated self-locking grade 40 chrome steel balls, adjustable by means of an integrated mechanism, capable of accommodating load of 500 lb. Model: Gripple No. 2, 3 or 4 UniGrip.

2.2 HORIZONTAL PIPING HANGERS AND SUPPORTS

A. Manufacturers:

1. Armacell.

2. Anvil International.

3. Cooper B-Line, Inc.

4. Elite Components.

5. ERICO/Michigan Hanger Co./Caddy

6. Ferguson/FNW.

7. Halfen-DEHA.

8. Hilti.

9. National Pipe Hanger Corporation.

10. PHD Manufacturing.

11. Power-Strut.

12. Unistrut.

B. Single Hangers:

1. Band Hanger: Carbon steel, adjustable band, adjustable swivel.

2. Split Ring: Carbon steel, adjustable swivel, split ring type.

3. Clevis Hanger: Carbon steel, adjustable, clevis type.

4. Roll Support Hanger: Adjustable steel yoke, cast iron roll.

C. Trapeze and Strut-mounted Supports:

1. Two-piece clamp: Designed for use with channel strut, held in place at channel shoulder when clamp attachment nut is tightened.

2. Roll Support: Adjustable cast iron roll attached to metal channel strut framing system with brackets and nuts.

D. Hangers and strut-mounted supports with pre-manufactured polymer inserts:

1. Manufacturers:

a. Anvil International.

b. Holdrite.

c. Klo-Shure.

2. Strut-mounted pipe clamps and clevis hangers with pre-manufactured polymer inserts designed to receive butted insulation internally. Inserts shall support piping independent of insulation to avoid crushing. Installed system shall provide equal thermal and vapor barrier performance as systems with continuous unbroken insulation. Metal shields are not required with clevis hangers of this type.

E. Spring Hangers:

1. Reference Section "Vibration Isolation for HVAC Piping and Equipment" for spring isolation hangers.

F. Wall Supports:

1. Two-hole strap, galvanized steel or copper to suit pipe material. Provide rigid insulation between strap and pipe to maintain continuous insulation and vapor barrier where required.

2. Welded steel bracket reinforced with angle or strut. Support pipe from bracket using horizontal pipe hanger or support appropriate for the pipe type.

3.

2.3 SADDLES AND SHIELDS

A. Pipe Covering Protection Saddles:

1. Manufacturers: Same as hanger and Supports.

B. Insulation Protection Shield:

1. Sheet metal construction, meeting MSS SP-58 Type 40, of 18 gauge for 5-1/2 inches inside dimension and smaller, 16 gauge for 6-1/2 inches to 10-3/4 inches inside dimension, 14 gauge for 11-3/4 inches to 17 inches inside dimension, and 12 gauge for 18 inches to 28 inches inside dimension.

2. Shield shall cover half of the circumference of the pipe and shall be of length indicated by manufacturer for pipe size and thickness of insulation.

3. Lengths for pipes greater than 2 inches: Minimum 8 inch long section at each support.

4. For pipes 2 inch and smaller without pre-insulated supports, provide insulation protection shields installed between hanger and pipe which meets the following minimum length requirements:

Pipe Size (NPS)	Insulation Thickness (inches)	Minimum Shield Length, (in) Hanger Spacing, (ft) 5	6	7	8	9	10
	0.5	5	6	8	-	-	-
	1	3	5	5	-	-	-
≤ 1	1.5	3	5	5	-	-	-
	2	3	3	3	-	-	-
	3	3	3	3	-	-	-
	0.5	8	8	11	11	12	14
	1	5	6	8	9	11	11
≤ 2	1.5	5	6	8	8	9	9
	2	5	5	6	6	8	8
	3	5	5	6	6	6	8

C. Plastic Saddles and Shields:

1. Manufacturers:

a. Armacell.

b. Eaton.

c. Hydra-Zorb.

d. PHD Manufacturing.

e. Zsi Foster.

2. Polymer-based, snap-on or clip-on design, with non-adhesive surface and lip to allow lateral movement of piping without damaging insulation, field-paintable.

2.4 VERTICAL-PIPING SUPPORTS

A. Manufacturers:

1. Armacell.

2. Anvil International.

3. Cooper B-Line, Inc.

4. Halfen-DEHA.

5. Hilti.

6. ERICO/Michigan Hanger Co.

7. National Pipe Hanger Corporation.

8. PHD Manufacturing.

9. Power-Strut.

10. Unistrut.

B. Components shall be factory fabricated of materials, design, and manufacturer complying with MSS SP-58.

1. Components shall have galvanized coatings where installed for piping and equipment that will not have factory applied or field-applied finish.

2. Pipe attachments shall be copper-plated or have nonmetallic coating for electrolytic protection where attachments are in direct contact with copper tubing.

3. Components as listed below shall be made of 304 stainless steel where installed in corrosive environments and/or where indicated on the drawings.

C. Riser Clamps with pre-manufactured polymer insert:

1. Manufacturers:

a. Hydra-Zorb; Titan Riser Clamp.

b. National Pipe Hanger.

c. Approved equal.

2. Riser clamp with pre-manufactured polymer inserts designed to withstand vertical loading and receive butted insulation internally. Inserts shall support piping independent of insulation to avoid crushing. Installed system shall provide equal thermal and vapor barrier performance as systems with continuous unbroken insulation.

2.5 PIPE ALIGNMENT GUIDES

A. Factory fabricated, constructed of cast semi-steel or heavy fabricated steel when applied to steel pipe and copper when applied to copper. Guide shall consist of bolted two-section outer cylinder and base with two-section guiding spider that bolts tightly to pipe. Length of guides shall be as recommended by manufacturer to allow indicated travel.

1. Pipe Diameter 8 inches and Smaller: Spider or sleeve type.

2. Pipe Diameter 10 inches and Larger: Roller type.

3. Pipe Diameter 18 to 30 inches: 1 inch U-bolt.

2.6 PIPE ANCHORS

A. Pre-Insulated Anchors: Carbon steel or stainless steel assembly with high density insulation insert and no metal-to-metal contact.

B. Anchor Clamps: Assembly with multi-piece clamp, constructed of compatible material with piping or with dielectric barrier.

C. PRE-ENGINEERED ROOF EQUIPMENT SUPPORTS

D. Reference Section "Vibration Isolation for HVAC" for vibration isolated pre-engineered roof equipment supports.

E. Manufacturers: Subject to compliance with requirements, provide roof equipment supports from the equipment manufacturer or from one of the following:

F. AES Industries.

G. Custom Curb, Inc.

H. Pate Company.

I. Thybar.

J. Single Rail Equipment Supports:

K. Construction:

L. Base plate with fully mitered raised cant and step to match roof insulation thickness.

M. Welded, minimum 18 gauge galvanized steel shell, internally reinforced to load bearing factors of equipment being supported.

N. Factory installed treated wood nailer.

O. 4 inch, minimum 18 gauge nailer jacket with counterflashing where equipment will not fully cover the equipment support.

P. Roof Curbs:

Q. Construction:

R. Comply with NRCA standards.

S. Base plate with fully mitered raised cant and step to match roof insulation thickness.

T. Welded, minimum 18 gauge galvanized steel shell, internally reinforced to load bearing factors of equipment being supported.

U. Minimum 1-1/2 inch thick, 3 pound density rigid insulation internal to shell to maintain continuous roof insulation.

V. Factory installed treated wood nailer and drain nipple.

W. Sloped to match roof structure to enable level installation.

2.7 ANCHORS AND FASTENERS

A. Manufacturers:

1. Hilti, Inc.

2. Illinois Tool Works, Inc.

3. Phillips.

4. Powers Fasteners, Inc.

5. Rawl.

6. Simpson Strong-Tie Company Inc.

B. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.

1. Concrete: Use preset concrete inserts or expansion anchors.

2. Solid or Grout-Filled Masonry: Use expansion anchors.

3. Hollow Masonry: Use toggle bolts.

4. Hollow Stud Walls: Use toggle bolts.

5. Steel: Use beam clamps.

6. Sheet Metal: Use sheet metal screws.

7. Wood: Use wood screws.

8. Plastic and lead anchors are not permitted.

9. Hammer-driven anchors and fasteners are permitted only as follows:

   a. Nails are permitted for attachment of nonmetallic boxes to wood frame construction.

   b. Staples are permitted for attachment of nonmetallic-sheathed cable to wood frame construction.

C. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.

1. Comply with MFMA-4.

2. Channel Material: Use galvanized steel.

3. Minimum Channel Thickness: Steel sheet, 12 gage, 0.1046 inch minimum base metal thickness.

4. Spot Inserts: Carbon steel with zinc plating or galvanized steel body and base plate, with protective sleeve for anchor rod insert, sized to accommodate anchor rode dimensions.

5. Manufacturers:

   a. Same as manufacturer of metal channel (strut) framing system.

   b. DeWalt "Bang-It" concrete inserts.

D. Post-Installed Concrete and Masonry Expansion Anchors:

1. Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) for compliance with applicable building code.

2. Self-drilling, drilled flush or shell type. Size inserts to suit threaded rods.

E. Beam Clamps: MSS SP-58 C-Type or adjustable, Types 19 through 23, 25 or 27 through 30 based on required load.

1. Material: ASTM A36/A36M carbon steel or ASTM A181/A181M forged steel.

1. Provide clamps with hardened steel cup-point set screws and lock-nuts for anchoring in place.

F. Vibration Isolation Anchors: Reference Section "Vibration Isolation for HVAC Piping and Equipment" for vibration isolation anchors.

2.8 MISCELLANEOUS MATERIALS

A. Steel Plates, Shapes, and Bars: ASTM A 36.

B. Malleable Iron: ASTM A47

C. Cement Grout: Portland cement (ASTM C 150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix ratio shall be 1.0 part cement to 3.0 parts sand, by volume, with minimum amount of water required for placement and hydration.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that mounting surfaces are ready to receive support and attachment components.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.2 INSTALLATION, GENERAL

A. Install products in accordance with manufacturer's instructions.

B. Provide hangers and supports according to the Pipe Hanger and Support Schedule below.

C. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.

D. Provide independent support from building structure. Do not provide support from piping, ductwork, conduit, or other systems.

E. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.

F. Unless specifically indicated or approved by Architect, do not provide support from roof deck.

G. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.

H. Provide thermal insulated pipe supports complete with hangers and accessories. Install thermal insulated pipe supports during the installation of the piping system.

3.3 INSTALLATION OF HANGERS AND SUPPORTS

A. Install in accordance with ASME B31.9, ASTM F708, or MSS SP-58 unless indicated otherwise.

B. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.

C. Space attachments within maximum piping span length specified in Division 23 piping sections.

D. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.

E. Install hangers, supports, clamps and attachments to support piping properly from building structure.

F. Do not attach to ceilings, equipment, ductwork, conduit and other non-structural elements such as floor and roof decking.

G. Hanger and clamps sizing:

1. Cold Piping: Provide pipe hangers sized for the pipe outside diameter plus insulation thickness.

2. Hot Piping: Provide pipe hangers sized for the pipe outside diameter.

3. Vertical Piping: Provide clamps sized for the pipe outside diameter and extend clamp through insulation.

4. Refer to Section 230700 for definition of hot and cold piping and required insulation thickness.

H. Where several pipes can be installed in parallel and at the same elevation, Contractor has option to provide metal channel strut framing. Install supports with maximum spacing specified within Division 23 piping sections.

1. Space strut framing at the required distance for the smallest pipe size or install intermediate supports for smaller diameter pipe as specified above for individual pipe hangers.

2. Where strut systems are attached to walls, install anchor bolts per manufacturer's recommendations.

a. Uninsulated Copper Pipe: Install with plastic galvanic isolators

b. Insulated Tube or Pipe: Install with 360° insulation protection shields or pre-engineered thermal hanger-shield inserts as specified in Division 23 Section "HVAC Insulation".

I. Install building attachments within concrete or to structural steel.

1. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping as specified in Division 23 piping sections.

2. Install concrete inserts before concrete is placed; fasten insert to forms. Where concrete with compressive strength less than 2,500 psi is indicated, install reinforcing bars through openings at top of inserts.

J. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories. Provide two nuts on threaded supports to securely fasten the support.

K. Install appropriate types of hangers and supports to allow controlled 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.

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

M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes, and so that maximum pipe deflections allowed by ASME B31.9 Building Services Piping Code is not exceeded.

N. Insulated Piping: Comply with the following installation requirements.

1. Riser Clamps: Attach riser clamps, including spacers (if any), to piping with riser clamps projecting through insulation. Do not use riser clamps to support horizontal, insulated piping. Seal insulation for hot piping and protect vapor barrier for cold piping as specified in Division 23 Section "HVAC Insulation".

2. Pipe Covering Protection Saddles: Install pipe covering protection saddles where insulation without vapor barrier is indicated. Fill interior voids with segments of insulation that match adjoining pipe insulation.

3. Insulation Protection Shield: Install insulation protection shield with high density insulation insert where vapor barrier is indicated, sized for the insulation thickness used as specified in Division 23 Section "HVAC Insulation". Do not use polymer-based shields for hot piping.

a. Exception for horizontal cold piping with fiberglass, cellular glass, flexible elastomeric, or polyisocyanurate insulation 2 inch and smaller: Rest fiberglass insulated pipe on hanger shield with length specified for pipe size and insulation thickness to prevent puncture or other damage.

4. Contractor's Option: Provide pre-engineered thermal hanger inserts for piping insulated with flexible elastomeric insulation at pipe supports for piping 2-1/2 inches and larger.

5. Contractor's Option: Provide strut-mounted pipe clamps and clevis hangers with pre-manufactured polymer inserts.

O. Strut Framing Systems: Channel strut systems can be used at the Contractors option in lieu of individual hangers for horizontal pipes. Arrange for grouping of parallel runs of horizontal piping. Space channel strut systems at the required distance for the smallest pipe supported. Provide channel gauge and hanger rods per the manufacturer's recommendations for the piping supported. Where strut systems are attached to walls, install anchor bolts per manufacturer's recommendations.

1. Uninsulated Copper Pipe: Install with plastic galvanic isolators

2. Insulated Tube or Pipe: Install with 360 degree insulation protection shields or pre-engineered thermal hanger-shield inserts as specified in Division 23 Section "HVAC Insulation".

P. Vertical Piping Risers:

1. Reference Section "Vibration Isolation for HVAC Piping and Equipment" for piping riser supports.

Q. Wire Rope Hanging Systems:

1. Install in accordance with manufacturer's instructions.

2. Supported load shall not exceed manufacturer's recommended load rating.

3. Applications for Pipe Supports:

a. 3 inch and smaller.

b. Wire rope hanging system is not allowed for steam or steam condensate piping.

4. Do not support pipe by wrapping the rope around the pipe.

5. Provide appropriate hanger or support compatible with the wire rope hanging system adjustable fastener as specified in the Pipe Hanger and Support Schedule.

6. Install cast-in-place concrete inserts in elevated concrete slabs.

7. Install bream clamps for attachment to structural beams as required.

3.4 INSTALLATION OF ANCHORS

A. Install anchors at proper locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

B. Fabricate and install anchors by welding steel shapes, plates, and bars to piping and to structure. Comply with ASME B31.9 and with AWS Standards D1.1.

C. Spacing: Where not otherwise indicated, install anchors at ends of principal pipe runs, at intermediate points in pipe runs between expansion loops and bends. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.

3.5 INSTALLATION OF ROOF EQUIPMENT SUPPORTS

A. Attach roof equipment support to the roof structure according to the manufacturer's installation instructions.

B. Provide multiple single rail equipment supports to uniformly support the equipment.

C. Provide rigid backing material (e.g., insulation, wood, etc.) to maintain cant slope.

D. Install supports to maintain continuous insulation on roof.

E. Provide vibration isolators between roof equipment support and equipment according to Division 23 Section "Vibration Isolation for HVAC."

F. If vibration isolation is not required or units are internally isolated, attach equipment directly to pre-engineered roof equipment support using one of the following:

1. Single Rail Equipment Supports: Secure each equipment support leg to the rail with a minimum of 4 points of connection per leg.

2. Roof Curbs:

   a. Secure each corner of the equipment to the curb nailer using a minimum of 4 lag screws, located along the length of the equipment.

   b. Secure equipment to the curb using hold-down brackets. Provide minimum 6 inch long, 14 gauge galvanized steel brackets sized to wrap around top of curb and under equipment base rail with sufficient horizontal offset to cover overlap gap between the equipment rail and curb. Secure bracket to equipment and curb nailer using a minimum of 8 points of connection per bracket. Provide one bracket at each corner along the length of the unit.

3.6 EQUIPMENT SUPPORT AND ATTACHMENT

A. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.

B. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls.

C. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.

D. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.

E. Preset Concrete Inserts and Expansion Anchors: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.

   1. Where concrete slabs form finished ceiling, locate anchors flush with slab surface.

F. Secure fasteners according to manufacturer's recommended torque settings.

G. Remove temporary supports.

H. Fabricate structural steel supports to suspend equipment from structure above or support equipment from floor.

I. Grouting: Place grout under supports for piping and equipment.

3.7 METAL FABRICATION

A. Cut, drill, and fit miscellaneous metal fabrications for pipe anchors and equipment supports. Install and align fabricated anchors in indicated locations.

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

C. Field Welding: Comply with AWS D1.1 for procedures of manual shielded metal-arc welding, appearance and quality of welds made, methods used in correcting welding work, and 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 that no roughness shows after finishing, and so that contours welded surfaces to match adjacent contours.

3.8 FIELD QUALITY CONTROL

A. Inspect support and attachment components for damage and defects.

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

C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

D. Touch-Up Painting: Immediately after erection of anchors and supports, clean field welds and abraded areas of shop paint and paint exposed areas with same material as used for shop painting to comply with SSPC-PA-1 requirements for touch-up of field-painted surfaces. Comply with Division 09 Section "Painting."

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

E. For galvanized surfaces clean welds, bolted connections and abraded areas and apply galvanizing repair paint to comply with ASTM A 780.

F. Correct deficiencies and replace damaged or defective support and attachment components.

3.9 PIPE HANGER AND SUPPORT SCHEDULE

A. Provide the following acceptable hangers and supports for each type of piping system. Hangers and supports may be single type or strut-mounted:

B. Single Hangers:

1. All pipe sizes 1-1/2 inch and less:

a. Band hanger.

b. Swivel split ring.

c. Clevis hanger.

2. Cold and Hot pipe sizes 2 to 4 inches: Clevis hanger.

3. Cold and Hot pipe sizes 6 inches and greater: Roll support hanger.

C. Trapezes and Strut-mounted Supports:

1. All pipe sizes less than 6 inches: Two-piece clamp.

2. Pipe sizes 6 inches and greater: Roll support.

D. Wall Supports:

1. Pipe sizes 3 inches and less:

a. Two-hole strap mounted to wall.

b. Welded steel bracket with reinforced angle or strut.

2. Pipe sizes 4 inch and greater:

a. Welded steel bracket with reinforced angle or strut.

E. Floor Supports:

1. Pipe sizes 4 inch and less: Pipe saddle.

2. Pipe sizes 6 inch and greater: Roll support.

END OF SECTION 230529

SECTION 230550 - VIBRATION ISOLATION FOR HVAC

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Vibration isolation requirements.

B. Vibration-isolated equipment support bases.

C. Vibration isolators.

1.2 COORDINATION

A. Contractor's Responsibility:

1. Verify the completeness of the isolation installation and the overall suitability of the equipment to meet the intent of this specification. Any additional equipment needed to meet the intent of this specification, even if not specifically mentioned herein or in the Contract Documents, shall be supplied by the Contractor without claim for additional payment.

2. Performance or waiving of inspection, testing or surveillance for any portion of the Work shall not relieve the Contractor of the responsibility to conform strictly with the Contract Documents. The Contractor shall not construe performance or waiving of inspection, testing or surveillance by the Owner or Architects to relieve the Contractor from total responsibility to perform in strict accordance with the Contract Documents.

3. Coordinate selection and arrangement of vibration isolation components with the actual equipment 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. Sequencing:

a. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured.

B. Manufacturer's Responsibility:

1. Determine vibration isolation types for all equipment and systems in accordance with the local governing code.

2. Calculate the static deflection requirements for all equipment and systems to provide uniform deflection based on distributed operating weight of actual installed equipment.

3. Select the vibration isolation systems to provide static deflection indicated on the Vibration Isolation Schedule and as specified below. Determine the mounting sizes and layout.

4. Guarantee specified isolation system deflection.

5. Provide installation instructions, drawings and field supervision to ensure proper installation and performance.

6. Verify that all equipment to be isolated has sufficient support structure to distribute equipment loads onto isolators.

1.3 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for products, including materials, fabrication details, dimensions, and finishes.

1. Vibration Isolators: Include rated load capacities and deflections; include information on color coding or other identification method for spring element load capacities. Include clearly outlined procedures for installing and adjusting the isolators.

B. Shop Drawings:

1. Include dimensioned plan views and sections indicating proposed arrangement of vibration isolators on each piece of isolated equipment. Indicate equipment weights and static deflections.

2. Vibration-Isolated Equipment Support Bases: Include base weights, including concrete fill where applicable. Indicate equipment mounting provisions.

3. Piping isolators shown and identified on piping layout drawings.

4. Concrete foundations, supports, and required reinforcing and forms. These appurtenances shall be provided by another trade. This trade shall furnish the shop drawings, including the following:

a. Concrete reinforcing steel details and templates for all foundations and supports.

b. Required hanger bolts.

c. All other appurtenances necessary for proper installation of equipment.

C. Vibration Isolation System Schedule: Include the following for each isolation element:

1. Manufacturer, isolator type, model number, size.

2. Height when uncompressed and static deflection.

3. Spring constant.

4. Spring outside diameter, free operating, and solid heights.

5. Design of supplementary bases.

6. Details of attachment to load-bearing structure or supplementary framing.

D. Post-Installation Inspection Report:

1. Vibration isolation vendor notice of inspection of all vibration isolators.

2. Vibration isolation vendor notice of approval that all vibration isolators have been properly installed and conform to the specification.

3. Itemized list of deficiencies.

4. Vibration Isolation System Schedule.

5. For each isolator containing steel springs, record the following:

a. Size.

b. Uncompressed height.

c. Design static deflection.

d. Measured static deflection.

1.4 QUALITY ASSURANCE

A. All vibration isolation equipment shall be furnished by one manufacturer unless specifically approved otherwise in writing by the Engineer.

B. All vibration isolation equipment and materials shall be new and manufactured specifically for the purpose intended.

C. Maintain at the project site a copy of each reference document that prescribes execution requirements.

D. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.

1.5 DELIVERY, STORAGE, AND HANDLING

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

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

A. BRD Noise and Vibration Control.

B. Caldyn, California Dynamics Corp.

C. Kinetics Noise Control.

D. Mason Industries, Inc.

E. Vibration Eliminator Co., Inc.

F. Vibration Mounting and Controls.

G. Vibro-Acoustics.

2.2 VIBRATION ISOLATION REQUIREMENTS

A. Construct vibration isolators out of resilient materials resistant to oil, ozone, and oxidant.

B. Select vibration isolators to provide the static deflection as specified in Part 2 "Products" unless otherwise specified for the application listed in Part 3 "Execution."

C. Where a pipe run connects multiple equipment, select the pipe isolators for the entire run to suit the connected equipment of greatest static deflection.

D. Vibration isolators shall have either known undeflected heights or calibration markings so that the amount of deflection can be verified after adjustment to determine that the load is within the proper range of the device and that the correct degree of vibration isolation is provided according to the design.

E. Vibration isolators, base frames, and inertia bases shall provide uniform deflection and stability under all operating loads.

F. Isolators for fans shall be sized so that thrust restraints (which would act against turning moment caused by static pressure) are not required.

G. Lateral restraining isolators shall have the same static deflection as the vertical isolators for the equipment being isolated.

H. The theoretical vertical natural frequency for each support point based upon load per isolator and isolator stiffness shall not differ from the design objectives for the equipment as a whole by more than plus/minus 10 percent.

I. All elastomeric mountings shall have a Shore hardness of 30 to 60 plus/minus 5 after minimum aging of 20 days or corresponding over-aging, or as specified herein.

J. Elastomeric isolators that will be exposed to temperatures below 32 degrees F shall be fabricated of natural rubber instead of neoprene.

K. Equipment mounted on vibration isolated bases shall have minimum operating clearance of 1 inch between the base and floor or support beneath unless noted otherwise.

L. Vibration Isolator Assemblies with Steel Springs:

1. Housed or caged spring isolators are not acceptable.

2. Assemblies shall use bare springs, color coded or otherwise identify springs to indicate load capacity.

3. Spring diameter shall not be less than 0.8 of the loaded operating height of the spring.

4. The ratio of the horizontal to vertical spring constant shall be between 1 and 2.

5. Springs shall be sized to be non-resonant with equipment forcing frequencies or support structure natural frequencies.

6. Assembly shall be designed and installed so that the ends of the spring remain parallel during and after the spring installation.

7. Springs shall operate in the linear portion of their load versus deflection curve over a deflection range of not less than 50 percent above the design deflection.

M. Vibration isolators exposed to weather and other corrosive environments shall be protected with factory corrosion resistance.

1. Exterior applications:

a. Springs: Cadmium-plated and neoprene coated.

b. Nuts and bolts: Cadmium plated.

c. Other metal mounting parts: Hot-dip galvanized.

2. Interior applications: Painted.

2.3 VIBRATION ISOLATED EQUIPMENT SUPPORT BASES

A. Pre-Engineered Roof Equipment Support (Type RES):

1. Reference Section "Hangers and Supports for HVAC Piping and Equipment" for specification of non-vibration isolated, pre-engineered roof equipment supports.

B. Structural Rails (Type SR):

1. Assembly: Structural steel channels furnished with double-deflection neoprene mountings or spring isolators.

2. Base: All metal mounting parts shall be covered with neoprene to avoid corrosion and metal-to-metal contact.

3. Selection: Channel length and isolator type with deflection as required for proper isolation of equipment.

4. Type SR: Mason Industries Type RND or approved equal.

C. Vibration Isolation Roof Curb (Type CMB):

1. Description: Engineered, structural steel frame mounted directly to the structure with an upper floating section on adjustable steel springs. The upper frame shall provide continuous support for the equipment.

2. Steel springs shall rest on minimum 1/4 inch thick elastomeric pads and have a minimum static deflection of 2 inches.

3. All-directional elastomeric snubber bushings shall be minimum 1/4 inch thick.

4. Weatherproofing: Continuous galvanized flexible counterflashing nailed over the lower curb's waterproofing and joined at the corners by elastomeric bellows.

5. Access Ports: Provided for all spring locations with removable waterproof covers to allow for adjustment or replacement of springs.

6. Lower curbs shall have provision for 2 inches insulation.

7. Type CMB: Mason Industries Type RSC or approved equal.

2.4 VIBRATION ISOLATORS

A. Ribbed Neoprene "Waffle" Pads (Type WP):

1. Assembly: Single ribbed or crossed double ribbed elastomer in-shear pads, in one or more layers separated and bonded to a minimum 1/4 inch thick galvanized steel shim plate as required to provide selected deflection.

2. Thickness: Each layer 5/16 inch thick.

3. Selection: Maximum durometer of 50 and designed for 15 percent strain, static deflection of 0.05 inches.

4. Type WP: Mason Industries Type W, Type WSW, or approved equal.

B. Neoprene Bushing (Type NR):

1. Assembly: Neoprene restraint, rubber-in-shear bushings for lightweight, suspended equipment supported from structure with all-thread rod and angle iron or Unistrut.

2. Selection: Maximum durometer of 50 and designed for 15 percent strain, static deflection of 0.15 inches.

3. Type NR: Mason Industries Type HMIB or approved equal.

C. Double Deflection Neoprene Hangers ((Type DDNH)

1. Assembly: Steel hanger box containing a laterally stable, double deflecting, neoprene isolator . Neoprene isolator shall prevent contact between the lower hanger rod and hanger box and short-circuiting the isolating function.

a. Housing: Bottom opening sized to allow hanger rod to swing through a 30 degree arc.

2. Selection: Maximum durometer of 50 and designed for 15 percent strain, static deflection of 0.4 inches.

3. Type DDNH: Mason Industries Type HD or approved equal.

D. Spring and Neoprene Hanger (Type SPNH)

1. Assembly: Steel hanger box containing a laterally stable, double deflecting, neoprene isolator in series with a steel spring.

a. Housing: Include a neoprene bushing to prevent contact between the lower hanger rod and hanger box and short-circuiting the isolating function. Bottom opening sized to allow hanger rod to swing through a 30 degree arc.

2. Selection:

a. Neoprene isolator: Maximum durometer of 50 and designed for 15 percent strain, static deflection of 0.4 inches unless specified otherwise.

b. Spring isolator: Minimum static deflection of 2 inches unless specified otherwise.

3. Type SPNH: Mason Industries Type 30N or approved equal.

E. Neoprene Mounting Sleeves, Grommets, and Bushings: Designed to prevent steel-to-steel contact within vibration isolators.

F. Flexible Connectors:

1. Pipe: Refer to Section "Hydronic Piping Specialties."

2. Duct: Refer to Section "Air Duct Accessories."

G. Pipe Riser Guide (Type PRG):

1. Assembly: Telescoping arrangement of two sizes of steel tubing separated by minimum 1/2 inch thick, 60 durometer neoprene with set screw to prevent lateral movement. Guide shall include tapped hole on the top plate for bolt attachment to riser clamp.

2. Type PRG: Mason Industries Type VSGH or approved equal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that mounting surfaces are ready to receive vibration isolation and associated attachments.

3.2 INSTALLATION - GENERAL

A. Install in accordance with manufacturer's instructions.

B. External spring isolators are not required if unit is provided with internal spring isolation. If external spring isolators are provided, internal spring isolation shall not be approved.

C. Mount or suspend all equipment, piping, ductwork, etc. from approved foundations and supports as specified herein or as shown on the drawings.

D. Secure fasteners according to manufacturer's recommended torque settings.

E. Support piping, ductwork, conduit, and mechanical equipment building structure. Do not support from other equipment, piping, or ductwork.

F. Install isolators to prevent short-circuiting of the isolation.

G. All wiring connections to mechanical equipment on isolators shall have a minimum 18 inch long flexible conduit in a "U" shaped loop. Coordinate with Division 26.

H. Flexible Connectors: Install flexible connectors sized to match equipment connections and to provide sufficient slack for vibration isolation as required.

I. Equipment connected to water or other fluid piping shall be erected on isolators or isolated foundations at correct operating heights prior to connection of piping. Block-up equipment with temporary shims to final operating height. When the system is assembled full load is applied, adjust the isolators shall be adjusted to allow shim removal.

J. Refer to Division 23 Section "Common Work Results for HVAC" for noise critical spaces.

3.3 INSTALLATION OF VIBRATION ISOLATED EQUIPMENT SUPPORT BASES

A. All floor-mounted equipment shall be erected on housekeeping pads. Refer to Section "Common Work Results for HVAC" for concrete housekeeping pad requirements.

B. Maintain minimum 4 inches clearance between isolated equipment and the walls, ceiling, floors, columns, and any other equipment not installed on vibration isolators.

C. Set steel bases for one inch clearance between housekeeping pad and base.

D. Set concrete inertia bases for 2 inches clearance between housekeeping pad and base.

E. Adjust equipment to be level.

F. Verify no material is left to short-circuit the isolator.

G. Type CMB:

1. Attach roof equipment support to the roof structure according to the manufacturer's installation instructions.

2. Provide flexible duct connector using a foam rubber gasket to seal against the unit bottom.

3. Provide rigid backing material (e.g., insulation, wood, etc.) to maintain cant slope on roof equipment support bases.

4. Install roof equipment support bases to maintain continuous insulation on roof.

3.4 INSTALLATION OF VIBRATION ISOLATORS

A. Neoprene Mounting Sleeves, Grommets, and Bushings: Install on vibration isolators to prevent any metal to metal contact.

B. Spring Isolators:

1. On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.

2. Install springs so that the ends of springs remain parallel and all springs are installed with adjustment bolts.

3. Locate isolation hangers at the top of hanger rods.

4. Type SPNM: Unless otherwise specified, isolators need not be bolted to the floor for indoor installations.

5. Type SPNH and DDNH: Install the hanger box to allow it to rotate a full 360 degrees without encountering any obstruction.

C. Isolating Pipe Anchors:

1. Weld anchor base to support steel or bolt base plate to structure. Weld or bolt pipe clamp or bracket to anchor.

3.5 EQUIPMENT ISOLATION

A. Air Handling Units:

1. Units that are furnished with internal structural frames and external lugs (both of suitable strength and rigidity), or without any severe overhangs, do not require an additional structural frame installed beneath the unit.

2. Support condensate drain pipes from the isolated air handling unit frame.

3. Slab-on-Grade: Full perimeter housekeeping pad base, Type SPNM isolation with 1 inch static deflection.

4. Suspended Slab: Full perimeter housekeeping pad base, Type SPNM isolation with 2 inch static deflection.

5. Suspended: Type SPNH isolation with 2 inch static deflection.

B. Makeup Air Units:

1. Slab-on-Grade: Full perimeter housekeeping pad base, Type SPNM isolation with 0.75 inch static deflection.

C. Air-Cooled Condensers and Condensing Units:

1. Slab-on-Grade: Full perimeter housekeeping pad base, Type WP isolation continuous along support.

2. Suspended Slab: Housekeeping pad base, Type CSNM isolation with 0.75 inch static deflection.

3. Roof-mounted: Type RES base, Type CSNM isolation with 2 inch static deflection.

D. Water Source Heat Pumps, Fan Coil Units, and Computer Room Units:

1. Suspended: Flexible duct connectors with Type SPNH with 1 inch static deflection.

E. VAV Terminal Units:

1. Fan-Powered: Flexible duct connectors with Type SPNH isolation with 1 inch static deflection.

2. All other Types: Flexible duct connectors.

F. Screw Chillers:

1. Slab-on-Grade: Full perimeter housekeeping pad base, Type WP isolation continuous along support.

G. Boilers:

1. All Applications: Housekeeping pad base, Type WP isolation continuous along support.

H. Inline Pumps:

1. Supported in-line with piping: Provide vibration isolators on the piping per the article "Pipe Isolation" below.

2. Supported independent of piping:

a. Provide flexible connectors on each side of pump. The vertical load shall be carried by the supports, not by the flexible couplings.

I. Base-mounted Pumps:

1. Suspended Slab (3 hp and less): Housekeeping pad base, Type DDNM isolation with 0.5 inch static deflection.

2. Suspended Slab (Between 3 hp and 50 hp): Housekeeping pad under Type CIB base, Type SPNM isolation with 1 inch static deflection.

3. Minimum Type CIB Thickness:

Motor Size	Thickness
HP to 7.5 HP	6 inches
HP to 50 HP	8 inches
HP to 100 HP	12 inches

J. Fans

1. Suspended:

a. Fans 1 hp and less: Type NR isolation with 0.15 inch static deflection.

b. Fans greater than 1 hp: Type SPNH isolation with 2 inch static deflection.

K.

L. Unit Heaters: Type SPNH isolation with 2 inch static deflection.

M. All other equipment not specifically identified in this specification that contains rotating or vibrating elements and any associated electrical apparatus installed by this division that contains transformers or inductors shall be installed on Type DDNM or RNM neoprene isolators as appropriate.

3.6 DUCT ISOLATION

A. Connect ducts to equipment, fans, fan casings, and fan plenums with flexible connectors.

B. Support grease exhaust ducts with Type SPNH and/or SPNM isolators as appropriate. Install neoprene riser guides if lateral restraint is required in shafts.

3.7 FIELD QUALITY CONTROL

A. Arrange for inspection of all isolation and noise control equipment by the vibration isolation vendor and submit post-installation inspection report.

B. The installation of all vibration isolation systems shall be under the supervision of the manufacturer's representative.

C. Guarantee: If, in the actual installation, any equipment fails to meet the vibration control requirements specified herein, that equipment shall be corrected or replaced without claim for additional payment, inclusive of all labor and material costs. Such corrective measures shall be done within a time schedule specified by the Owner.

END OF SECTION

SECTION 230553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Nameplates.

B. Tags.

C. Adhesive-backed duct markers.

D. Stencils.

E. Pipe markers.

F. Ceiling markers.

G. Engraved plastic-laminate signs.

1.2 CODES AND STANDARDS:

A. ANSI Standards: Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

1.3 SUBMITTALS

A. Custom Signage: Submit list of wording, symbols, letter size, and color coding for mechanical identification. Terminology shall exactly match contract documents and shall be approved by Engineer prior to fabrication. Submit list of equipment to be provided with ceiling markers.

B. Valve Tag Schedule: Submit 8-1/2 x 11 inch typewritten valve schedule. Furnish one extra copy for each maintenance manual. Include the following information in the schedule:

1. Valve tag number.

2. Piping system and system abbreviation as shown on tag.

3. Location of valve (room or space).

4. Variations for identification (if any).

5. Function. Specially mark valves which are intended for emergency shut-off and similar special uses in margin of schedule.

6. Valve manufacturer's name and model number.

C. Product Data: Submit manufacturer's technical product data for each product required.

D. Manufacturer's Installation Instructions: Indicate special procedures and installation for each product required.

1.4 SPARE PARTS

A. Furnish minimum of 5 percent extra stock of each mechanical identification material required for each system that uses the identification material.

B. Furnish not less than 3 additional numbered valve tags for each piping system.

C. Where stenciled markers are provided, clean and retain stencils after completion of stenciling and include used stencils in extra stock along with stenciling paints and applicators.

PART 2 - PRODUCTS AND MATERIALS

2.1 ACCEPTABLE MANUFACTURERS

A. Allen Systems, Inc.

B. W.H. Brady Corporation.

C. Brimar Industries, Inc.

D. Seton Identification Products, a Tricor Direct Company.

2.2 IDENTIFICATION APPLICATIONS AND REQUIREMENTS

A. General:

1. Provide manufacturer's standard products of categories and types required for each application as referenced in other Division 23 sections. Where more than a single type is specified for application, selection is the installer's option, but provide single selection for each product category.

2. Lettering: Coordinate names, abbreviations, and other designations used in mechanical identification work with the corresponding designations shown on the drawings, scheduled, and specified. If not otherwise indicated, provide numbering, lettering, and wording as recommended by the manufacturer or as required for proper identification, operation, and maintenance of mechanical systems and equipment.

3. Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (e.g., Boiler No. 3, Air Supply No. 1H, etc.).

B. Air Handling Units: Nameplates, stencils, or engraved plastic laminate signs.

C. Air Terminal Units: Tags, stencils, or engraved plastic laminate signs.

D. Automatic Controls: Tags, use the same naming convention coordinated with the building automation system.

E. Control Panels: Nameplates.

F. Dampers: Ceiling tacks where located above lay-in ceiling. Do not use ceiling tacks in a gyp ceiling.

G. Ductwork: Adhesive-backed duct markers. Stencils are only acceptable for concealed ductwork, exterior ductwork, or in mechanical rooms.

H. Fans: Nameplates, stencils, or engraved plastic laminate signs.

I. Instrumentation: Tags.

J. Major Control Components including Variable Frequency Drives: Nameplates or engraved plastic laminate signs.

K. Piping: Pipe Markers.

L. Pumps: Nameplates or engraved plastic laminate signs.

M. Relays: Tags.

N. Small-sized Equipment: Tags.

O. Tanks: Nameplates or engraved plastic laminate signs.

P. Thermostats: Nameplates.

Q. Valves: Tags. Ceiling tacks are acceptable where located above a lay-in ceiling. Do not use ceiling tacks in a gyp ceiling.

R. Water Treatment Devices: Nameplates or engraved plastic laminate signs.

S. General Signs: Engraved plastic laminate signs.

2.3 NAMEPLATES

A. Nomenclature: Include the following, matching terminology on schedules as closely as possible:

1. Name and mark number.

2. Equipment service.

3. Design capacity.

4. Other design parameters such as pressure drop, entering and leaving conditions, rpm, etc.

B. Size: 2-1/2 inch x 4 inch for control panels and components, 4-1/2 inch x 6 inch for equipment.

C. Letter Color: White.

D. Letter Height: 1/4 inch.

E. Background Color:

1. Cooling equipment: Green.

2. Heating equipment: Yellow.

3. Combination cooling and heating equipment: Yellow/Green.

4. Energy reclamation equipment: Brown.

5. Hazardous equipment: Colors and designs recommended by ASME.

6. Equipment and components that do not meet any of the above criteria: Blue.

F. Plastic: Conform to ASTM D709.

2.4 TAGS

A. Plastic Laminate Tags: Laminated three-layer plastic, minimum 3/32 inch thick, with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter and 5/32 inch hole for fastener.

B. Solid Plastic Tags: Solid plastic, minimum 3/32 inch thick, with printed black letters on white color. Tag size minimum 1-1/2 inch diameter and 5/32 inch hole for fastener.

C. Metal Tags: Provide 19-gauge polished brass with stamped letters. Tag size minimum 1-1/2 inch diameter with smooth edges and 5/32 inch hole for fastener. Fill tag engraving with black enamel paint.

A. Accident Prevention Tags: Pre-printed or partially pre-printed, of plasticized card stock with matte finish suitable for writing, minimum 3-1/4 inch x 5-5/8 inch size, with brass grommet in hole for fastener. Order with appropriate pre-printed wording (e.g., DANGER, CAUTION, DO NOT OPERATE, etc.).

D. Tag Fasteners: Solid brass chain (wire link or beaded type), or solid brass S-hooks of the size required for proper attachment of tags to valves, manufactured specifically for that purpose.

E. Valve Tag Chart: Typewritten letter size list in anodized aluminum or finished hardwood frame, covered with SSB-grade sheet glass. Provide frame and mounting screws for removable mounting.

F. Letter Height:

1. System Abbreviation: Minimum 1/4 inch.

2. Valve Number: Minimum 1/2 inch.

2.5 ADHESIVE-BACKED DUCT MARKERS

A. Material: High gloss acrylic adhesive-backed vinyl film 0.0032 inch; printed with UV and chemical resistant inks.

B. Style: Individual label.

C. Nomenclature: Include air handling unit identification number, duct size, service, and arrows indicating direction of flow.

D. Specialty Exhaust: Identify the specialty using the system terminology (e.g., Grease, Dishwasher, Dryer, Fume Hood, etc.).

E. Color: Yellow background with black lettering or blue background with white lettering.

1. Hazardous Exhaust: Use colors and designs recommended by ASME A13.1.

2.6 STENCILS

A. Stencils: With clean cut symbols and letters of following size, complying with ASME A13.1:

1. 3/4 to 1-1/4 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 1/2 inch high letters.

2. 1-1/2 to 2 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 3/4 inch high letters.

3. 2-1/2 to 6 inch Outside Diameter of Insulation or Pipe: 12 inch long color field, 1-1/4 inch high letters.

4. 8 to 10 inch Outside Diameter of Insulation or Pipe: 24 inch long color field, 2-1/2 inch high letters.

5. Over 10 inch Outside Diameter of Insulation or Pipe: 32 inch long color field, 3-1/2 inch high letters.

6. Ductwork and Equipment: 2-1/2 inch high letters.

7. Access Doors: 3/4 inch high letters.

8. Operational Instructions: 3/4 inch high letters.

9. Provide arrows indicating direction of flow.

B. Stencil Paint: Oil based, alkyd enamel, either brushing grade or pressurized spray-can form and grade, black color, except for piping. For piping systems use colors conforming to ASME A13.1.

2.7 PIPE MARKERS

A. Snap-On Type: Provide manufacturer's standard pre-printed, semi-rigid snap-on, color-coded pipe markers, complying with ANSI A13.1

B. Pressure-Sensitive Type: Provide manufacturer's standard pre-printed, permanent adhesive, color-coded, pressure-sensitive vinyl pipe markers, complying with ANSI A13.1. Each end of the marker shall be secured to the pipe with one complete wrapping of pressure-sensitive tape.

C. Semi-rigid Plastic Pipe Markers: Factory fabricated, flexible, semi- rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.

D. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings, minimum 3 mil thick.

1. Width: 1-1/2 inch for pipes less than 6 inches (including insulation), 2-1/2 inch for pipes 6 inches and larger (including insulation).

2. Color shall match color of pipe markers.

E. Pipe Marker with Insulation: 1 inch thick molded fiberglass insulation with jacket for each plastic pipe marker to be installed on uninsulated pipes subjected to fluid temperatures of 125 degrees F or greater. Insulation shall extend 2 inches beyond each end of plastic pipe marker.

F. Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.

1. Detection: Provide multi-ply tape consisting of solid aluminum foil core between two layers of plastic ribbon tape.

G. Weather resistance: Where pipe markers shall be exposed to the weather, provide products suitable for use in weather.

H. Nomenclature: Manufacturer's standard pre-printed nomenclature which best describes piping system. Differentiate between supply and return. In the case of a variance, provide nomenclature as approved by the Engineer.

I. Arrows: Provide pipe markers with integral arrows indicating direction of flow, as a separate unit of plastic, or printed on pressure sensitive tape.

J. Color:

1. Conform to .

2. Heating, Cooling, and Boiler Feedwater: Green with white letters.

3. Toxic and Corrosive Fluids: Orange with black letters.

4. Compressed Air: Blue with white letters.

K. Letter Height: Minimum 1/2 inch for pipes up to 3 inch, minimum 1 inch for larger pipes.

2.8 CEILING MARKERS

A. Description: Paper dot, self-adhesive with 3/4 inch diameter color coded head.

B. Color:

1. HVAC Equipment: Yellow.

2. Fire Dampers and Smoke Dampers: Red.

3. Heating/Cooling Valves: Blue.

2.9 ENGRAVED PLASTIC-LAMINATE SIGNS

A. General: Engraving stock melamine plastic laminate complying with Fed. Spec L-P-387, engraved with manufacturer's standard letter style, black with white core letter color except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.

B. Thickness: 1/16 inch thick for units up to 20 square inches, or 8 inches in length; 1/8 inch thick for larger units.

B. Size: 1-1/2" high for single line, 2" high for two lines

C. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.

D. Nomenclature: When used to identify equipment, match terminology on schedules, including the following:

1. Name and mark number.

2. Equipment service.

3. Design capacity.

E. Access Panel Markers: Laminated three-layer plastic, minimum 1/16 inch thick and 1/8 inch hole for fastener, with abbreviations and numbers corresponding to concealed valve.

PART 3 - EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

B. Prepare surfaces in accordance with Division 09 for stencil painting.

3.2 GENERAL INSTALLATION

A. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

B. Install products in accordance with manufacturer's instructions.

C. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

D. Install tags on piping 3/4 inch diameter and smaller.

E. Install in clear view and align with axis of piping.

F. Apply stencil painting in accordance with Division 09.

G. Identify service, flow direction, and pressure.

H. All identification signs and markers shall be easily visible and legible. Relocate signs or markers that become visually blocked by work of others.

3.3 PIPING IDENTIFICATION

A. General: Provide pipe markers and flow arrows of one of the types specified for all systems. Provide only one type of marker for all systems. Install identification on the most obviously visible portion of the pipe from the point of access.

B. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.

C. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe during back-filling/top-soiling of each underground piping system, Where multiple pipes are buried in common trench and do not exceed overall width of 16 inches, install single pipe marker. For tile fields and similar artificial field installations, mark only edge pipe lines of field.

D. Pipes less than 6 inches diameter (including insulation):, Provide full-band pipe markers with 360 degree coverage.

E. Pipes 6 inches diameter and larger (including insulation): Provide either full-band or strip-type pipe markers.

F. Location: Install piping identification where piping is exposed to view, concealed by a removable ceiling system, located in accessible maintenance spaces (shafts, tunnels, plenums, etc.) and exterior non-concealed locations as follows:

1. Within 5 feet of each valve, tee, and control device.

2. Within 5 feet of each branch, excluding branches less than 25 feet in length to fixtures or terminal heating and cooling units.

3. Within 5 feet of each side of a penetration of a wall, floor, ceiling, structure, or enclosure.

4. At access doors, manholes and similar access points which permit view of concealed piping.

5. Within 5 feet of equipment outlets and other points of origination and termination.

6. Spaced intermediately at a maximum spacing of 50 feet along each riser and run. Reduce spacing to 25 feet in congested areas where there are more than two piping systems or pieces of equipment.

7. On piping above removable acoustical ceilings.

3.4 VALVE IDENTIFICATION

A. Provide a tag on each valve, cock, and control device. Exclude check valves, valves within factory-fabricated equipment, HVAC terminal devices, and similar rough-in connections of end-use fixtures and units.

B. Mount valve tag chart and schedule frame in mechanical room, or where indicated on plans. If not indicated, mount where directed by Engineer. Where more than one mechanical room is included on the project, mount framed copies of valve tag chart and schedule in each mechanical room.

3.5 DUCTWORK IDENTIFICATION

A. Install identification on the most obviously visible portion of the duct from the point of access.

B. Location: Install ductwork identification where ductwork is exposed to view, concealed by a removable ceiling system, located in accessible maintenance spaces (shafts, tunnels, plenums, etc), and exterior non-concealed locations as follows:

1. Within 5 feet of each control damper or balancing damper, excluding balancing dampers installed in duct take-offs to individual grilles, registers, or diffusers that are less than 25 feet in lengths and installed in the same space as the air device.

2. Within 5 feet of each branch duct, excluding branch ducts that are less than 25 feet in length and located in the same space as the main duct.

3. Within 5 feet of each side of a penetration of a wall, floor, ceiling, structure, or enclosure.

4. Spaced intermittently at a maximum spacing of 50 feet along each duct run. Reduce spacing to 25 feet in congested areas when there are more than two types of duct systems or pieces of equipment.

5. Within 5 feet of equipment outlets and other points of origin or termination.

6. Install marker on the most obviously visible portion of the duct from point of access.

3.6 ACCESS DOOR IDENTIFICATION

A. Provide identification on each access door, indicating purpose of access, maintenance and operating instructions, and appropriate safety and procedural information.

B. Where access doors are concealed above a removeable ceiling system or similar concealment, tags may be used in lieu of specified identification.

3.7 CEILING MARKER INSTALLATION

A. Locate ceiling marker to locate valves or dampers above lay-in panel ceilings. Locate in corner of panel closest to equipment.

3.8 EQUIPMENT IDENTIFICATION

A. Install nameplates and engraved plastic laminate signs for identification of each major item of mechanical equipment, each operational device, and on all other devices required by the Engineer. Provide additional signs and lettering as follows:

1. To distinguish between multiple units in close proximity.

2. To inform operator of operational requirements.

3. To indicate safety and emergency precautions.

4. To warn of hazards and improper operations.

B. Adjust lettering size based on viewing distance from normal location of identification:

1. Up to 6 feet: Minimum 1/2 inch.

2. Greater than 6 feet: Proportionally increase letter size.

3. Provide secondary lettering 2/3 to 3/4 of size of principal lettering.

4. Stencils may be used in lieu of nameplates when lettering greater than 1 inch is needed for proper identification because of distance from normal location of required identification.

C. Where equipment to be identified is concealed above acoustical ceilings or similar removeable concealment, equipment tags may be installed in the concealed space to reduce the amount of text in exposed sign.

D. Terminology:

1. Air handling units: AHU-1, AHU-2, etc.

2. Boilers: B-1, B-2, etc.

3. Condensing Units: CU-1, CU-2, etc.

4. Computer room unit: CR-1, CR-2
5. Exhaust fans: EF-1, EF-2, etc.
6. Air-Cooled chilling units: ACCH-1, ACCH-2, etc.
7. Make-up air units: MAU-1, MAU-2, etc.
8. Outside air units: OAU-1, OAU-2, etc.
9. Unit heaters: UH-1, UH-2, etc.
10. Pumps: P-1, P-2, etc.
11. Expansion tanks: ET-1, ET-2, etc.

END OF SECTION 230553

SECTION 230593 - TESTING, ADJUSTING AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. General testing, adjustment, and balancing requirements.

B. Testing, adjustment, and balancing of air systems.

C. Testing, adjustment, and balancing of hydronic systems.

D. Testing, adjustment, and balancing of domestic water systems.

E. Testing, adjustment, and balancing of steam systems.

F. Testing, adjustment, and balancing of specialty systems:

1. Laboratory fume hoods.

G. Sound and vibration measurement of equipment operating conditions.

H. This section excludes:

1. Testing boilers and pressure vessels for compliance with safety codes;

2. Specifications for materials for patching mechanical systems;

3. Specifications for materials and installation of adjusting and balancing devices. If devices must be added to achieve proper adjusting and balancing, refer to the respective system sections for materials and installation requirements.

4. Requirements and procedures for piping and ductwork systems leakage tests.

1.2 DEFINITIONS

A. TAB: Testing, adjusting, and balancing.

B. Test: To determine quantitative performance of equipment.

C. Adjust: To regulate the specified fluid flow rate and air patterns at the terminal equipment (e.g., reduce fan speed, throttling).

D. Balance: To proportion flows within the distribution system (submains, branches, and terminals) according to specified design quantities.

E. Procedure: Standardized approach and execution of sequence of work operations to yield reproducible results.

F. Report forms: Data sheets arranged for collecting test data in logical order for submission and review. Data should also form the permanent record to be used as the basis for required future testing, adjusting, and balancing.

G. Terminal: The point where the controlled fluid enters or leaves the distribution system. Examples include inlets and outlets on water terminals, inlets and outlets from air terminal units, and inlets and outlets on air terminals such as registers, grilles, diffusers, louvers, and hoods.

H. Main: Duct or pipe containing the major or entire fluid flow of the system.

I. Submain: Duct or pipe containing part of the system capacity and serving two or more branch mains.

J. Branch main: Duct or pipe serving two or more terminals.

K. Branch: Duct or pipe serving a single terminal.

1.3 SUBMITTALS

A. Qualifications:

1. Submit qualifications of TAB agency.

2. Submit qualifications of TAB supervisor.

B. 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.

C. Sample Forms: Submit sample forms if they are other than the standard forms available from the certification association followed for the project.

D. 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.

E. Progress Reports.

F. Certified TAB Reports:

1. General:

a. Submit within two weeks after completion of testing, adjusting, and balancing.

b. Revise TAB plan to reflect actual procedures and submit as part of final report.

c. Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.

2. Draft Report: Submit draft copies of report for review prior to final acceptance of Project. Draft reports may be hand written, but must be complete, factual, accurate, and legible. Organize and format draft reports in the same manner specified for the final reports. Submit 2 complete sets of draft reports. Only 1 complete set of draft reports will be returned.

3. Final Report: Upon verification and approval of draft reports, prepare final reports, type written, and organized and formatted as specified below. Submit 2 complete sets of final reports. The final report shall be certified proof of the following:

    a. The systems have been tested, adjusted, and balanced in accordance with the referenced standards.

    b. The report reflects an accurate representation of how the systems have been installed.

    c. The report reflects a true representation of how the systems are operating at the completion of the testing, adjusting, and balancing procedures.

    d. The report is an accurate record of all final quantities measured to establish normal operating values of the systems.

4. Report Format: Provide reports in soft cover, letter size, 3-ring binder manuals, complete with index page and indexing tabs, and cover identification at front and side. Include set of reduced size drawings indicating air outlets, equipment, and thermostat locations identified to correspond with report forms. Divide the report into the following divisions:

    a. General Information and Summary

        1) Include project name, location, altitude, and date.

        2) Identify TAB agency, contractor, owner, architect, and engineer.

        3) Include addresses, contact names, and telephone numbers.

        4) Include certification sheet containing the seal, name, address, telephone number, and signature of the certified TAB Supervisor.

        5) Include actual instrument list, with manufacturer name, serial number, and date of calibration.

    b. Air Systems

    c. Hydronic Systems

    d. Temperature Control Systems

    e. Special Systems

    f. Sound and Vibration Systems

5. Report Forms: Standard forms prepared by the TAB certification standard being followed for each respective item and system to be tested, adjusted, and balanced. If not specified, follow ASHRAE 111.

6. Units of Measure: Report data in I-P (inch-pound) units only.

G. Project Record Documents: Provide drawings that record actual locations of flow measuring stations and balancing devices.

1.4 QUALITY ASSURANCE

A. Comply with ASHRAE Standard 111, Practices for Measurement, Testing, Adjusting, and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems.

B. Comply with ASHRAE Handbook, HVAC Applications Volume, Chapter "Testing, Adjusting, and Balancing", most current edition.

C. TAB Agency Qualifications:

1. Act as the single source of responsibility for TAB of the HVAC systems.

2. Staff the project at all times by qualified personnel.

3. Have a minimum of 5 years documented experience on projects with TAB requirements similar to those required for the project.

4. Certified by one of the following Certification Associations:

a. NEBB: National Environmental Balancing Bureau, Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.

D. TAB Supervisor and Technician Qualifications:

1. Certified by the same organization as TAB agency.

2. TAB Supervisor shall be a professional engineer licensed in the state in which the project is located.

E. Pre-Qualified TAB Agencies:

1. AccuTech

2. Doyle Field Services.

3. Pro Balance.

PART 2 - PRODUCTS AND MATERIALS – NOT USED

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Begin work after systems to be tested, adjusted, or balanced are fully operational, duct systems are sealed, piping systems have been tested for leaks, and equipment is operational. Complete work prior to Substantial Completion of the project.

B. Test, adjust, and balance the air systems before hydronic, steam, and refrigerant systems.

C. Coordinate with Division 22 drawings for testing, adjusting, and balancing scope of work.

D. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.

E. Submit progress reports at least once a week to the General Contractor to communicate status of work so that the TAB work is completed in a timely manner.

F. Notice of Tests: Provide seven days advance notice for each test. Include scheduled test dates and times.

G. 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.

H. All required instrumentation shall be calibrated to tolerances specified in the referenced standards within a period of six months prior to starting the project.

3.2 EXAMINATION

A. 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. Motors and bearings are lubricated.

5. Final filters are clean and in place. If required, install temporary media in addition to final filters.

6. Duct systems are clean of debris.

7. Fans are rotating correctly and belts have tension.

8. Fire, smoke, fire/smoke, and volume dampers are in place and open.

9. Air coil fins are cleaned and combed.

10. Volume dampers are installed at locations needed for balancing the air systems.

11. Access doors are closed and duct end caps are in place.

12. Air outlets are installed and connected.

13. Visually inspect duct systems to ensure they are sealed and leakage is minimized.

14. Hydronic systems are flushed, filled, and vented.

15. Hydronic systems are tested for leaks.

16. Test ports, gauge cocks, thermometer wells, flow-control devices, and balancing valves are properly installed and that their location is accessible.

17. Pumps are rotating correctly.

18. Proper strainer baskets are clean and in place.

19. Service and balance valves are open.

20. Expansion tanks are not air bound and have appropriate charge.

21. Air vents are operating freely.

B. Submit field reports. Report defects and deficiencies that will or could prevent proper system balance.

C. Beginning of work means acceptance of existing conditions.

3.3 PREPARATION

A. Pre-Balancing Conference: Prior to beginning of the testing, adjusting, and balancing procedures, schedule and conduct a coordination meeting with all installers whose work will be tested, adjusted, or balanced.

B. Furnish all instruments required for testing, adjusting, and balancing operations.

1. Verify all instruments have been calibrated.

2. Furnish instruments as recommended by the manufacturer for the TAB application.

3. Furnish instruments that are best suited to the function being measured.

4. Furnish instruments with minimum scale and maximum subdivisions and with scale ranges proper for the value being measured.

C. Furnish additional balancing devices as required for TAB to the appropriate contractor for installation.

D. Obtain copies of approved shop drawings of air handling equipment, terminal outlets, and temperature control diagrams.

E. Obtain manufacturer's fan and terminal device outlet factors and recommended procedures for testing. Prepare a summation of required outlet volumes to permit a crosscheck with required fan volumes.

F. Determine best locations in main and branch ductwork for most accurate duct traverses.

G. Prepare schematic diagrams of system "as-built" ductwork and piping layouts to facilitate reporting.

3.4 ADJUSTMENT TOLERANCES

A. Air Handling Systems: Balance main ducts and equipment to within plus or minus 5 percent of design airflow.

B. Air Outlets and Inlets: Balance branch ducts and terminal devices to within plus or minus 10 percent of design airflow.

C. Hydronic Systems: Balance to within plus or minus 5 percent of design flow.

3.5 RECORDING AND ADJUSTING

A. Record data regarding design conditions from contract documents and installed conditions from shop drawings including equipment identification number, model number, location, area served, manufacturer, model number, serial number, motor nameplate horsepower and rpm, fan rpm, capacity and electrical voltage, amps and phases.

B. For all systems measure and record the ambient conditions at the time of testing and balancing. Include the following:

1. Dry bulb temperature.
2. Relative humidity.
3. Cloud cover.
4. Wind speed.
5. Time.

C. 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.

D. Ensure recorded data represents actual measured or observed conditions.

E. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.

F. Mark on drawings the locations where traverse and other critical measurements were taken and cross reference the location in the final report.

G. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.

H. Cut insulation around ductwork and piping for installation of test probes to the minimum extent necessary to allow adequate performance of procedures.

I. Patch and seal insulation, vapor barrier, ductwork, and housings, using materials identical to those removed.

J. Seal ducts and piping and test and repair leaks.

K. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

L. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Owner.

M. Check and adjust systems approximately six months after final acceptance and submit report.

N. When averaging values, take a sufficient quantity of readings which will result in a repeatability error of less than 5 percent. When measuring a single point, repeat readings until 2 consecutive values are obtained.

O. Take all readings at eye level of the indicated value to prevent parallax.

P. Use pulsation dampeners where necessary to eliminate error involved in estimating average of rapidly fluctuation readings.

Q. Take measurements in the system where best suited for the task.

R. Retest, adjust, and balance systems subsequent to significant system modifications, and resubmit test results.

3.6 FUME HOOD TESTING (ON SITE)

A. General: Test fume hoods as installed to assess airflow velocity, airflow visualization, and level of containment. Perform tests with static mode (set sash position) conditions. Conduct testing as outlined below for 100% of the hoods provided in the Project.

B. Preparation: Visit the project site to confirm that construction activities related to the fume hood system(s) and equipment are complete. Review design documents and Contractor's submittals. Verify that mechanical ventilation systems serving the space are functioning and operating in the normal mode. Notify Owner in writing, if conditions exist which preclude proper fume hood testing. Starting of testing constitutes acceptance of site conditions.

C. Testing Requirements:

1. Perform the following tests, in order:

   a. Airflow Velocity Test.

   b. Airflow Visualization Test.

   c. Tracer Gas Containment Test.

2. Airflow Velocity Test: Conform to Section 9 of NEBB (FHT) Fume Hood Testing Standard - current edition.

3. Airflow Visualization Test: Conform to Section 10 of NEBB (FHT) Fume Hood Testing Standard - current edition.

4. Tracer Gas Containment Test:

   a. Conform to Section 11 of NEBB Fume Hood Testing Standard - current edition.

   b. Conduct a static mode test of the hood and laboratory configuration. Conduct testing in accordance with , except as modified herein:

      1) Test hood with simulated scientific apparatus set-up within the hood. Apparatus to consist of: two (2) each 1 gal. round paint cans, one (1) 1' by 1' by 1' cardboard box, and three (3) each 6" by 6" by 12" high cardboard boxes. Position these items from 6 to 10 inches behind the sash, randomly distributed, and supported off of the work surface by 2 inch by 2 inch by 2 inch block of any material.

      2) 6 liters per minute release rate for tracer gas.

      3) Conduct only at the center position for the manikin.

      4) Each tracer gas test duration to be 5 minutes.

      5) Acceptable test results will be 0.05 PPM or better.

      6) At the conclusion of each 5-minute test there will be three rapid walk-by at 1' behind the manikin. Each walk-by to be spaced 30 seconds apart. If a rise in test gas concentration occurs, it cannot exceed 0.10 ppm and must return to 0.05 ppm within 15 seconds.

      7) There must be a minimum of three and a maximum of five people in the space in which the fume hood is located during the test procedure.

      8) Representatives of the Architect, Engineer, Owner, and Contractor must witness the tests.

      9) Test of Alarm: Shut off the fume hood exhaust and verify that the individual fume hood alarm activates.

      10) Test individual controls: Test any controls that are provided at the fume hood such as unoccupied cycle override, alarm override, etc.

   c. Conduct a dynamic mode test of the hood to measure performance parameters of fume hood control systems during the following test events:

      1) Sash movement: 25 percent to 100 percent, and 50 percent to 100 percent operating positions.

      2) Rapid walk-by in front of the hood. Conduct only at center position for the manikin.

      3) Opening and closing main space entrance door, to simulate a person entering or exiting the space.

5. Reporting Requirements: Conform to Section 5 of NEBB (FHT) Fume Hood Testing Standard - current edition. Organize and include, at a minimum, the following information:

   a. Report Title.

   b. Report Certification.

   c. Table of Contents.

   d. Report Summary/ Remarks.

   e. Appropriate Forms.

   f. Instrument Calibration.

   g. List of Abbreviations Used.

   h. A room layout drawing for each tested item. Identify: walls; doors; fume hood(s); other present environmental enclosures (e.g. biological safety cabinet(s), laminar flow hood(s), canopy hood(s), etc.); location and airflow pattern of all air supply, return, and exhaust grilles, registers and diffusers.

3.7 AIR SYSTEM TESTING, ADJUSTMENT, AND BALANCING PROCEDURE

A. Check filters for cleanliness.

B. Check dampers (both volume and fire) for correct and locked position, and temperature control for completeness of installation before starting fans.

C. Verify volume dampers are installed at locations needed for balancing the air systems.

D. Prepare report test sheets for both fans and outlets. Obtain manufacturer's outlet factors and recommended procedures for testing. Prepare a summation of required outlet volumes to permit a crosscheck with required fan volumes.

E. Determine best locations in main and branch ductwork for most accurate duct traverses.

F. Place outlet dampers in the full open position.

G. Prepare schematic diagrams of system "as-built" ductwork and piping layouts to facilitate reporting.

H. Lubricate all motors and bearings.

I. Check fan belt tension.

J. Check fan rotation.

K. Energize fan motors and adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude. Replace fan and motor pulleys as required to achieve design conditions.

L. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.

M. Measure air quantities at air inlets and outlets.

N. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.

O. Use volume control devices to regulate air quantities only to extent that adjustments do not create objectionable air motion or sound levels. Affect volume control by duct internal devices such as dampers and splitters.

P. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.

Q. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.

R. 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.

S. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.

T. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

U. Where modulating dampers are provided, take measurements and balance at design conditions. Balance variable volume systems at design air flow rate and at minimum air flow rate.

V. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship to maintain building pressure setpoint.

W. Multi-Zone units with Mixing Dampers: Check for motorized damper leakage. Adjust air quantities with mixing dampers set first at design cooling, then at design heating.

X. For variable air volume boxes, set volume controller to air flow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable air volume temperature control.

Y. On fan powered VAV boxes, adjust air flow switches for proper operation.

Z. Procedure for establishing minimum and absolute minimum outdoor air damper position on air handling units:

1. Open the minimum outdoor air damper and return air damper fully. Close the economizer air damper.

2. Operate supply fan at design speed and measure the outdoor airflow.

3. If the outdoor airflow is above the scheduled minimum ventilation airflow, adjust the damper linkage on the minimum outdoor air damper so that outdoor airflow equals the scheduled minimum ventilation airflow with damper fully stroked.

4. If outdoor airflow is below the scheduled minimum ventilation airflow, adjust the damper linkage on the return air damper so that outdoor airflow equals the schedule minimum ventilation airflow with the damper fully stroked.

5. Convey the measured setpoint and/or damper position to the BAS installer and note on air balance report.

6. Repeat this procedure to determine damper position for absolute minimum ventilation.

3.8 HYDRONIC SYSTEM TESTING, ADJUSTMENT, AND BALANCING PROCEDURE

A. Open valves to full open position. Close coil bypass valves.

B. Remove and clean all strainers.

C. Check pump rotation.

D. Clean and set automatic fill valves for required system pressure.

E. Check expansion tanks to determine that they are not air bound and that the system is completely full of water.

F. Check air vents at high points of systems and determine if all are installed and operating freely (automatic type) or to bleed air completely (manual type).

G. Set temperature controls so all coils are calling for full flow.

H. Check operation of automatic bypass valves.

I. Check and set operating temperatures of chillers to design requirements.

J. Lubricate all motors and bearings.

K. Adjust water systems to provide required or design quantities.

L. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gages to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on correlated flow from temperature and pressure gauges across the heat transfer elements in the system.

M. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.

N. Affect system balance with automatic control valves fully open to heat transfer elements.

O. Affect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.

P. Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.

Q. Record the necessary information for optimizing pump operation as defined on the controls drawings. Give this information to the controls contractor for building automation system programming.

3.9 DOMESTIC WATER SYSTEM TESTING, ADJUSTMENT, AND BALANCING PROCEDURE

A. Before balancing the system perform these steps:

1. Open valves to full open position.

2. Examine plumbing system and equipment installations to verify that indicated balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices and balancing valves and fittings are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

3. Remove and clean all strainers.

4. Check pump rotation.

5. Check expansion tanks to determine that they are not air bound and that the system is completely full of water.

6. Lubricate all motors and bearings.

END OF SECTION 230593

SECTION 230700 - HVAC INSULATION

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. Extent of Mechanical insulation required by this Section is indicated on drawings and schedules, and by requirements of this Section.

B. Types of Mechanical insulation specified in this Section include the following:

1. Piping Systems Insulation:

a. Fiberglass

b. Flexible Elastomeric

2. Ductwork System Insulation:

a. Fiberglass

C. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 23 Section "Hangers & Supports for HVAC Piping & Equipment," for insulation shields and pipe saddles for protecting insulation vapor barrier and materials and methods for piping installations.

2. Division 23 Section "Underground Hydronic and Steam Piping," for insulation of piping installed below grade.

1.2 DEFINITIONS

A. Cold Pipe: Piping that carries fluid with a minimum operating temperature less than 60 degrees F.

B. Hot Pipe: Piping that carries fluid with a minimum operating temperature greater than 105 degrees F.

1.3 QUALITY ASSURANCE

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

B. Flame/Smoke Ratings: Provide composite mechanical insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by UL 723 or ASTM E 84 (NFPA 255) method.

1. Exception: Outdoor mechanical insulation may have flame spread index of 75 and smoke developed index of 150.

2. Exception: Industrial mechanical insulation that will not affect life safety egress of building may have flame spread index of 75 and smoke developed index of 150.

3. Exception: Polyisocyanurate insulation that is not installed in a return air plenum may have a flame spread index of 25 and smoke developed index of 450.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data and installation instructions for each type of mechanical insulation. Submit schedule showing manufacturer's product number, k-value, thickness, and furnished accessories for each mechanical system requiring insulation.

B. Maintenance Data: Submit maintenance data and replacement material lists for each type of mechanical insulation. Include this data and product data in maintenance manual.

C. Samples: Submit manufacturer's sample of each piping insulation type required, and of each duct and equipment insulation type required. Affix label to sample completely describing product.

PART 2 - PRODUCTS AND MATERIALS

2.1 ACCEPTABLE MANUFACTURERS

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

1. Aeroflex USA, Inc.

2. Armacell LLC.

3. CertainTeed Corp.

4. Johns Manville

5. Knauf Insulation

6. K-Flex USA

7. Owens Corning

8. Pittsburgh Corning Corp.

2.2 PIPING INSULATION MATERIALS

A. Fiberglass Piping Insulation: ASTM C547, Type I or II, Grade A.

B. Flexible Elastomeric Piping Insulation: ASTM C534, Type I.

C. Jackets for Piping Insulation: ASTM C1136, Type I.

1. PVC: One-piece, pre-molded PVC cover conforming to ASTM D1784, Johns Manville Zeston 2000 PVC or approved equivalent. Factory supplied, pre-cut insulation blanket inserts for use with PVC fitting covers are acceptable.

D. Jackets for Pipe Insulation Exposed to Weather (All Insulation except Flexible Elastomeric): Approved by the jacket manufacturer for use with the specific insulation material that it covers.

1. Rigid aluminum shell and fitting covers conforming to ASTM C1729 with weather-proof construction. Shell shall have the following minimum thickness based on the outer insulation diameter:

Outer Insulation	Minimum Aluminum Jacket Thickness, (in)		
Diameter (in)	Non-Rigid Insulation	Rigid Insulation	Finish
≤ 8	0.016	0.016	Stucco

Note 1: Use corrugated finish for non-rigid insulation. Use stucco finish for rigid insulation.

a. Banding:

1) For piping less than or equal to 8 inches, provide 0.020 inch thick, 3/4 inch wide aluminum bands.

2) For piping larger than 8 inches, provide 0.020 inch thick, 3/4 inch wide stainless steel bands.

2. Cladding consisting of a UV-resistant aluminum outer layer, multi-ply cross-laminated polyethylene film, and rubberized asphalt formulated for use on faced insulated duct and piping applications.

a. Polyguard Products, Inc. Alumaguard 60 mils thick cladding, Alumaguard Low Temp (LT) 35 mils thick cladding, or approved equivalent.

3. Cladding consisting of 13 ply fabric reinforced UV resistant outer layer and cold weather acrylic adhesive.

a. VentureClad Plus 1579CW 15.5 mils thick cladding or approved equivalent.

E. Staples, Bands, Wires, and Cement: As recommended by insulation manufacturer for applications indicated.

Table: Recommended Maximum Permeance of Water Vapor Retarders (Note 1)

Insulation Application	Insulation Permeability, Less than 4.0 perm-in. (Note 2)	Insulation Permeability, 4.0 or greater perm-in. (Note 2)
	Vapor Retarder perms	Vapor Retarder perms
Pipe and vessels (33 F to ambient)	0.05	0.05
Ducts (40 F to ambient)	1.0	0.03

Notes:

1. Water vapor permeance of the vapor retarder in perms when tested in accordance with Test Methods E96.

2. Water vapor permeability of the insulation material when tested in accordance with Test Methods E96.

F. Adhesives, Sealers, and Protective Finishes: As recommended by insulation manufacturer for applications indicated.

1. Vapor Barrier Coating: Comply with MIL-PRF-19565C, Type II.

a. Water-Based Mastic

1) Permeance in accordance with ASTM C755 for insulation application and service conditions and tested in accordance ASTM E96.

a) Pipe and vessels (33 deg. F to Ambient): 0.05 perms or less.

b) Pipe and vessels (-40 deg. F to 32 deg. F): 0.02 perms or less.

c) Ducts (40 degrees F to Ambient): 0.02 perms or less.

2) Foster 30-80, Childers CP-38 or equal.

b. Solvent-Based Mastic: Permeance shall be 0.05 perms or less at 35 mils dry per ASTM F 1249.

2. Lagging Adhesive: Comply with MIL-A-3316C, Class 1, Grade A. Provide Foster 30-36, Childers CP-50AHV2 or equal.

3. Weather Barrier Breather Mastic: Permeance shall be 1.0 perms or less at 62 mils dry per ASTM E96, Procedure B. Provide Foster 46-50, Childers CP-10/11 or equal.

G. Insulation Diameters: Comply with ASTM C585 for inner and outer diameters of rigid thermal insulation.

H. Pipe, Valve and Fitting Covers: Comply with ASTM C450 for fabrication of fitting covers for pipe, valves and fittings.

I. High Density Insulation:

1. Flexible elastomeric piping insulation conforming to ASTM C534, Type 1.

2.3 DUCTWORK INSULATION MATERIALS

A. Flexible Fiberglass Ductwork Insulation: UL/ULC classified, meeting ASTM C553, Type II.

1. Density:

a. 1.5 pounds per cubic foot.

B. Jackets for Ductwork Insulation: ASTM C1136, Type I or Type II for ductwork. Protective jackets for ductwork shall be ASTM C921 Type I made of sheet aluminum in accordance with ASTM B 209, 3003

alloy, H-14 temper, minimum 0.032 inch thick with a moisture barrier lining except where the protective jacket is applied over a Type I vapor barrier jacket and with stainless steel draw bands.

C. Ductwork Insulation Accessories: Provide staples, bands, wires, tape, pins with insulation retaining washers, anchors, corner angles and similar accessories as recommended by insulation manufacturer for applications indicated.

D. Ductwork Insulation Compounds: Provide cements, adhesives, coatings, sealers, protective finishes and similar compounds as recommended by insulation manufacturer for applications indicated.

1. Vapor Barrier Coating: Comply with MIL-PRF-19565C, Type II.

a. Water-Based Mastic: Permeance shall be 0.013 perms or less at 43 mils dry per ASTM E 96. Provide Fosters 30-80, Childers CP-38 or equal.

b. Solvent-Based Mastic: Permeance shall be 0.05 perms or less at 35 mils dry per ASTM F 1249.

2. Fiberglass Adhesive: Comply with ASTM C916, Type 2 or MIL-A-3316C, Class 2, Grade A. Provide Foster 85-60, Childers CP-127 or equal water based adhesive.

E. Jackets for Duct Insulation Exposed to Weather:Jackets installed over exterior duct insulation shall be approved by the jacket manufacturer for use with the specific insulation material that it covers. Jackets utilized to cover exterior duct insulation shall include one of the following options:

1. Encase fiberglass insulation with rigid aluminum shell with weather-proof construction. Shell shall be minimum 0.032 inch stucco embossed aluminum with three aluminum attachment bands per section and with aluminum fitting covers.

2. Provide Polyguard Products, Inc. Alumaguard 60 mils thick cladding, or approved equivalent, consisting of a UV-resistant aluminum outer layer, multi-ply cross-laminated polyethylene film, and rubberized asphalt formulated for use on faced insulated duct and piping applications. Alumaguard shall only be applied when ambient temperature is above 50˚F. For installation in low temperatures down to 10˚F, Polyguard Products, Inc. Alumaguard Low Temp (LT) or approved equal rubberized bitumen with 35 mils thick cladding can be used.

3. Provide VentureClad Plus 1579CW 15.5 mils thick cladding, or approved equivalent, consisting of 13 ply fabric reinforced UV resistant outer layer and cold weather acrylic adhesive that may be applied at temperatures as low as -10˚F.

2.4 EQUIPMENT INSULATION MATERIALS

A. Rigid Fiberglass Equipment Insulation: ASTM C612, Class 2.

B. Flexible Fiberglass Equipment Insulation: ASTM C553, Types IA and IB

C. Flexible Elastomeric Equipment Insulation: ASTM C534, TYPE II.

D. Jacketing Material for Equipment Insulation: Provide pre-sized glass cloth jacketing material, not less than 7.8 ounces per square yard, or metal jacket at Installer's option, except as otherwise indicated.

E. Equipment Insulation Compounds: Provide adhesives, cements, sealers, mastics and protective finishes as recommended by insulation manufacturer for applications indicated.

1. Vapor Barrier Coating: Comply with MIL-PRF-19565C, Type II.. Permeance shall be 0.013 perms or less at 43 mils dry per ASTM E 96 or 0.08 perms at 37 mils dry per ASTM F 1249. Provide Foster 30-80, Childers CP-38 or equal.

2. Lagging Adhesive: Comply with MIL-A-3316C, Class 1, Grade A. Provide Foster 30-36. Childers CP-50AHV2 or equal.

3. Fiberglass Adhesive: Comply with ASTM C916, Type II.

F. Equipment Insulation Accessories: Provide staples, bands, wire, wire netting, tape, corner angles, anchors and stud pins as recommended by insulation manufacturer for applications indicated.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.

3.2 PIPING SYSTEM INSULATION

A. General: Reference Insulation Schedules at the end of this specification for minimum insulation conductivity and thickness requirements.

B. Insulation Omitted: Omit insulation on the following:

1. Hot piping within radiation enclosures or unit cabinets;

2. Cold piping within unit cabinets provided piping is located over drain pan;

3. Heating piping between coil and shutoff valves provided piping is located within heated space and not more than three feet from coil;

4. Condensate piping between steam trap and union; and

5. Flexible connections and expansion joints in pipes with fluids above ambient temperatures.

C. Exterior Piping: Insulate all exterior HVAC piping with flexible elastomeric of thickness noted.

D. Sub-Freezing Piping (0 to 39 degrees F (-18 to 4 degrees C)):

1. Application Requirements: Insulate the following piping systems:

a. Refrigerant liquid lines between the expansion valve and the evaporator coil.

b. Refrigerant suction lines between evaporator coil and compressor.

2. Insulate each piping system specified above with one of the following types of insulation:

a. Fiberglass

E. Cold Piping (40 degrees F (4.4 degrees C) to ambient):

1. Application Requirements: Insulate the following piping systems:

a. HVAC chilled water supply and return piping.

b. HVAC make-up water piping.

c. Air conditioner condensate drain piping.

d. Condenser water supply and return piping when used for free cooling.

e. Heat pump supply and return water piping.

2. Insulate each piping system specified above with one of the following types and thicknesses of insulation:

a. Fiberglass

F. Warm Temperature Piping (100 degrees to 140 degrees F (38 to 94 degrees C)):

1. Application Requirements: Insulate the following piping systems:

a. HVAC hot water supply and return piping.

b. Refrigerant hot gas lines between the compressor and condensing unit.

c. Refrigerant liquid lines between the condensing unit and expansion valve.

2. Insulate each piping system specified above with one of the following types of insulation.

a. Fiberglass

3.3 DUCTWORK SYSTEM INSULATION

A. Insulation Omitted: Do not insulate fibrous glass ductwork, or lined ductwork. Refer to Section "Metal Ductwork" for requirements for duct liner material.

B. Application Requirements:

1. Insulate the following duct systems:

a. Outdoor Air.

b. Supply Air.

1) Insulate neck and bells of supply diffusers in locker rooms with shower areas and shower areas.

c. Return Air:

1) Omit insulation on return ductwork located in return air ceiling plenums except all return air ductwork within 10 feet of exterior roof or wall penetrations.

d. Exhaust and Relief Air:

1) Within 10 feet of exterior discharge outlet.

2) Downstream of heat recovery device (wheel, plate, heat pipe, etc.) to exterior discharge outlet.

e. HVAC plenums and unit housings not pre-insulated at factory or lined.

f. Range and kitchen hood non-grease exhaust ductwork.

g. Dishwasher exhaust ducts within 10 feet of discharge to the outdoors.

2. Insulate each ductwork system specified above with one of the following types and thickness of insulation:

a. Flexible Fiberglass:

1) 2" thick, minimum R-5.0.

2) Meet R-value installed at maximum 25% compression, **application limited to concealed locations**.

b. Flexible Elastomeric:

1) 1-1/2" thick, minimum R-5.0.

3. Insulate each ductwork system specified above with one of the following types and thickness of insulation:

a. Flexible Elastomeric: 2" thick, minimum R-8.0.

C. Range and hood grease exhaust ductwork: Refer to Section "Air Duct Accessories" for requirements of fire-rated wrap insulation for grease exhaust duct.

3.4 EQUIPMENT INSULATION

A. Cold Equipment (Below Ambient Temperature):

1. Application Requirements: Insulate the following cold equipment unless pre-insulated at factory:

a. Refrigeration equipment, including chillers, tanks and pumps.

b. Drip pans under chilled equipment.

c. Chilled water storage tanks.

d. Chilled water expansion tanks, air separators and piping accessories.

e. Chilled water pumps.

2. Insulate each item of equipment specified above with one of the following types and thicknesses of insulation:

a. Fiberglass: 2" thick for cold surfaces above 35 degrees F (2 degrees C) and 3" thick for surfaces 35 degrees F (2 degrees C) and lower.

b. Flexible Elastomeric: 1" thick.

B. Hot Equipment (Above Ambient Temperature):

1. Application Requirements: Insulate the following hot equipment unless pre-insulated at factory:

a. Boilers.

b. Condensate receivers.

c. Hot water expansion tanks.

d. Hot water pumps.

2. Insulate each item of equipment specified above with one of the following types and thicknesses of insulation:

a. Fiberglass: 2" thick, except 3" thick for low-pressure boilers and steam-jacketed heat exchangers.

b. Flexible Elastomeric: 1" thick. Do not use for equipment operating above 180 degrees F (82 degrees C) or 300F (149C) for high-temperature formula.

C. Breeching and Stacks:

1. Application Requirements: Insulate the following breechings and stacks:

a. Breechings between heating equipment outlet and stack or chimney connection, except for double wall or factory insulated breechings.

b. Stack from bottom to top except for factory insulated stacks.

2. Insulate each breeching and stack specified above with one of the following types and thicknesses of insulation:

a. Fiberglass: 2" thick.

b. Calcium Silicate: 2" thick.

3.5 INSTALLATION OF PIPING INSULATION

A. Maintain continuous thermal and vapor-retarder integrity throughout entire installation.

B. Install insulation on pipe systems subsequent to installation of heat tracing, painting, testing, and acceptance of tests.

C. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with a single cut piece to complete run. Do not use cut pieces or scraps abutting each other.

D. Clean and dry pipe surfaces prior to insulating.

E. Cold Pipe Insulation:

1. Insulate all cold piping to prevent moisture condensation on exterior surfaces.

2. Provide high density insulation material under supports or pre-insulated supports.

3. Protect insulation with shields to prevent puncture or other damage. Refer to Section "Hangers & Supports for HVAC Piping & Equipment" for pre-insulated supports and insulation shields.

4. High density insulation material shall extend a minimum 2 inches past the pipe shield on each side.

5. Butt pipe insulation tightly at insulation joints. Apply wet coat of vapor barrier lap cement on joint and seal with 3 inch wide vapor barrier tape or band and coat all taped seams and staple penetrations with vapor barrier coating to prevent moisture ingress.

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

1. Insulate pipe elbows using fiberglass inserts with pre-molded PVC parts, 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.

2. Insulate tee fittings with fiberglass inserts with pre-molded PVC parts, 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.

3. Insulate valves using fiberglass inserts with pre-molded PVC parts, 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.

4. Insulate strainers using fiberglass inserts with pre-molded PVC parts, 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.

5. Insulate flanges and unions using fiberglass inserts with pre-molded PVC parts or 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.

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

7. 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.

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

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

H. 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 at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.

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

4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

5. Provide PVC or metal jacket to protect insulation that is exposed in mechanical rooms and exposed below 10 feet.

a. Do not install PVC jacketing in return air plenums.

I. Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where otherwise indicated.

J. Exterior Piping:

1. Except for flexible elastomeric insulation, encase piping insulation exposed to weather with one of the following:

a. PVC jackets where installation is not exposed to direct sunlight.

b. Rigid aluminum shell with attachment bands spaced 12 inches on center and directly centered over end joints.

c. Alumaguard cladding only when ambient temperature is above 50 degrees F. For installation in low temperatures down to 10 degrees F, use Alumaguard Low Temp (LT).

d. VentureClad Plus cladding for installations at temperature as low as minus 10 degrees F.

2. Locate longitudinal seams of outer shell (aluminum, flexible elastomeric, or cladding as applicable) at bottom of pipe. Install cladding in strict conformance with cladding manufacturer's instructions and apply coatings in strict conformance with insulation manufacturer's instructions. Provide insulation shields so that the piping supports cannot puncture, cut or break the jacket.

3.6 INSTALLATION OF DUCTWORK INSULATION

A. Install insulation materials with smooth and even surfaces.

B. Clean and dry ductwork prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.

C. Maintain integrity of vapor-barrier on ductwork insulation, and protect it to prevent puncture and other damage,

D. Extend ductwork insulation without interruption through walls, floors and similar ductwork penetrations, except where otherwise indicated.

E. Lined Ductwork: Except as otherwise indicated, omit insulation on ductwork where internal insulation or sound absorbing linings have been installed. At interface of lined and wrapped ductwork, overlap lined ductwork by 2 feet (minimum) with wrapped insulation.

F. Cold Ductwork in Mechanical Rooms or Other Non-Conditioned Spaces: To prevent condensation from forming on the duct supports, provide one or more of the following:

1. Install thermal break such as rigid board insulation between the support and duct.

2. Wrap support that is in contact with the duct with external duct wrap insulation to prevent condensation. Wrap shall extend a minimum of 12" from point of contact of the support with the duct. Tape joints to provide a thermal and vapor barrier. Coat all taped joints, punctures and seams with 4" wide coating of vapor barrier mastic.

3. If a support device similar to unistrut is used, foam fill or stuff tube.

G. Protect outdoor insulation from weather by installing outdoor protective weather barrier mastic and reinforcing mesh as recommended by manufacturer or protective jacket as specified. Install protective jacket in accordance with manufacturer's recommendations.

H. Corner Angles: Except for oven and hood exhaust duct insulation, install corner angles on external corners of insulation on ductwork in exposed finished spaces before covering with jacketing.

I. Where rectangular ducts are 24" (600mm) in width or greater, duct wrap shall be additionally secured to the bottom of the duct with mechanical fasteners, spaced on 18" (425mm) centers (maximum) to prevent sagging of insulation. Fasteners shall include 2-inch square self-sticking galvanized carbon-steel base plates with minimum 0.106-inch diameter zinc-coated, low carbon steel, fully annealed shank spindle, length to suit depth of insulation. Insulation shall be secured to spindles with self-locking washers incorporating a spring steel insert to ensure permanent cap retention.

3.7 INSTALLATION OF EQUIPMENT INSULATION

A. Install insulation materials with smooth and even surfaces and on clean and dry surfaces. Redo poorly fitted joints. Do not use mastic or joint sealer as filler for gapping joints and excessive voids resulting from poor workmanship.

B. Maintain integrity of vapor-barrier on equipment insulation and protect it to prevent puncture and other damage.

C. Do not apply insulation to equipment, breechings, or stacks while hot.

D. Apply insulation using the staggered joint method for both single and double layer construction, where feasible. Apply each layer of insulation separately. Tape all joints using a suitable, matching acrylic adhesive tape; minimum 3" wide.

E. Coat insulated surfaces of calcium silicate with layer of insulating cement, troweled in workmanlike manner, leaving a smooth continuous surface. Fill in scored block, seams, chipped edges and depressions, and cover over wire netting and joints with cement of sufficient thickness to remove surface irregularities.

F. Cover insulated surfaces with all-service jacketing neatly fitted and firmly secured. Lap seams at least 2". Apply over vapor barrier where applicable. Tape all joints using a suitable, matching acrylic adhesive tape; minimum 3" wide.

G. Do not insulate boiler manholes, handholes, cleanouts, ASME stamp, and manufacturer's nameplate. Provide neatly beveled edge at interruptions of insulation.

H. Provide removable insulation sections to cover parts of equipment which must be opened periodically for maintenance; include metal vessel covers, fasteners, flanges, frames and accessories.

I. Equipment Exposed to Weather: Protect outdoor insulation from weather by installation of Self-Adhesive Water and Weather Seal material (such as VentureClad) or jacketing, as recommended by the manufacturer.

3.8 PROTECTION AND REPLACEMENT

A. Provide all required protection for insulation (installed and uninstalled) throughout the duration of construction to avoid exposure to plaster, dust, dirt, paint, moisture, deterioration, and physical damage.

B. Replace damaged insulation which cannot be repaired satisfactorily at no additional expense to the Owner, including insulation with vapor barrier damage and insulation that has been exposed to moisture during shipping, storage, or installation. Drying the insulation is not acceptable. Dry surfaces prior to installation of new insulation that replaces the damaged or wet insulation.

3.9 PIPE INSULATION SCHEDULES

A. IECC – 2018 Requirements, Pipe Insulation

Minimum Pipe Insulation Thickness

Fluid Operating Temp. Range (°F) And Usage	Insulation Conductivity Conductivity, Btu·in./(hr·ft²·°F)	Mean Rating Temp., °F.	Nominal Pipe or Tube Size (in.) <1	1 to <1-1/2	1-1/2 to <4	4 to <8	≥8
			Insulation Thickness, in.				
>350°F	0.32–0.34	250	4.5	5.0	5.0	5.0	5.0
251°F–350°F	0.29–0.32	200	3.0	4.0	4.5	4.5	4.5
201°F–250°F	0.27–0.30	150	2.5	2.5	2.5	3.0	3.0
141°F–200°F	0.25–0.29	125	1.5	1.5	2.0	2.0	2.0
105°F–140°F	0.21–0.28	100	1.0	1.0	1.5	1.5	1.5
40°F–60°F	0.21–0.27	75	0.5	0.5	1.0	1.0	1.0
<40°F	0.20–0.26	50	0.5	1.0	1.0	1.0	1.5

Notes:

a. For piping smaller than 1-1/2 inch and located in partitions within conditioned spaces, reduction of these thicknesses by 1 inch shall be permitted (before thickness adjustment required in footnote b) but not to a thickness less than 1 inch.

b. For insulation outside the stated conductivity range, the minimum thickness (T) shall be determined as follows: $T = r[(1 + t/r)^{(K/k)} – 1]$ where

1) T = minimum insulation thickness (in.),

2) r = actual outside radius of pipe (in.),

3) t = insulation thickness listed in the table for applicable fluid temperature and pipe size,

4) K = conductivity of alternate material at mean rating temperature indicated for the applicable fluid temperature (Btu·in/hr·ft²·°F); and

5) k = the upper value of the conductivity range listed in this table for the applicable fluid temperature.

c. Insulation thicknesses are based on energy efficiency considerations only. Add insulation where noted on the drawings.

d. For piping that shall be installed below grade, reference Division 23 section "Underground Hydronic and Steam Piping."

e. The table is based on steel pipe. Non-metallic pipes schedule 80 thickness or less shall use the table values. For other non-metallic pipes having thermal resistance greater than that of steel pipe, reduced thicknesses are permitted if documentation is provided showing that the

pipe with the proposed insulation has no more heat transfer per foot than a steel pipe of the same size with the insulation thickness shown on the table.

END OF SECTION

SECTION 230913 - INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Control panels.

B. Control dampers.

C. Flow measuring apparatus.

D. Humidistats.

E. Input/Output sensors and transmitters.

F. Output control devices.

G. Power Supplies.

H. Thermostats.

I. Time clocks.

1.2 DEFINITIONS

A. BAS: Building Automation System.

B. Control Wiring: Includes conduit, wire and wiring devices to install complete control systems including motor control circuits, interlocks, thermostats, EP and IP switches and like devices. Includes all wiring from Intelligent Devices and Controllers to all sensors and points defined in the input/output summary shown on the drawings or specified herein and required to execute the sequence of operations

C. Cv: Design Valve Flow Coefficient.

D. DDC: Direct Digital Control.

E. EPDM: Ethylene Propylene Diene Monomer.

F. High voltage: 50 volts or higher.

G. Low voltage: Below 50 volts.

H. PTFE: Polytetrafluoroethylene.

I. TEFZEL: A modified ETFE (ethylene tetrafluoroethylene) fluoroplastic.

1.3 CONTRACTOR RESPONSIBILITIES

A. Reference Division 23 Section "Electrical Coordination for Mechanical Equipment" for contractor responsibilities.

B. BAS Contractor:

1. Installation of the BAS shall be by the BAS Contractor or his subcontractors.

2. Low voltage control wiring.

3. Coordinate high voltage control wiring to instrumentation and control devices with Division 26. Where high voltage power is required for instrumentation and control devices that is in addition to what is shown on the drawings, the BAS contractor shall cover the cost of providing this wiring.

4. All interlock wiring regardless of voltage (e.g., exhaust fan interlocked to supply fan).

5. Coordinate with Division 26 that motor starters are provided with auxiliary contacts as required for interlocks.

6. Coordinate power wiring to BAS controllers and instrumentation and control devices with Division 26.

7. Coordinate installation of back-box rough-in for wall-mounted control devices sensors, etc. with Division 26. Coordinate with mechanical contractor all locations, quantities, and sizes required for installation by Division 26.

C. Sheet Metal Contractor:

1. Installation of automatic control dampers, smoke control dampers, and necessary blank off plates.

2. Access doors where and as required.

D. Mechanical Contractor:

1. Installation of immersion wells.

2. Installation of flow switches.

3. Installation of automatic control valves.

4. Installation of pressure tappings and associated shut-off cocks.

5. Coordinate conduit and wall box rough-in, power wiring and magnetic starter requirements for controls and mechanical equipment with Division 26.

1.4 SUBMITTALS

A. Refer to Division 01 for submittal procedures.

B. Product Data: Provide description and engineering data for each control system component. Include dimensions, capacities, size, performance characteristics, electrical characteristics, and finishes of materials.

C. Shop Drawings: Indicate complete operating data, system drawings, wiring diagrams, and written detailed operational description of sequences. Submit schedule of valves indicating size, flow, and pressure drop for each valve. For automatic dampers indicate arrangement, velocities, and static pressure drops for each system.

D. Schedule for control valves and actuators, including the following:

1. Tag.
2. Quantity.
3. Model number.
4. Equipment served.
5. Flow at project design conditions.
6. Selected valve flow coefficient (Cv). For butterfly valves, submit the corresponding valve position at which the Cv is calculated.
7. Pressure differential drop across valve at project design flow conditions and selected Cv.
8. Maximum close-off pressure.
9. Valve Configuration (2-way/3-way).
10. Valve Normal Position and Fail Position (e.g., NO/FO; normally open/fail open).
11. Valve Size.
12. Line Size.
13. Valve Type.
14. Actuator Signal Type (Open/Close, Modulating 0-10 Vdc, 2-10 Vdc, 4-20 mA, etc.)
15. Torque required to close valve at pump shutoff head.
16. Selected actuator maximum torque output.

E. Manufacturer's Instructions: Provide for all manufactured components.

F. Operation and Maintenance Data: Include inspection period, cleaning methods, recommended cleaning materials, and calibration tolerances.

G. Project Record Documents: Record actual locations of control components, including panels, thermostats, and sensors. Accurately record actual location of control components, including panels, thermostats, and sensors.

H. Warranty: Submit manufacturer warranty and ensure forms have been filled out in Owner s name and registered with manufacturer.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

C. Control valves shall be manufactured in plants located in the United States or certified to meet the specified ASTM, ANSI and MSS standards.

D. Measurement devices and sensors shall be calibrated using NIST traceable standards.

1.6 WARRANTY

A. Correct defective Work within a two year period after Substantial Completion.

B. Provide extended warranty for control devices and equipment as specified herein.

PART 2 - PRODUCTS

2.1 OWNER FURNISHED PRODUCTS

A. New Products: None/Not Applicable.

2.2 CONTROL PANELS

A. Construction:

1. Panel shall be UL 508A listed.

2. NEMA 250, general purpose utility enclosures with enameled finished face panel.

3. NEMA 4X utility enclosure for outdoor or wash-down applications.

4. Provide common keying for all panels.

2.3 CONTROL VALVES

A. General:

1. Factory fabricated of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated. Each valve shall be equipped with proper packing to ensure there will be no leakage at the valve stem.

2. Pressure Ratings:

a. Valve body and packing rated to withstand the system static head plus the maximum pump head and the maximum temperature of the control medium (i.e. chilled water, steam, hot water, etc.).

1) Minimum pressure class 150psig.

b. Two-way modulating valves and their operators shall have close-off pressure ratings exceeding the dead-head condition of the pump in the system it serves.

c. Two-way modulating valves with equal percentage flow characteristics and their operators shall be rated to safely operate within a differential pressure range between 2 and 50 psi across the valve without cavitating.

3. Sizing:

a. Hydronic Systems:

1) Two-Position: Line size or sized using a pressure differential of 1 psi. Size butterfly valves using the 90 degree flow coefficient (Cv).

2) Modulating: Select valves with an appropriate flow coefficient (Cv) to achieve a minimum design valve authority of 0.5 relative to the total pressure drop of the piping branch the valve controls. Calculate Cv based on the larger of the following:

a) 5-psig pressure drop at the design flow rate specified in the Schedules.

b) Twice the equipment design pressure drop as specified in the Schedules unless otherwise noted:

c) Valve shall not be less than 1/2 Inch in size.

d) Size butterfly valves using the 60 degree of full open flow coefficient (Cv).

4. Flow Characteristics:

a. Hydronic Service:

1) Two-way valves: Equal percentage characteristic.

2) Chiller isolation valves: Linear characteristic.

b. Steam Service: Linear flow characteristics.

5. End Connections:

a. Reference the Control Valve Schedule in Part 3 for allowable end connections by pipe material.

b. Carbon steel and stainless steel valves shall comply with ASME B16.34.

c. Comply with ASME B16.10 for face-to-face and end-to-end dimensions.

d. Threads:

1) Comply with ASME B1.20.1.

2) Comply with ASME B16.4 for cast iron.

3) Comply with ASME B16.15 for cast copper alloys, including bronze and brass.

e. Flanges:

1) Comply with ASME B16.5 for steel.

2) Comply with ASME B16.1 for cast iron

3) Comply with ASME B16.24 for cast copper alloys, including bronze and brass.

f. Grooved Fittings:

1) Water services to 230 deg F and 250 psig.

B. Globe Pattern:

1. Size: Reference the Control Valve Schedule in Part 3 for allowable valve size and end connection by application.

2. Construction:

a. Up to 2 inches: Class 150, ASTM B62 bronze body, bronze trim, rising stem, renewable composition disc, screwed ends with backseating capacity repackable under pressure.

1) Bronze body and bonnet shall conform to ASTM B62 up to pressure class 150. Conform to ASTM B61 for pressure class 200 and higher.

b. Over 2 Inches: Iron body, bronze trim, rising stem, plug-type disc, flanged ends, renewable seat and disc.

1) Iron body and bonnet shall conform to ASTM A126, class B.

c. Bonnet:

1) Bronze body, Class 125: Threaded type.

2) Bronze body, Class 150 or higher: Union type.

3) Iron body: Bolted type.

d. Disc Material:

1) PTFE.

2) Stainless steel.

e. Stem: Outside screw and yoke. Include extension for insulation.

f. Two-piece brass packing gland assembly, non-asbestos composition packing.

3. Rangeability: Minimum 50:1.

4. Leakage:

a. Up to 1-1/4 Inch: Minimum ANSI Class III per ANSI/FCI 70-2.

b. 1-1/2 Inch and Larger: Minimum ANSI Class IV per ANSI/FCI 70-2.

5. Design and Testing:

a. MSS SP-80 for bronze.

b. MSS SP-85 for cast iron.

C. Ball Pattern:

1. Size: Reference the Control Valve Schedule in Part 3 for allowable valve size by application.

2. Construction:

a. Body:

1) Bronze conforming to ASTM B61, B62, and B584.

2) Forged brass with or without nickel plating conforming to ASTM B283.

3) Cast carbon conforming to ASTM A216.

4) Cast iron according to ASTM A126.

5) Stainless steel conforming to ASTM A351.

b. Up to 2 inches: Two-piece construction

c. 2-1/2 inch to 3 inch: Three-piece construction.

d. Stainless steel, blowout proof stem. Include extension for insulation.

e. Replaceable PTFE seats and EPDM O-ring or PTFE packing seals.

3. Ball: Full port with characterized insert comprised of the following material:

a. Stainless steel.

b. Chrome-plated.

c. Nickel-plated.

4. Rangeability: Minimum 50:1.

5. Leakage: Minimum ANSI Class IV per ANSI/FCI 70-2.

6. Design and Testing:

a. MSS SP-72 for flanged ends.

b. MSS SP-110 for threaded and grooved ends.

D. Butterfly Pattern:

1. Size: Reference the Control Valve Schedule in Part 3 for allowable valve size by application.

2. Construction:

a. Body: Lug ends suitable for connecting to ASME B16.5 flanges, or grooved ends.

1) Cast iron according to ASTM A126.

2) Ductile iron according to ASTM A536.

3) Cast steel according to ASTM A216.

b. Disc:

1) Aluminum bronze.

2) Stainless steel.

3) One-piece nylon coated ductile iron disc. Nylon coated discs are not allowed for open loop condenser water systems.

c. Stem: 416 Stainless steel. Include extension for insulation.

d. Replaceable PTFE or EPDM seats and seals.

3. Rangeability: Minimum 20:1.

4. Leakage: Minimum ANSI Class IV, per ANSI/FCI 70-2.

5. Design and Testing: MSS SP-67 for Class 150 and MSS SP-68 for pressure classes above 150.

E. Manufacturers:

1. Belimo.

2. Bray.

3. Danfoss.

4. Griswold Controls.

5. Kele.

6. Victaulic (Tour & Andersson).

F. At the contractor's discretion, control valves and balancing valves may be combined into a single device. Submit pricing deduct as an alternate to the base bid.

1. Manufacturers:

a. Victaulic, TBV-TC/TCM Series.

2. Construction:

a. Factory fabricated, Integrated valve body that incorporates an adjustable flow coefficient (Cv) chamber and separate pressure regulating chamber to maintain a constant differential pressure across the valve.

b. Field-adjustable: Capable of modifying the valve flow characteristics without removing the valve from the piping system.

c. Valve shall have a minimum of two integral ports factory installed capable of being used to measure pressure or temperature. If valve does not have these ports, contractor shall provide test ports on each side of valve for field verification.

d. 2 Inch and Smaller:

1) Forged brass body conforming to ASTM B283.

e. 2-1/2 Inch and Larger:

1) Ductile iron body conforming to ASTM A536.

2) Cast carbon body conforming to ASTM A216.

3) Stainless steel body conforming to ASTM A351.

f. Flow Regulator: Stainless steel.

g. Stem: Brass or stainless steel, blowout proof. Include extension for insulation.

h. Replaceable PTFE seats and EPDM O-ring or PTFE packing seals.

i. Characterizing Disc:

1) Ball Type: Full port with characterized insert comprised of the following material:

a) Stainless steel.

b) Chrome-plated.

c) Nickel-plated.

2) Plug Type: Brass, TEFZEL, or stainless steel characterizing disc.

3. Electronic Actuator:

a. Direct mounted, self-calibrating type designed for minimum 60,000 full-stroke cycles at rated force.

b. Supplied from the same manufacturer as the valve.

c. Include visible position indicator.

d. Overload Protection: Electronic overload or digital rotation-sensation circuitry.

e. Fail-Safe Operation: Mechanical, spring-return mechanism or Capacitance return.

f. Power Requirements: 24 VAC/DC motor; accepting a 0-10 Vdc or 4-20 mA signal.

4. Accuracy: PI control valve shall accurately control the flow from 0 to 100 percent rated flow within an operating pressure differential range of 5 to 50 psi across the valve.

5. Leakage: Minimum ANSI Class IV per ANSI/FCI 70-2. Valve shall be equipped with proper packing to ensure there will be no leakage at the valve stem.

6. Design and Testing:

a. MSS SP-72 for flanged ends.

b. MSS SP-110 for threaded and grooved ends.

7. PI control valves shall be provided with electronic actuator driven by a 24VAC/DC motor from a 0-10Vdc or 4-20 mA signal.

8. Extended Warranty: Minimum of 5 years from date of shipment.

9. Manufacturers:

a. Belimo.

b. Bray.

c. Danfoss.

d. Flow Control Industries.

e. Griswold Controls.

f. Oventrop.

g. Victaulic (Tour & Andersson).

G. Solenoid-Operated Control Valves:

1. Construction:

a. Factory fabricated, heavy duty assembly.

b. Body and Trim:

1) Bronze

2) Stainless steel.

c. Replaceable PTFE seats and disc.

d. Solenoid Enclosure: NEMA 250, Type 4.

2. Action:

a. As indicated on the drawings.

b. Manual override capable.

3. Operator: Spring return with normal position and power requirements as indicated on the drawings.

a. Reference Valve Operators section below for additional requirements.

2.4 CONTROL DAMPERS

A. Dampers shall be factory fabricated and sized as shown on drawings and as specified.

B. Individual damper sections shall not be larger than 48 inches x 60 inches. Provide a minimum of one damper actuator per section.

C. Performance: Test in accordance with AMCA 500-D.

1. Pressure Drop: Unless otherwise scheduled or indicated on the Drawings, size control dampers as follows:

a. Modulating Dampers: Provide dampers with linear flow characteristics. Size modulating dampers based on the smaller of the following.

1) Maximum velocity of 1,500 feet per minute.

2) Maximum Full-open air pressure drop of 0.1 inches W.C.

b. Two Position Dampers: Dampers shall be full duct size and selected to minimize pressure drop.

2. Leakage:

a. Motorized dampers shall not exceed 4.0 CFM/square foot in full closed position at 1 inch W.G. pressure differential across damper.

3. All control dampers used for smoke control shall conform to UL555S and be provided with end switches for remote indication of damper blade position.

D. Frames: Galvanized steel, extruded aluminum, or stainless steel, welded or riveted with corner reinforcement.

1. Use minimum 16 gauge for rectangular dampers.

2. Use minimum 20 gauge for round dampers.

3. For aluminum frames, use 1/8 inch thick material.

4. All damper frames shall have a flange for duct mounting.

5. Reference Part 3 Execution for application of the material type.

E. Blades: Galvanized steel, extruded aluminum, or stainless steel, maximum blade size 6 inches wide, 48 inches long, attached to minimum 1/2 inch shafts with set screws.

1. Use minimum 16 gauge for rectangular dampers.

2. Use minimum 16 gauge for round dampers.

3. For aluminum blades, use 1/8 inch thick material.

4. The blades shall be suitable for the air velocities to be encountered in the system.

5. Dampers longer than the maximum blade length shall be fabricated in sections.

6. Reference Part 3 Execution for application of the material type.

F. Blade Seals: Synthetic elastomeric inflatable or Neoprene, mechanically attached, field replaceable.

1. Installed along the top and bottom of the frame and on all mating surfaces.

G. Jamb Seals: Spring stainless steel.

1. Installed inside the frame sides.

H. Shaft Bearings: One of the following as recommended by manufacturer for the application:

1. Oil impregnated sintered bronze.

2. Graphite impregnated nylon sleeve with thrust washers at bearings.

3. Lubricant free, stainless steel, single row, ground, flanged, radial, antifriction type with extended inner race.

4. Molded synthetic bearings.

I. Linkage Bearings: One of the following as recommended by manufacturer for the application:

1. Oil impregnated sintered bronze

2. Graphite impregnated nylon.

J. Maximum Pressure Differential: 6 inches wg.

K. Temperature Limits: -40 to 200 degrees F.

L. Manufacturers:

1. Greenheck.

2. CESCO.

3. Pottorff.

4. Nailor.

5. Ruskin.

M. Reference the Damper Schedule in Part 3 for basis of design damper model and material for the application.

2.5 OPERATORS

A. General:

1. Voltage: Voltage selection shall be as required to achieve the required torque for the application.

a. Reference Part 3 for Damper Operator Voltage Schedule.

2. Type: Motor operated, with or without gears. Motor type shall be continuous duty.

3. Construction:

a. For Actuators Less Than 100 W: Fiber or reinforced nylon gears with steel shaft, copper alloy or nylon bearings, and pressed steel enclosures.

b. For Actuators from 100 to 400 W: Gears ground steel, oil immersed, shaft hardened steel running in bronze, copper alloy or ball bearings. Operator and gear trains shall be totally enclosed in dustproof cast-iron, cast-steel or cast-aluminum housing.

c. For Actuators Larger Than 400 W: Totally enclosed reversible induction motors with auxiliary hand crank and permanently lubricated bearings.

4. Field Adjustment:

a. Spring Return Actuators: Easily switchable from fail open to fail closed in the field without replacement.

b. Gear Type Actuators: External manual adjustment mechanism to allow manual positioning when the actuator is not powered.

5. Two-Position Actuators: Single direction, spring return or reversing type. End-switches shall be integral to the actuator to determine actuator status.

6. Modulating Actuators:

a. Operation: Capable of stopping at all points across full range, and starting in either direction from any point in range.

b. Control Input Signal:

1) Three Point, Tristate, or Floating Point: Clockwise and counter-clockwise inputs. One input drives actuator to open position and other input drives actuator to close position. No signal of either input remains in last position.

2) Proportional: Actuator drives proportional to input signal and modulates throughout its angle of rotation. Suitable for zero- to 10-Vdc or 2- to 10-Vdc and 4- to 20-mA signals.

3) Pulse Width Modulation (PWM): Actuator drives to a specified position according to pulse duration (length) of signal from a dry contact closure, triac sink, or source controller.

c. Programmable Multi-Function:

1) Control Input, Position Feedback, and Running Time: Factory or field programmable.

2) Diagnostic: Feedback of hunting or oscillation, mechanical overload, mechanical travel, and mechanical load limit.

3) Service Data: Include, at a minimum, number of hours powered and number of hours in motion.

7. Position Feedback:

   a. Where indicated on the controls drawings, equip two-position actuators with limits switches or other positive means of a position indication signal for remote monitoring of open and close position.

   b. Where indicated on the controls drawings, equip modulating actuators with a position feedback through current or voltage signal for remote monitoring.

   c. Actuator shall contain position indicator and graduated scale indicating open and closed travel limits.

8. Integral Overload Protection:

   a. Provide against overload throughout the entire operating range in both directions.

   b. Electronic overload, digital rotation sensing circuitry, mechanical end switches, or magnetic clutches are acceptable methods of protection.

9. Attachment:

   a. Unless otherwise required for valve interface, provide an actuator designed to be directly coupled to device without the need for connecting linkages.

   b. Attach actuator to device drive shaft in a way that ensures maximum transfer of power and torque without slippage.

10. Temperature and Humidity:

    a. Temperature: Suitable for operating temperature range encountered by application.

    b. Humidity: Suitable for humidity range encountered by application, non-condensing.

11. Enclosure:

    a. Suitable for ambient conditions encountered by application.

    b. NEMA 4 for indoor wash-down or wet locations.

    c. NEMA 4X, Belimo ZS-300, or equivalent; for outdoor applications.

12. Stroke Time:

    a. Coordinate with stroke time indicated on the control drawings.

    b. Unless otherwise noted, select operating speed to be compatible with equipment and system operation.

B. Damper Operators:

1. Controls contractor shall size damper operator.

2. Sizing: Provide smooth proportional control with sufficient power for air velocities 20 percent greater than maximum design velocity and to provide tight seal against maximum system pressures. Provide spring return for two position control and for fail safe operation.

    a. Provide sufficient number of operators to achieve unrestricted movement throughout damper range.

    b. Provide one operator for maximum 20 sq ft damper section or maximum 7 in-lb/sq ft damper area.

3. Fail Positions:

    a. Spring return to normal position as indicated on freeze, fire, temperature, or loss of power protection. Normal positions are indicated on the control drawings.

        1) Return air damper, normally open.

        2) Outside air damper, normally closed.

        3) Exhaust/Relief air damper, normally closed.

    b. Operator shall fail in place for all other applications not listed under spring return.

    c. Batteries, capacitors, or other non-mechanical forms of fail-safe operation are required for ICC 500 Storm Shelter natural ventilation louvers/openings. The actuator shall be capable of operating the damper (even during primary power loss) from the closed damper position to the open damper position when activated by a wall mounted switch.

C. Valve Operators

1. Sizing: Select operator with sufficient torque capacity to operate the valve under all conditions and to guarantee tight shut-off of as specified against system pressure encountered.

    a. Operators for Hydronic Control Valves: Capable of closing valve against system pump dead head.

2. Fail Positions:

    a. Spring return to normal position as indicated on freeze, fire, temperature, or loss of power protection.

        1) Pre-heat coil, normally open.

        2) Humidifier, normally closed.

        3) Other devices needing fail safe operation to account for freeze protection, power failure, overheating or moisture damage, reference control drawing points list for normal position.

b. Operator shall fail in place for all other applications not listed under spring return.

D. Manufacturers:

1. Damper Operators:

a. Belimo.

2. Valve Operators:

a. Belimo.

b. Bray.

c. Danfoss.

2.6 FLOW MEASURING APPARATUS

A. Airflow Measuring Stations

1. Sensor quantity and spacing shall comply with the Equal-Area or Log-Tchebycheff method as defined in the ASHRAE Handbook of Fundamentals.

2. Element Construction: Non-corrosive material such as stainless steel, aluminum, or cadmium-plated.

3. Stations and insertion elements utilizing thermal dispersion technology shall utilize hermetically sealed thermistors for each sensor and shall be factory calibrated to NIST traceable standards.

4. Stations and insertion elements using velocity pressure shall be tested and certified in accordance with AMCA 611.

5. Air Inlet Measuring Stations:

a. Intended for location within an air inlet to equipment, such as a hood or louver.

b. Elements:

1) Element constructed of 316 stainless steel, factory mounted in a circular puck constructed of 14 gauge galvanized steel. Housing shall meet NEMA 1.

2) Element shall not induce a measurable pressure drop, adversely affect fan performance or amplify the sound level within the fan system by its presence in the airstream.

3) Element shall not be affected by the presence of moisture, dirt, or debris in the airstream and shall be unaffected by gusting wind.

4) Density corrected for ambient temperature variances and atmospheric pressure due to altitude.

c. Range: Minimum 100 to 2,400 fpm.

d. Accuracy: Plus/minus 5.0 percent of reading within the calibrated airflow range.

e. Manufacturers:

1) Air Monitor Corporation.

2) Approved equal.

6. Fan Inlet Air Flow Measuring Stations:

a. Located in the fan cone inlet with a minimum of two sensing elements.

b. Traverse Type Elements:

1) The elements shall not induce a measurable pressure drop, adversely affect fan performance or amplify the sound level within the fan system by its presence in the airstream.

c. Surface Mount Probes:

1) Thermal Dispersion Type: Two surface mounted thermal dispersion probes mounted on opposite ends of the fan cone shall monitor the airflow.

2) Velocity Pressure Type: The piezometer ring probes shall monitor the pressure difference between the largest and smallest diameters of the inlet cone venturi. High and low pressure sensors shall be connected to flow tubes extending to a termination plate mounted on the fan housing.

d. Range: Minimum 100 to 10,000 fpm.

e. Accuracy: Plus/minus 3.0 percent of the measured airflow range.

f. Manufacturers:

1) Air Monitor Corporation.

2) Ebtron.

3) Greenheck

4) Johnson Controls.

5) Paragon Controls.

6) Ruskin.

7) Sensocon.

7. Duct Air Flow Measuring Stations

a. Located in a configuration and size equal to that of the duct it is installed.

b. The airflow traverse probe shall not induce a measurable pressure drop, nor amplify the sound level within the duct by its presence in the airstream.

c. Flow Straightener: Provide flow straightener as required by manufacturer of construction as needed to meet the application.

d. Range: Minimum 400 to 4,000 fpm.

e. Accuracy: Plus/minus 2.0 percent of the measured airflow.

f. Manufacturers:

1) Air Monitor Corporation.

2) Ebtron.

3) Johnson Controls.

4) Paragon Controls.

5) Ruskin.

6) Sensocon.

8. Signal Processor:

a. Microprocessor-based, field programmable, capable of local display of the measured airflow rate.

b. Factory calibrated to NIST traceable standards.

c. Accuracy: 0.1 percent of full scale, including linearity, hysteresis, dead band, and repeatability.

d. Output: 0 to 10 Vdc or 4-20 mA scaled output signal for remote monitoring.

B. Water Flow Meter: Provide Water Flow Meter as specified in Division 23 Section, "Meters and Gauges for HVAC Piping.".

C. BTU Meter: Provide BTU Meter as specified in Division 23 Section, "Meters and Gauges for HVAC Piping."

D. Gas Flow Meter: Furnish gas flow meter as specified in Division 23 Section, "Meters and Gauges for HVAC Piping."

2.7 HUMIDISTATS

A. Room Humidistats:

1. Performance Characteristics:
    a. Throttling range: Adjustable 2 percent relative humidity.
    b. Accuracy: Plus/minus 3 percent over the operating range.
        1) Accuracy shall include temperature effects.
    c. Operating range: 20 to 80 percent.
    d. Drift: Less than 1 percent per year.
2. Construction:
    a. Wall-mounted enclosure: Plastic, NEMA 250, Type 1.
3. Output: Linear, proportional type over shielded cable pair, 4 - 20 mA or 0 – 10 Vdc signal..

B. Limit Duct Humidistat:

1. Insertion, two position switch type.
2. Performance Characteristics:
    a. Throttling range: Adjustable 2 percent relative humidity.
    b. Accuracy: Plus/minus 5 percent over the operating range.
        1) Accuracy shall include temperature effects.
    c. Operating range:
        1) High Limit Type: Minimum 50 to 95 percent.
    d. Drift: Less than 1 percent per year.
3. Construction:
    a. Enclosure: Metal, NEMA 250, Type 1.

2.8 INPUT/OUTPUT SENSORS AND TRANSMITTERS

A. General:

1. Performance Requirements:
    a. Device must be compatible with project DDC controllers.
    b. Elements used shall be general-purpose type.

c. Provide transmitters or transducers with sensors as required, with range suitable for the system encountered.

1) Transmitters and transducers shall have offset and span adjustments.

2) Shock and vibration shall not harm the transmitter or transducer.

3) Transmitters and transducers shall have a zeroing capability of readjusting the transmitter zero.

d. Accuracy requirements shall include the combined effects of linearity, hysteresis, repeatability, and the transmitter.

2. Output: Linear, proportional type over shielded cable pair, 4 - 20 mA or 0 – 10 Vdc signal.

3. Input Power: Low voltage, nominal 24 Vdc.

B. Temperature Sensors:

1. Use thermistor or RTD type temperature sensing elements with characteristics resistant to moisture, vibration, and other conditions consistent with the application without affecting accuracy and life expectancy. Sensor shall be UL 873 listed for temperature equipment.

2. Performance Requirements:

a. Thermistor:

1) Accuracy (All): Plus/minus 0.36 degrees F minimum.

2) Temperature Differential Accuracy: Plus/minus 0.15 degrees F minimum.

3) Resolution: Plus/minus 0.2 degrees F minimum.

4) Heat Dissipation Constant: 2.7 mW per degree C.

5) Drift: 0.04 degree F after 10 years within temperature range.

b. RTD:

1) Construct RTD of nickel or platinum with base resistance of 1000 ohms at 70 degrees F. 100 ohm platinum RTD is acceptable if used with project DDC controllers.

2) Accuracy (All): Plus/minus 1 degree F minimum, unless otherwise noted below.

a) Room Sensor Accuracy: Plus/minus 0.5 degrees F minimum.

b) Chilled Water Accuracy: Plus/minus 0.5 degrees F minimum.

c) Temperature Differential Accuracy: Plus/minus 0.15 degrees F minimum.

3) Resolution: Plus/minus 0.2 degree F.

4) Drift: 0.04 degrees F after 10 years within temperature range.

c. Sensing Range:

1) Provide limited range sensors if required to sense the range expected for a respective point.

2) Use RTD type sensors for extended ranges beyond minus 30 degrees F to 230 degrees F.

d. Wire Resistance:

1) Use appropriate wire size to limit temperature offset due to wire resistance to 1.0 degree F or use temperature transmitter when offset is greater than 1.0 degree F due to wire resistance.

2) Compensate for wire resistance in software input definition when feature is available in the DDC controller.

3. Outside Air Sensors: Watertight inlet fitting shielded from direct rays of the sun.

4. Room Temperature Sensors:

a. Construct for surface or wall box, or enclosure with insulated backing suitable for exterior wall mounting.

b. Button Sensor for High Finish Spaces: Where noted on the drawings or scheduled, provide cable type, button probe sensor designed for flush mounting in wall or ceiling with the following features:

1) 6 inch leads.

2) 1/2 inch plastic spacer with locking nut.

3) Finish as specified on the drawings. If not specified, provide Aluminum finish.

c. Provide the following features:

1) Setpoint reset slide switch, dial wheel, or push-button interface with an adjustable temperature range.

2) Locking cover where noted on the drawings.

3) Integral digital display with the following:

a) Indication of space temperature.

b) Setpoint adjustment to accommodate room setpoint.

5. Temperature Averaging Elements:

   a. Use on duct sensors for ductwork 10 sq ft or larger.

   b. Use averaging elements where prone to stratification with sensor length range between 16-22 ft.

   c. Provide for all mixed air and heating coil discharge sensors regardless of duct size.

6. Insertion Elements:

   a. Use in ducts not affected by temperature stratification or smaller than 10 sq ft.

   b. Provide dry type, insertion elements for liquids, installed in immersion wells, with minimum insertion length of 2.5 inches for pipe sizes greater than 4 inches.

   c. Immersion Well Housing: 1/2 inch NPT brass or stainless steel. Stainless steel required for piping 6 inch and larger.

C. Humidity Sensors:

1. Elements: Accurate within 3 percent full range with linear output.

   a. Accuracy shall include temperature effects.

2. Resolution: Plus/minus 1 percent.

3. Drift: Less than 1 percent full scale per year.

4. Sensing Range: 0 to 100 percent relative humidity.

5. Room Sensors: Provide housing with integral sensor. Housing shall be plastic, NEMA 250, Type 1. Provide with insulated backing suitable for exterior wall mounting.

6. Duct Sensors: Insertion type probe with mounting plate. Housing shall be metal, NEMA 250, Type 1.

7. Outside Air Sensors: With element guard and mounting plate.

D. Pressure Transmitters:

1. Duct Static Pressure:

   a. Type: Unidirectional, fixed range.

   a. Performance Characteristics:

      1) Accuracy: Plus/minus one percent of full scale.

      2) Thermal Effects: Temperature compensated over a minimum 40 to 120 F range. Zero and span shift of plus/minus 0.06 percent or less of full scale per degree F.

3) Sensing Range: Select sensor so that the high end of the nominal sensor range is not less than 150 percent and not more than 300 percent of maximum expected input.

4) Long Term Thermal Stability: Plus/minus one percent full scale per year.

b. Construction:

1) Insertion or traverse type sensor suitable for use in flat oval, rectangular, and round duct configurations.

2) Insertion length selected as appropriate for duct size.

3) Traverse sensors shall have at least one pickup point every 6 inches.

4) Element: Variable capacitance sensing technology.

5) Housing: Fire retardant glass-filled polyester, brass, stainless steel, or aluminum.

2. Hydronic Pressure:

a. Type: Unidirectional, fixed range.

a. General Sensor Performance Characteristics:

1) Accuracy: Plus/minus 1.0 percent of full scale.

2) Thermal Effects: Temperature compensated minimum 30 to 150 F range. Zero and span shift of plus/minus 0.02 percent or less of full scale per degree F

3) Long Term Thermal Stability: Plus/minus 0.5 percent full scale per year.

4) Range: Select sensor so that the scheduled differential pressure setpoint is near the midrange of the sensor pressure range.

b. Performance Characteristics for Chiller/Boiler Equipment Differential Pressure:

1) Application: Variable-Primary Flow Systems.

2) Accuracy: Plus/minus 0.05 percent of full scale.

3) Thermal Effects: Temperature compensated minimum 30 to 150 F range. Zero and span shift of plus/minus 0.02 percent or less of full scale per degree F.

4) Long Term Thermal Stability: Plus/minus 0.125 percent full scale per year for minimum 5 years.

5) Range: Select sensor so that the scheduled differential pressure setpoint is near the midrange of the sensor pressure range.

6) Manufacturers:

a) Rosemount, 3051S

b) Approved equal.

c. Construction:

1) Suitable for the media temperature and pressure.

E. Chiller/Boiler differential sensor shall have push button zero and span adjustments. No internal mechanical linkages shall be used in the transmitterEquipment Operation Sensors:

1. Status Inputs for Airside Equipment:

a. Type: Fixed range differential pressure switch with adjustable setpoint.

b. Performance Characteristics:

1) Range: Not greater than two times the design fan static pressure.

c. Construction:

1) Enclosure: Comply with NEMA enclosure ratings, suitable for the ambient conditions encountered.

2) Provide Insertion tube for use in duct configurations. Insertion length selected as appropriate for duct size.

3) Contact Type: Single-pole, single-throw (SPST). Provide multiple poles or throw contacts to meet additional alarms required.

2. Status Inputs for Hydronic Equipment:

a. Differential Pressure Switch: Fixed range type with adjustable setpoint.

1) Range: Not greater than two times the design equipment differential pressure.

2) Enclosure: Comply with NEMA enclosure ratings, suitable for the ambient conditions encountered.

3) Contact Type: Single-pole, single-throw (SPST). Provide double-throw contacts to meet additional alarms required.

b. Flow Switch:

1) Thermal dispersion flow switch enclosed in insertion device, of material suitable for fluid encountered and magnetic setpoint coordinated with the desired flow rate.

a) Range: Sensitivity suitable for the maximum and minimum design flow rates of the system in which it is installed.

b) Enclosure: Comply with NEMA enclosure ratings, suitable for the ambient conditions encountered, with LED status indicators for visual switch indication.

c) Contact Type: Automatic reset upon regain of flow.

3. Status Inputs for Electric Motors:

a. Analog Current Transducer:

1) Type: Split core design, cable of being installed or removed without dismantling the primary bus cables.

2) Performance Characteristics:

a) Accuracy: Plus/minus 2 percent of selected range.

b) Range: Multi-range device, suitable for the amperage encountered with internal zero and span adjustment.

3) Construction:

a) 24 V or Self-powered.

b) Provide with integral command relay.

c) Device shall accept overcurrent up to twice its trip into range.

d) Enclosure: UL 94 approved thermoplastic, rated for V-0. No metal parts shall be exposed other than the terminals.

b. Binary Current Sensing Relay:

1) Type: Split core with current transformers, adjustable and set to 175 percent of rated motor current.

2) Self-powered with solid-state circuitry and a dry contact output.

3) Adjustable trip point.

4) Contact Type: Single-pole, double-throw (SPDT).

5) LED indicating the on or off status.

6) A conductor of the load shall be passed through the window of the device.

7) Device shall accept overcurrent up to twice its trip into range.

F. Leak Detection Sensors

G. Leak detection sensors shall be stand alone as described in Division 23 Section, Common Work Results for HVAC". Monitor leak detection sensors as noted on the drawings.Carbon Dioxide Sensors:

1. General: Provide non-dispersive infrared (NDIR) CO2 sensors with integral transducers and linear output.

a. Linear, CO2 Concentration Range Display: 0 to 2000 ppm.

b. Full Scale Accuracy: Plus/minus 75 ppm at concentrations of both 600 and 1,000 ppm when measured at sea level at 77 degrees F.

c. Maximum Response Time: 1 minute.

d. Analog Output: 0-10 Vdc or 4-20 mA.

e. Rated Ambient Conditions:

1) Air Temperature: Range of 32 to 122 degrees F.

2) Relative Humidity: Range of 0 to 95 percent (non-condensing).

2. Calibration Characteristics:

a. Factory calibrated and certified by the manufacturer to require calibration not more frequently than once every 5 years.

b. Automatically compensating algorithm for sensor drift due to sensor degradation.

c. Sensor shall be temperature compensated throughout entire operating range.

d. Maximum Drift: 2 percent per year.

3. Construction:

a. Sensor Chamber: Non-corrosive material for neutral effect on carbon dioxide sample.

b. Duct Mounting: Provide duct mounted sensors with duct probe designed to protect sensing element from dust accumulation and mechanical damage.

c. Wall/Surface Mounting: Construct for surface or wall box or enclosure suitable for wall mounting.

2.9 OUTPUT CONTROL DEVICES

A. Control Relays:

1. Provide relay with contact rating, configuration, and coil voltage that is suitable for the application.

2. Provide NEMA 1 enclosure when relay is not installed in a local control panel.

3. Control relays shall be UL listed plug-in type with dust cover and LED "energized" indicator.

4. Time delay relays shall be UL listed solid-state plug-in type with adjustable time delay. Delay shall be adjustable plus/minus 200 percent minimum from setpoint.

B. Fan Speed Controllers:

1. Solid-state model providing field-adjustable proportional control of motor speed. Equip with filtered circuit to eliminate radio interference.

2.10 POWER SUPPLIES

A. Reference Division 23 Section "Direct Digital Controls for HVAC" for DC power supply requirements.

B. Control power transformers shall meet NEMA/ANSI standards.

C. Control power transformers shall be UL listed for Class 2 current-limited service or provided with over-current protection on both primary and secondary circuits for Class 2 current-limited service.

D. Connected load on the transformer shall not exceed 80 percent of the transformer's rated capacity.

E. The core and windings shall be completely encased in a UL approved thermoplastic. No metal parts shall be exposed other than the terminals.

F. Performance Characteristics:

1. Accuracy: Plus/minus 1 percent at 5.0 A full scale output.

G. Provide a disconnect switch for each transformer.

2.11 THERMOSTATS

A. General:

1. Programmable, with the following features:

a. LCD or LED display screen.

b. Button our touch-screen Interface.

c. Temperature information display.

d. Setpoint display and adjust.

2. Performance Requirements:

a. Accuracy: Plus/minus 1.0 degree F minimum.

b. Resolution: Plus/minus 0.2 degrees F.

c. Range:

1) Operating Temperature: 32 degrees F to 122 degrees F minimum.

2) Operating Humidity: 0 percent to 95 percent relative humidity, non-condensing.

3) Setpoint Control:

a) Heating: 40 degrees to 90 degrees F.

d. Multi-stage as required to match unit cooling and heating stages scheduled on the drawings.

B. Electric Room Thermostats:

1. Type: 24 volts, two position switch, programmable with setback/setup temperature control.

2. Covers: Locking with set point adjustment and indication.

3. Setpoint functional range: 45 degrees F to 90 degrees F.

C. Line Voltage Thermostats:

1. Integral manual On/Off/Auto selector switch, single or two pole as required.

2. Dead band: Maximum 2 degrees F.

3. Covers: Locking with set point adjustment and indication.

4. Setpoint functional range: 45 degrees F to 90 degrees F.

5. Rating: Motor load.

D. Room Thermostat Accessories:

1. Thermostat Covers: Brushed aluminum.

2. Insulating Bases: For thermostats located on exterior walls.

3. Thermostat Guards: Locking transparent plastic mounted on separate base.

4. Adjusting Key: As required for device.

5. Aspirating Boxes: Where indicated for thermostats requiring flush installation.

6. Integrated sensors: At the contractor's option, the following sensors may be provided with the thermostat in a single device. Refer to the drawings where additional sensors are required. Refer to "Input/Output Sensors" section of this specification for language governing performance of the integrated sensors.

a. Humidity sensor.

b. Carbon dioxide sensor.

E. Immersion Thermostat:

1. Remote bulb or bimetallic rod and tube type, proportional action with adjustable setpoint and adjustable throttling range.

F. Airstream Thermostat:

1. Remote bulb or bimetallic rod and tube type, proportional action with adjustable setpoint in middle of range and adjustable throttling range.

2. Averaging service remote bulb element: minimum 7.5 feet or length as required to fit duct.

G. Electric Low Limit Thermostat:

1. Snap acting, single pole, single throw, manual or automatic reset switch as indicated on the drawings that trips if temperature sensed across any 12 inches of bulb length is equal to or below setpoint,

a. Provide double-throw contacts (one for direct equipment control, one for BAS system notification) where additional alarms are scheduled.

2. Bulb length: Minimum 1 foot for every 1 square foot of coil cross sectional area.

3. Provide one thermostat for every 20 sq ft of coil surface.

4. Setpoint shall be adjustable.

H. Electric High Limit Thermostat:

1. Snap acting, single pole, single throw, manual reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or above setpoint,

2. Bulb length: Minimum 1 foot for every 1 square foot of coil cross sectional area.

3. Provide one thermostat for every 20 sq ft of coil surface.

4. Setpoint shall be adjustable.

2.12 TIME CLOCKS

A. Solid state programmable time control with owner designated quantity of separate programs, 24 hour battery carry over, duty cycling, individual on/off/auto switches for each program, 7 day programming, 365 day calendar with 20 programmable holidays, choice

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify that systems are ready to receive work.

C. Beginning of installation means installer accepts existing conditions.

D. Sequence work to ensure installation of components is complementary to installation of similar components in other systems.

E. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.

3.2 INSTALLATION

A. Cooperate with other contractors performing work on this project as necessary to achieve a complete and coordinated installation. Each Contractor shall consult the Drawings and Specifications for all trades to determine the nature and extent of others work.

B. General Workmanship:

1. Install equipment, piping, and wiring/raceway parallel to building lines wherever possible.

2. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.

3. Install all equipment in readily accessible locations.

4. All installations shall comply with industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.

5. Install all products in accordance with manufacturer's instructions.

C. Sensors:

1. Mount sensors rigidly and adequately for the environment within which the sensor operates.

2. Room temperature sensors shall be installed on concealed junction boxes properly supported by the wall framing.

3. All wires attached to sensors shall be air sealed in their raceways or in the wall to stop air transmitted from other areas affecting sensor readings.

4. Sensors used in mixing plenums and hot and cold decks shall be of averaging type. Averaging sensors shall be installed in a serpentine manner vertically across the duct. Each bend shall be supported with a capillary clip.

5. Low-limit sensors used in mixing plenums shall be installed in a serpentine manner horizontally across duct. Each bend shall be supported with a capillary clip. Provide 1 foot of sensing element for each square foot of coil area.

6. Do not install temperature sensors within the vapor plume of a humidifier. If installing a sensor downstream of a humidifier, install it at least 10 feet downstream.

7. Install temperature, humidity, and smoke detectors for both supply air and return air applications a minimum of 10'-0" downstream or upstream of the air handling unit and prior to any branch duct takeoffs.

8. All pipe-mounted temperature sensors shall be installed in wells. Install all liquid temperature sensors with heat-conducting fluid in thermal wells.

9. Install outdoor air temperature sensors on north wall, complete with sun shield where shown on the plans. If not shown, locate sensors in an accessible location, a minimum of 15 feet away from exhaust or relief air locations.

10. Differential air static pressure.

    a. Supply Duct Static Pressure: Pipe the high-pressure tap to the duct using a pitot tube. Pipe the low-pressure port to a tee in the high-pressure tap tubing of the corresponding building static pressure sensor (if applicable) or to the location of the duct high-pressure tap and leave open to the plenum.

    b. Return Duct Static Pressure: Pipe the high-pressure tap to the duct using a pitot tube. Pipe the low-pressure port to a tee in the low-pressure tap tubing of the corresponding building static pressure sensor or the plenum.

    c. The piping to the pressure ports on all pressure transducers shall contain a capped test port located adjacent to the transducer.

    d. All pressure transducers, other than those controlling VAV boxes, shall be located in field device panels, not on the equipment monitored or on ductwork. Mount transducers in a location accessible for service without use of ladders or special equipment.

    e. All air and water differential pressure sensors shall have gauge tees mounted adjacent to the taps. Water gauges shall also have shutoff valves installed before the tee.

11. Adjust flow switch to meet sensitivity required to ensure minimum flow through the equipment.

12. Check and verify location of thermostats, humidistats, and exposed control sensors with plans and room details before installation. Locate 48 inches above floor. Align with adjacent lighting switches and humidistats.

    a. Install devices to meet ADA requirements unless otherwise noted on the plans.

13. Mount freeze protection thermostats using flanges and element holders.

    a. Install thermostat completely across the surface the thermostat serves.

14. Mount outdoor reset thermostats and outdoor sensors indoors, with sensing elements outdoors with sun shield.

15. Provide separable sockets for liquids and flanges for air bulb elements.

16. Provide thermostats in aspirating boxes in areas where flush mounting is required.

17. Provide guards on thermostats in areas indicated on the drawings.

18. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.

19. Install shutoff valves in the high and low pressure reference lines connecting to hydronic pressure sensors and switches. Install a shunt valve across the high and low reference pressure ports for servicing. Valves may be ordered as an integral option with the sensor.

D. Control Valves:

1. Do not install brass valves in open-loop systems.

2. Install pipe reducers for valves smaller than line size. Position reducers as close to valve as possible but at distance to avoid interference and impact to performance. Install with manufacturer-recommended clearance.

3. Install flanges or unions to allow valve removal and installation.

4. Locate valves for easy access and provide separate support of valves that cannot be handled by service personnel without hoisting mechanism.

5. Valve Orientation:

   a. Where possible, install globe and ball valves installed in horizontal piping with stems upright and not more than 15 degrees off of vertical, not inverted.

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

   c. Where possible, install butterfly valves that are installed in horizontal piping with stems in horizontal position and with low point of disc opening with direction of flow.

6. Provide valves with position indicators where sequenced with other controls.

7. Tag valves in accordance with Division 23 Section, "Identification for HVAC Piping and Equipment."

8. Install a pressure/temperature port on each side of pressure independent control valves (PICVs) which are not factory provided with integral ports.

E. Control Dampers:

1. Install dampers with extruded aluminum or stainless steel frames and blades in corrosive environments and areas with high humidity.

2. Install smooth transitions, not exceeding 30 degrees, to dampers smaller than adjacent duct. Install transitions as close to damper as possible but at distance to avoid interference and impact to performance. Consult manufacturer for recommended clearance.

3. Clearance:

   a. Locate dampers for easy access and provide separate support of dampers that cannot be handled by service personnel without hoisting mechanism.

   b. Install dampers with at least 24 inches of clear space on sides of dampers requiring service access.

4. Service Access:

   a. Dampers and actuators shall be accessible for visual inspection and service.

   b. Install access door(s) in duct or equipment located upstream of damper to allow service personnel to hand clean any portion of damper, linkage, and actuator. Comply with requirements in Division 23 Section, "Air Duct Accessories.".

5. Duct openings shall be free of any obstruction or irregularities that might interfere with blade or linkage rotation or actuator mounting.

6. Install dampers straight and true, level in all planes, and square in all dimensions. Install supplementary structural steel reinforcement for large multiple-section dampers if factory support alone cannot handle loading.

7. Provide mixing dampers of parallel blade construction arranged to mix streams. Where shown on the drawings, provide separate minimum outside air damper section adjacent to return air dampers with separate damper motor.

8. Provide isolation (two position) dampers of parallel blade construction.

9. Provide opposed blade damper configuration for all other applications.

10. Install damper motors on outside of duct in warm areas. Do not install motors in locations at outdoor temperatures.

11. After installation of low-leakage dampers and seals, caulk between frame and duct or opening to prevent leakage around perimeter of damper.

F. Operators:

1. Mount and link control damper actuators according to manufacturer's instructions.

   a. To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5 degrees open position, manually close the damper, and then tighten the linkage.

   b. Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.

c. Provide all mounting hardware and linkages for actuator installation.

2. Dampers: Actuators shall be direct-mounted on damper shaft or jackshaft unless shown as a linkage installation. For low-leakage dampers with seals, the actuator shall be mounted with a minimum 5 degree available for tightening the damper seals.

3. Valves: Actuators shall be connected to valves with adapters approved by the actuator manufacturer.

G. Control Panels:

1. Install control panels where shown on the drawings and where required to house controllers for the controlled systems and equipment.

2. Mount control panels adjacent to associated equipment on vibration free walls or free standing angle iron supports. One cabinet may accommodate more than one system in same equipment room. Provide engraved plastic nameplates for instruments and controls inside cabinet and engraved plastic nameplates on cabinet face.

3. Coordinate 120V power requirements with Division 26 to panels used for the building automation system and transformers for low voltage power to controllers.

H. Install "hand/off/auto" selector switches to override automatic interlock controls when switch is in "hand" position.

I. Provide an insulation standoff on control devices, cables, and other items that do not require flush mounting to ductwork, piping, or equipment.

J. Install room pressure monitoring system per manufacturer installation instructions. Provide additional rough-in and tubing for accessories such as pressure snubbers and remote annunciators required to perform the system functions. Schedule manufacturer representative to provide start up, testing, and owner operating instructions to owner.

3.3 MAINTENANCE

A. Refer to Division 01 closeout requirements for additional requirements relating to maintenance service.

B. Provide service and maintenance of control system for one year from Date of Substantial Completion.

C. Provide complete service of controls systems, including call backs, and submit written report of each service call.

3.4 STARTUP AND DEMONSTRATION

A. Control Dampers and Valves:

1. Stroke and adjust control valves and dampers following manufacturer's recommended procedure, from 100 percent open to 100 percent closed back to 100 percent open.

2. Check and document open and close cycle times for applications with a cycle time of less than 30 seconds.

3. For control valves and dampers equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

4. Verify that all two-position dampers and valves operate properly and that the normal positions are correct.

5. Verify that all modulating dampers and valves are functional, that the start and span are correct, that direction and normal positions are correct, and that they achieve proper closure.

B. PI Control Valves:

1. Field verify installation and operating differential pressure range of all PI control valves.

2. Verify total system flow to be within plus/minus 10 percent of system design.

3. Verify correct individual performance for each valve as noted on the drawings.

4. Individual field adjustments for the PI control valve assembly shall be performed using the PI control valve manufacturer's documented procedures.

3.5 DAMPER SCHEDULE

SERVICE	RUSKIN MODEL	MATERIAL
Outside Air Control	CD-50	Aluminum
Fire and Smoke Control	FSD-60	Galvanized Steel
Corrosive Environments	CD-35	Aluminum or Stainless steel
All Other	CD-35	Galvanized Steel

3.6 DAMPER OPERATOR VOLTAGE SCHEDULE

SERVICE	VOLTAGE
Interlocked with HVAC fans	120V
Multi-section dampers	120V
Large dampers (> 60 inches in any dimension)	120V
All other operators control wiring	24V

1. Note: Coordinate with Division 26 if 120V power is required for operator to achieve appropriate torque requirements for damper actuation.

3.7 CONTROL VALVE SCHEDULES

A. Allowable Valve Type and Size by Control Application:

VALVE TYPE	CONTROL APPLICATION MODULATING	TWO-POSITION
Globe	≤ 4 IN	≤ 2 IN
Characterized Ball	≤ 4 IN	≤ 4 IN

Butterfly	> 4 IN	≥ 2-1/2 IN

B. Allowable Valve Body Material by Service Application:

VALVE BODY MATERIAL	SERVICE APPLICATION CLOSED LOOP	OPEN LOOP
Bronze	Allowed	Allowed
Brass	Allowed	Not Allowed
Iron	Allowed	Allowed
Stainless Steel	Allowed	Allowed

C. Allowable End Connection by System Material:

1. Copper Tube:

   a. 2-1/2 Inch and smaller: Threaded ends.

2. Steel Pipe:

   a. 2 Inch and Smaller: Threaded.

   b. 2-1/2 Inch and Larger:

      1) Flanged.

      2) Grooved ends for water systems.

D. Allowable End Connection by Size Schedule:

VALVE TYPE	END CONNECTION TYPE THREADED	FLANGED	GROOVED
Globe	≤ 2-1/2 IN	≤ 4 IN	N/A
Characterized Ball	≤ 2-1/2 IN	≤ 3 IN	N/A
Butterfly	N/A	≥ 2-1/2 IN	≥ 2-1/2 IN

END OF SECTION

SECTION 230923 - DIRECT-DIGITAL CONTROL FOR HVAC

PART 1 - GENERAL

1.1 INSTRUCTIONS TO BIDDERS

A. The system specified in this section shall be WebCtrl manufactured by Automated Logic Corporation for interface with the District's existing building automation controls and service infrastructure. Contact Controls Service Co., Inc. (816)-600-5800.

1.2 SECTION INCLUDES

A. System Description.

B. Operator Interface.

C. Controllers.

D. Electrical Control Power Wiring and Low Voltage Wiring.

E. Local Area Network.

F. System Software.

G. Controller Software.

1.3 REFERENCE STANDARDS

A. ANSI/CEA 709.1.D - Control Network Protocol Specification; 2014.

B. ASHRAE Std 135 - BACnet - A Data Communication Protocol for Building Automation and Control Networks; most current edition.

C. IEEE C37.90.1 – IEEE Standard for Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus, most current edition.

D. IEEE C62.41.2 – IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits, most current edition.

E. ISO 7498 – Information Processing Systems – Open System Interconnection – Basis Reference Model, International Standards Organization, most current edition.

F. NEMA – National Electrical Manufacturers Association.

G. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.

1.5 DEFINITIONS

A. ASC: Application Specific Controller. Examples include controllers for specific applications (e.g., FCU, VAV box, etc.) that can be configured through any network services software.

A. ATU: Air Terminal Unit (e.g., VAV boxes, fan-powered boxes, fan coil units).

B. BAS: Building Automation System.

C. BTL: BACnet Testing Laboratories. Third party independent testing and listing program for devices which have been tested according to ASHRAE Standard 135.

D. Control Wiring: Includes conduit, wire and wiring devices to install complete control systems including motor control circuits, interlocks, thermostats, EP and IP switches and like devices. Includes all wiring from Intelligent Devices and Controllers to all sensors and points defined in the input/output summary shown on the drawings or specified herein and required to execute the sequence of operations

E. DDC: Direct Digital Control.

F. EMT: Electrical Metallic Tubing

G. High voltage: 50 volts or higher.

H. IP: Internet Protocol.

I. LAN: Local Area Network.

J. VLAN: Virtual Local Area Network.

K. Low voltage: Below 50 volts.

L. OSI: Open System Interconnection

M. PC: Personal Computer.

N. PICS: Protocol Implementation Conformance Statement.

O. Point: Point is a generic term used to describe a single item of information in a BAS. Points may be further described as input, output, digital, binary, discrete, analog, modulating, internal, external, virtual or global. Each unique point used by digital controllers, or in a BAS, is typically identified by an address.

1.6 CONTRACTOR RESPONSIBILITIES

A. Reference sections the following sections for additional contractor responsibilities and coordination:

1. Division 23 Section "Electrical Coordination for Mechanical Equipment."

2. Division 23 Section "Instrumentation and Control Devices for HVAC."

B. Reference Part 3 for additional electrical contractor responsibilities for BAS controls.

1.7 SUBMITTALS

A. Refer to Division 01 and Division 23 Section "General Mechanical Requirements" for submittal procedures.

B. General:

1. The drawings and specifications are not intended to show all details. The BAS contractor shall secure satisfactory information before submitting the proposal and include in the proposal a sum sufficient to cover all items of labor and material required for the complete installation for the devices and system described.

1. Inform Engineer in writing of any deviation in the exhibits submitted from the requirements of the drawings, specifications, and sequences of operations.

C. Product Data:

1. Submit manufacturer technical data for each system component and software module required for a complete installation.

2. Indicate dimensions, weights, and enclosure construction for all BAS distributed controllers.

2. Submit technical data on all new software supplied including description of functions performed by software and location within the system where software shall reside. Include all software licensing agreements.

3. Submit the PICS for each BACnet device used in the BAS.

D. Power and Communication Wiring Transient Protection:

1. Submit catalog data sheets providing evidence that all BAS products offered by the manufacturer are tested and comply with IEEE C62.41.2.

2. Testing shall include power and communication trunk wiring.

3. Compliance with IEEE C62.41.2 shall imply conformance with IEEE C37.90.1based on the stated position of ANSI and IEEE.

E. Shop Drawings:

1. Submit a trunk cable schematic showing locations of all programmable control units, controllers, and workstations, with associated network wiring.

a. Indicate equipment served by each controller on the diagram.

b. Indicate switches, power requirements to each controller, and daisy chained controllers.

3. Submit detailed schematic control drawings for each controlled device and equipment.

c. Reference all control components to manufacturer make and model number.

d. Include all control and power wiring with termination point (controller and terminal number).

e. Include clearly indicated and written sequences of operation referenced to specific control components (e.g., "shall modulate valve V-3").

f. Include default position (e.g., N.O., N.C., etc.) for all components where applicable.

g. Clearly differentiate between existing components and new components.

a. Include detailed wiring diagrams showing methods of connections to VFDs, motor starters, energy meters, and all other devices, and all other field wiring necessary for system installation.

b. The use of "typicals" will be allowed where appropriate.

2. Submit detailed drawings for each individual BAS distributed controller.

a. Include controller identification.

b. Include components included in the controller.

c. Include numbering of terminals and communications ports.

d. List connected data points, including connected control unit and input device.

e. Include type of cable connected to each terminal port.

f. Identify specific field devices wired to each terminal including identification of each field device and application.

g. Clearly differentiate between existing controllers and new controllers.

h. Indicate source (electrical panel ID) of 120V power to each panel to which 120V power is connected.

i. Indicate method of connecting controller to equipment supplied by others and to existing communications networks.

3. Submit floor plans that indicate the following:

a. Location of all new BAS distributed controllers and control panels.

b. Routing of all new building level network communications wiring not located in mechanical and electrical rooms.

c. Routing of wiring to controllers, sensors, and control points not located in mechanical and electrical rooms.

d. Location of building system connection to Owner's campus wide data network.

4. Submit methods and materials used to integrate into existing networks.

5. All control drawings and schematics shall be generated using AutoCAD software or equivalent. All project drawings shall be supplied to the Owner in a format as desired by the Owner upon project completion.

4. Submit system identification nomenclature.

a. Nomenclature shall be consistent throughout the network and consistent with any existing networks that are integrated. If not defined, nomenclature shall be similar to the point names shown on the drawings.

b. Control device name and ID number shall be unique within the network.

c. Network number shall be unique within the BAS.

F. Manufacturer's Instructions: Indicate manufacturer's installation instructions for all manufactured components.

G. Manufacturer's qualification statement.

H. Installer's qualification statement.

I. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors.

1. Revise shop drawings to reflect actual installation and operating sequences.

2. Include submittals data in final "Record Documents" form.

3. All additions or changes to the BAS during the course of construction shall be reflected upon the drawings and submitted to the Engineer before project close-out.

J. Testing and Commissioning Reports and Checklists: Submit completed versions of all reports and checklists, along with all trend logs, used to meet the requirements of Part 3, Startup and Demonstration.

K. Operation and Maintenance Data:

1. Include maintenance data and recommended spare parts list for digital control equipment and control components.

2. Include trouble-shooting maintenance guides.

3. Include interconnection wiring diagrams showing complete field installed systems with identified and numbered system components and devices.

4. Include keyboard illustrations and step-by-step procedures indexed for each operator function.

5. Include inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.

6. Include a maintenance manual which contains the information listed above, product data, shop drawings, final software code for sequences of operation and maintenance data in accordance with requirements of Division 01.

7. Include logbook for documentation of software updates and patches applied BAS for the time period included in the software licensing agreement.

8. Provide names, addresses, and telephone numbers of installing contractors and service representatives for equipment and control systems.

L. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer. On multi-phase contracts submit a list of warranty start dates if there is a different start date for the work of various phases.

M. Maintenance Materials:

1. Refer to Division 01 for additional provisions.

1.8 QUALITY ASSURANCE

A. Perform work in accordance with NFPA 70.

B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

C. BACnet devices used in the BAS shall be BTL listed according to its device profile.

D. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

E. Installer Qualifications: Company specializing in performing the work of the type specified and with minimum documented experience as follows:

1. All personnel of the BAS Contractor shall have a minimum of three years of experience within their appropriate trades.

2. All subcontractors utilized by the BAS Contractor shall have a minimum of five years experience within their appropriate trades.

F. Additional BAS Contractor Requirements:

1. Personnel, Coverage and Response Capabilities: The BAS Contractor shall have a fully staffed office with service technicians and systems engineers within a 50 mile radius of the project location.

2. Emergency Service: The BAS Contractor shall have an established 24 hour emergency service organization. A dedicated telephone number shall be provided to the Owner for requesting

emergency service. A maximum of four hour, electronic service technician on sight, response time shall be guaranteed by the BAS Contractor.

3. Parts Stocking: The BAS Contractor shall have an independently verifiable inventory of electronic service parts. This electronic service parts inventory must have a worth of at least $100,000 per year over the last five years.

1.9 WARRANTY

A. Refer to Division 01 for additional project warranty requirements.

B. Labor and materials for the BAS specified shall be warranted free from defects in workmanship and material for a period of 2 years after Substantial Completion and system acceptance.

C. BAS failures during the warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to the Owner.

D. All work shall have a single warranty date, even when the Owner has received beneficial use due to an early system start-up. If the work specified is split into multiple contracts or a multi-phase contract, then each contract or phase shall have a separate warranty start date and period.

E. Provide updates to operator workstation software, project-specific software, graphic software, database software, and firmware that resolve Contractor-identified software deficiencies at no charge during warranty period. If available, Owner can purchase in-warranty service agreement to receive upgrades for functional enhancements associated with above-mentioned items. Do not install updates or upgrades without Owner's written authorization.

F. Contractor shall maintain and provide a standard 12 month warranty for any existing equipment, wiring, and controllers that are selected to be reused for the project. Installation labor and materials shall be warranted. Demonstrate operable condition of reused devices at time of system engineer's acceptance or commissioning.

G. Provide five year manufacturer's warranty for field programmable micro-processor based units.

H. Special warranty on instrumentation:

1. All instrumentation shall be covered by manufacturer's transferable one-year "No Fault" warranty. If manufacturer warranty is not available, the BAS installer shall provide the same.

1.10 PROTECTION OF SOFTWARE RIGHTS

A. Prior to delivery of software, the Owner and the party providing the software will enter into a software license agreement with provisions for the following:

1. Limiting use of software to equipment provided under these specifications.

2. Limiting copying.

3. Preserving confidentiality.

4. Prohibiting transfer to a third party.

B. Software provider shall provide software updates and patches to the BAS as part of the software licensing agreement as the updates and patches are released. If any security vulnerabilities are discovered by the provider, the provider shall notify the client within five business days.

C. Ownership of Proprietary Material: Project-specific software and documentation shall become Owner's property upon project completion. This includes, but is not limited to the following:

1. Graphics.

2. Record drawings.

3. Database.

4. Application programming code.

5. Documentation.

PART 2 - PRODUCTS

2.1 OWNER FURNISHED PRODUCTS

A. New Products: None/Not Applicable

2.2 MANUFACTURERS

A. Corporate Edition Products: The following manufacturers and product lines shall be manufacturer's most current vintage and of open protocol design. Corporate editions shall be based on manufacturer developed software.

1. Automated Logic, WebCtrl.

B. The above list of manufacturers applies to operator workstation software, controller software, the custom application programming language, building controllers, custom application controllers, and application specific controllers. All other products specified under Division 23 Section "Instrumentation and Control Devices for HVAC" need not be manufactured by the above manufacturers.

2.3 SYSTEM DESCRIPTION

A. General:

1. The BAS shall consist of all necessary hardware and software to perform the control sequences of operation as called for in the Specifications and Drawings. Contractor shall install and commission all necessary devices to ensure a reliable and stable network.

2. System design is bases on a distributed system of fully intelligent, stand-alone controllers, operating in a multi-tasking, multi-user environment on token passing network, with central and remote hardware, software, and interconnecting wire and conduit.

3. Include computer software and hardware, operator input/output devices, control units, local area networks (LAN), sensors, control devices, actuators.

4. The BAS shall be capable of integrating multiple devices, sensors, and functions from multiple control vendors into a common front end, including equipment supervision and control, alarm management, energy management, and trend data collection.

5. The BAS shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, ASC's, and operator devices.

6. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.

B. Local Area Network:

1. The BAS shall be set up as a physically separate network within the building.

C. Network Architecture: The BAS network architecture shall be based upon the OSI basic reference model in accordance with ISO 7498.

1. Application/Network Layer:

a. BACnet protocol complying with ASHRAE Standard 135.

2. Physical/Data Link Layer:

a. Hard-wired type:

1) Ethernet according to ISO 8802-2 protocol.

2) EIA-485 Twisted Cable Pair according to Master Slave/Token-Passing (MS/TP) protocol.

b. Wireless type (where approved by owner):

1) Radio Frequency (RF) according to 902 MHz EnOcean protocol.

3. Communication between operator workstation(s) and building controller(s):

a. Ethernet.

4. Communication between building controller(s) and application specific and custom application controllers:

a. MS/TP.

b. PTP.

D. Web Services Enabled Network:

1. The network shall be capable of being accessed remotely over the internet via a virtual link according to Internet Protocol.

2. System software shall be based on a client/server architecture, designed around the open standards of web technology. The BAS server shall be accessed using a web browser over the BAS network, Owner's LAN, and remotely over the Internet (through the Owner's LAN).

3. No special software other than a web browser shall be required to access graphics, point displays, and trends, configure trends, configure points and controllers, or to edit programming. Connection shall be browser agnostic.

4. Software applications shall be designed and optimized for hand-held device interface (e.g., tablets, smart phones, etc.). Interface shall grant visibility and control access, at a minimum, to the following data: Summary, Alarm, Setpoints, Status, Schedule, and Trending.

E. Network Integration:

1. The BAS network shall be integrated with other automation networks controlled by the Owner. Coordinate with the Owner's information technology (IT) department for networks that shall be integrated.

2. Provide gateways or other integration devices across networks with different communication protocol to provide a single network visibility and interoperability at the operator workstation. Coordinate communication protocol with each automation system specified.

3. Interoperable networks shall be capable of sharing all point and point information across networks to a single BAS front end.

4. Interoperable networks shall be capable of automatically downloading application program changes.

5. For integrated networks that cannot automatically download application program changes, provide a link to the Controller Manual Download Schedule, as defined in the submittals section of Part 1 on the BAS front end summary page

6. Integrate the following networks:

a. Boiler plant master firing controller.

b. Chiller controller.

c. Pump control packages.

d. Lighting control systems (where indicated to be required by owner).

e. Refrigerant monitoring controller.

F. Network Interoperability:

1. Provide communication between control units over local area network (LAN).

2. Communication services over the LAN shall result in operator interface and value passing that is transparent to the network architecture as follows:

   a. Connection of an operator interface device to any one controller on the network shall allow the operator to interface with all other controllers as if that interface were directly connected to the other controllers. Data, status information, reports, system software, custom programs, etc., for all controllers shall be available for viewing and editing from any one controller on the network.

   b. All database values (e.g., objects, software variables, custom program variables) of any one controller shall be readable by any other controller on the network. This value passing shall be automatically performed by a controller when a reference to an object name not located in that controller is entered into the controller's database. An operator/installer shall not be required to set up any communication services to perform network value passing.

2.4 OPERATOR INTERFACE

A. General:

1. The Operator Interface shall provide overall BAS supervision and system software interface. Communications from the workstation shall be executed directly to and between the integration level building controllers and field level controllers.

2. The operator interface shall be capable of command entry, information and alarm management, database management, access of all system data, and be independent of hardware technology.

3. Database Save/Restore/Back-Up:

   a. Back-up copies of all Building Controller and ASC data as well as mass storage for trend logs shall be stored in the mass storage device designated by the Owner.

1.2 CONTROLLERS

B. Building Controllers

1. General:

   a. Input Power Requirements: 24Vac.

   b. Manage global strategies by one or more, independent, standalone, microprocessor based controllers.

   c. Provide sufficient memory to support controller's operating system, database, and programming requirements.

   d. Share data between networked controllers.

e. Controller operating system manages input and output communication signals allowing distributed controllers to share real and virtual object information and allow for central monitoring and alarms.

f. Utilize real-time clock for scheduling.

g. Continuously check processor status and memory circuits for abnormal operation.

h. Monitor and assume predetermined failure mode and generate alarm notification upon detection of abnormal operation.

i. Communication with other network devices to be based on assigned protocol.

j. Monitor the status of all overrides, and include this information in logs and summaries to inform the operator that automatic control has been inhibited.

2. Communication:

a. Perform routing when connected to a network of custom application and application specific controllers.

b. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.

1) Port shall be USB type.

3. Anticipated Environmental Ambient Conditions:

a. Outdoors and/or in Wet Ambient Conditions:

1) Mount within NEMA 4X waterproof enclosures.

2) Rated for operation at 40 to 150 degrees F and 95 percent RH, non-condensing.

b. Conditioned Space:

1) Mount within NEMA 1 dustproof enclosures.

2) Rated for operation at 32 to 120 degrees F.

4. Provisions for Serviceability:

a. Diagnostic LEDs for power, communication, and processor.

b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.

5. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.

6. Power and Noise Immunity:

a. Maintain operation at 90 to 110 percent of nominal voltage rating.

b. Perform orderly shutdown below 80 percent of nominal voltage.

c. Upon restoration of normal power, the controller shall automatically resume full operation without manual intervention.

d. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W. at 3 feet.

7. Surge and Transient Protection:

a. Isolation shall be provided at all network terminations, as well as all field point terminations, to suppress induced voltage transients consistent with IEEE Standard C62.41.2.

b. Isolation levels shall be sufficiently high as to allow all signal wiring to be run in the same conduit as high voltage wiring where acceptable by electrical code.

C. Custom Application Controllers

1. General:

a. Input Power Requirements: 24Vac.

b. Provide sufficient memory to support controller's operating system, database, and programming requirements.

c. Share data between networked, microprocessor based controllers.

d. Controller operating system manages input and output communication signals allowing distributed controllers to share real and virtual object information and allowing for central monitoring and alarms.

e. Utilize real-time clock for scheduling.

f. Continuously check processor status and memory circuits for abnormal operation.

g. Monitor and assume predetermined failure mode and generate alarm notification upon detection of abnormal operation.

h. Communication with other network devices to be based on assigned protocol.

i. Monitor the status of all overrides, and include this information in logs and summaries to inform the operator that automatic control has been inhibited.

2. Communication:

a. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.

3. Anticipated Environmental Ambient Conditions:

a. Outdoors and/or in Wet Ambient Conditions:

1) Mount within NEMA 4X waterproof enclosures.

2) Rated for operation at 40 to 150 degrees F and 95 percent RH, non-condensing.

b. Conditioned Space:

1) Mount within NEMA 1 dustproof enclosures.

2) Rated for operation at 32 to 120 degrees F.

4. Provisions for Serviceability:

a. Diagnostic LEDs for power, communication, and processor.

b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.

5. Memory: In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.

6. Power and Noise Immunity:

a. Maintain operation at 90 to 110 percent of nominal voltage rating.

b. Perform orderly shutdown below 80 percent of nominal voltage.

c. Upon restoration of normal power, the Digital Panel shall automatically resume full operation without manual intervention.

d. Operation protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W. at 3 feet.

7. Surge and Transient Protection:

a. Isolation shall be provided at all network terminations, as well as all field point terminations, to suppress induced voltage transients consistent with IEEE Standard C62.41.2.

b. Isolation levels shall be sufficiently high as to allow all signal wiring to be run in the same conduit as high voltage wiring where acceptable by electrical code.

D. Application Specific Controllers

1. General:

a. Input Power Requirements: 24Vac.

b. Not fully user programmable, microprocessor based controllers dedicated to control specific equipment.

c. Customized for operation within the confines of equipment served.

d. Provide sufficient memory to support controller's operating system, database, and programming requirements.

e. Communication with other network devices to be based on assigned protocol.

1) Each ASC shall be capable of stand-alone operation and shall continue to provide control functions without being connected to the network.

f. Monitor and assume predetermined failure mode and generate alarm notification upon detection of abnormal operation.

2. Communication:

a. Provide service communication port for connection to a portable operator's terminal or hand held device with compatible protocol.

3. Anticipated Environmental Ambient Conditions:

a. Outdoors and/or in Wet Ambient Conditions:

1) Mount within NEMA 4X waterproof enclosures.

2) Rated for operation at 40 to 150 degrees F.

b. Conditioned Space:

1) Mount within NEMA 1 dustproof enclosures.

2) Rated for operation at 32 to 120 degrees F and 95 percent RH, non-condensing.

4. Provisions for Serviceability:

a. Diagnostic LEDs for power, communication, and processor.

b. Make all wiring connections to field removable, modular terminal strips, or to a termination card connected by a ribbon cable.

5. Memory. In the event of a power loss, maintain all BIOS and programming information for a minimum of 72 hours.

6. Power and Noise Immunity:

a. Maintain operation at 90 to 110 percent of nominal voltage rating.

b. Perform orderly shutdown below 80 percent of nominal voltage.

c. Upon restoration of normal power, the controller shall automatically resume full operation without manual intervention.

d. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W. at 3 feet.

7. Surge and Transient Protection:

a. Isolation shall be provided at all network terminations, as well as all field point terminations, to suppress induced voltage transients consistent with IEEE Standard C62.41.2.

b. Isolation levels shall be sufficiently high as to allow all signal wiring to be run in the same conduit as high voltage wiring where acceptable by electrical code.

E. Input/Output Interface

1. Hardwired inputs and outputs shall tie into the BAS through building, custom application, or application specific controllers.

2. All Input/Output Points:

a. Protect controller from damage resulting from any point short-circuiting or grounding and from voltage up to 24 volts of any duration.

b. Provide universal type for building and custom application controllers where input or output is software designated as either binary or analog type with appropriate properties.

c. Universal-type inputs or outputs configurable between binary and analog are acceptable.

3. Binary Inputs:

a. Allow monitoring of On/Off signals from remote devices.

b. Provide wetting current of 12 mA minimum, compatible with commonly available control devices and protected against the effects of contact bounce and noise.

c. Sense dry contact closure with power provided only by the controller.

4. Pulse Accumulation Input Objects: Conform to all requirements of binary input objects and accept up to 10 pulses per second.

5. Analog Inputs:

a. Allow for monitoring of low voltage 0 to 10 Vdc, 4 to 20 mA current, or resistance signals (thermistor, RTD).

b. Compatible with and field configurable to commonly available sensing devices.

6. Binary Outputs:

a. Used for On/Off operation or a pulsed low-voltage signal for pulse width modulation control.

b. Outputs provided with three position (On/Off/Auto) override switches.

c. Status lights for building and custom application controllers to be selectable for normally open or normally closed operation.

7. Analog Outputs:

a. Monitoring signal provides a 0 to 10 Vdc or a 4 to 20 mA output signal for end device control.

b. Provide status lights and two position (AUTO/MANUAL) switch for building and custom application controllers with manually adjustable potentiometer for manual override on building and custom application controllers.

c. Drift to not exceed 0.4 percent of range per year.

8. Tri State Outputs:

a. Coordinate two binary outputs to control three point, floating type, electronic actuators without feedback.

b. Limit the use of three point, floating devices to the following zone and terminal unit control applications:

1) VAV terminal units.

2) Duct mounted heating coils.

3) Zone dampers.

4) Radiant devices.

c. Control algorithms shall run the zone actuator to one end of its stroke once every 24 hours for verification of operator tracking.

2.5 ELECTRICAL CONTROL POWER AND LOW VOLTAGE WIRING

A. Power Wiring: Copper wiring, plenum cable, and raceways shall be as specified in the applicable section of Division 26.

B. Power and Communication Wiring Transient Protection:

1. Comply with IEEE C62.41.2.

2. Communications trunk wiring shall be protected with a transient surge protection device providing the minimal protection required.

3. Communication circuitry, input/output circuitry, and communication unit shall provide protection against a 1000 volt, 3 amp transient signal, directly applied to the communication or input/output terminations.

a. For systems not complying with this requirement, provide equivalent protection external to the automatic temperature control system controller. Protection shall be provided for the

individual communications and input/output terminations for each automatic temperature control system controller.

b. Submittal documentation shall clearly define how this requirement will be met and how the external protection will not affect the performance of the controllers.

C. Power Supplies:

1. Provide UL listed control transformers with Class 2 current limiting type or over-current protection in both primary and secondary circuits for Class 2 service as required by the NEC.

2. Limit connected loads to 80 percent of rated capacity.

3. Match DC power supply to current output and voltage requirements.

4. Supplies shall be full wave rectifier type with output ripple of 5.0 mV maximum peak to peak.

5. Regulation to be 1 percent combined line and load with 100 microsecond response time for 50 percent load changes.

6. Provide over-voltage and over-current protection to withstand a 150 percent current overload for 3 seconds minimum without trip-out or failure.

7. Operational Ambient Conditions: 32 to 120 degrees F.

8. EM/RF meets FCC Class B and VDE 0871 for Class B and MIL-STD 810 for shock and vibration.

9. Line voltage units UL recognized and CSA approved.

D. Power Line Filtering:

1. Provide external or internal transient voltage and surge suppression component for all workstations and controllers.

2. Minimum surge protection attributes:

a. Dielectric strength of 1000 volts minimum.

b. Response time of 10 nanoseconds or less.

c. Transverse mode noise attenuation of 65 dB or greater.

d. Common mode noise attenuation of 150 dB or greater at 40 to 100 Hz.

E. Input/Output Control Wiring

1. Control wiring shall be sized to accommodate the voltage drop associated with the distance between the control device and the controller. Minimum size shall be as specified herein.

2. In all communication conduits, provide one spare twisted pair to be installed, tagged and labeled at each end.

3. Control wiring not installed in conduit shall be UL rated for plenum installation.

4. Ethernet control wiring shall be fiber optic or single pair of solid 24 gauge twisted, shielded copper cable.

5. RTD wiring shall be three-wire or four-wire twisted, shielded, minimum number 22 gauge.

6. Other analog inputs shall be a minimum of number 22 gauge, twisted, shielded.

7. Binary control function wiring shall be a minimum of number 18 gauge.

8. Analog output control functions shall be a minimum of number 22 gauge, twisted, shielded.

9. Binary input wiring shall be a minimum of number 22 gauge, twisted, shielded.

10. Thermistors shall be equipped with the manufacturer's calibrated lead wiring.

11. 120V control wiring shall be #14 THHN in 3/4 inch conduit. Provide 20% fill extra wire in each conduit.

F. Splices: Splices in shielded cables shall consist of terminations and the use of shielded cable couplers that maintain the integrity of the shielding.

G. Conduit and Fittings

1. Conduit for Control Wiring, Control Cable and Transmission Cable: EMT with compression fittings, cold rolled steel, zinc coated or zinc-coated rigid steel with threaded connections.

2. Outlet Boxes (Dry Location): Sheradized or galvanized drawn steel suited to each application, in general, four inches square or octagon with suitable raised cover.

3. Outlet Boxes (Exposed to Weather): Threaded hub cast aluminum or iron boxes with gasket device plate.

4. Pull and Junction Boxes: Size according to number, size, and position of entering raceway as required by National Electrical Codes. Enclosure type shall be suited to location.

H. Relays

1. Relays other than those associated with digital output cards shall be general purpose, enclosed plug-in type with 8-pin octal plug and protected by a heat and shock resistant duct cover. Number of contacts and operational function shall be as required.

2. Solid State Relays (SSR):

a. Input/output isolation: Greater than 10 E^9 ohms with a breakdown voltage of 1500V root mean square or greater at 60 Hz.

b. Contact Life: 10 x 10 E^6 operations or greater.

c. Ambient Temperature Range: Minus 20 to +140 degrees F.

d. Input impedance: Not be less than 500 ohms.

e. Relays shall be rated for the application. Operating and release time shall be for 100 milliseconds or less. Transient suppression shall be provided as an integral part of the relay.

3. Contactors:

a. Type: Single coil, electrically operated, mechanically held, double-break, silver-to-silver type protected by arcing contacts.

b. Positive locking shall be obtained without the use of hooks, latches, or semi permanent magnets.

c. The number of contacts and rating shall be selected for the application. Operating and release times shall be 100 milliseconds or less. Contactors shall be equipped with coil transient suppression devices.

2.6 SYSTEM SOFTWARE

A. General:

1. Provide all necessary system software to form a complete operating system for all operator interface devices.

2. System software shall integrate with all controller software and allow management of software applications at the operator workstation.

3. System software display language: English.

B. Device Profile: BACnet devices shall Conform to the following device profiles as specified in ASHRAE/ANSI 135 BACnet Annex L:

1. Operator workstation: BACnet Advanced Workstation (B-AWS).

2. Building Controller: BACnet Building Controller (B-C).

3. Advanced Application Controller: BACnet Advanced Application Controller (B-AAC).

4. Application Specific Controller: BACnet Application Specific Controller (B-ASC).

C. Software Programming:

1. Provide programming for the system and adhere to the sequences of operation provided. Provide actions for all possible situations. All other system programming necessary for the operation of the system shall be provided by the Contractor. Imbed into the control program sufficient comment statements to clearly describe each section of the program. The comment statements shall reflect the language used in the sequences of operation. Provide text-based, graphic-based, and parameter-based programming where appropriate.

D. Operating System:

1. Concurrent, multi-tasking capability.

2. Common Software Applications Supported:

   a. Microsoft Windows and Microsoft Office Suite.

   b. Open platform compatible database: Microsoft Access, Oracle Database, IBM Analytics, or other SQL database software. Proprietary databases shall not be acceptable.

3. Acceptable Operating Systems: Most recent version of operating system.

E. System Graphics:

1. Color type, saved in an industry-standard format such as BMP, JPEG, PNG, or GIF.

2. Allow simultaneous display for comparison and monitoring of system status.

3. Web based graphics shall require no plug-in (such as HTML and JavaScript) or shall only require widely available no-cost plug-ins (such as Active-X, Java Virtual Machine, and Adobe Flash).

4. Animate displayed objects by shifting image files of objects based on object status.

5. Functionality: Provide method for operator with password to perform the following:

   a. Move between, change size, and change location of graphic displays.

   b. Modify on-line.

   c. View a summary of the most important data for each controlled zone or piece of equipment.

   d. View a summary of the most important global data for the project, including but not limited to date, day of week, time, outdoor dry bulb temperature, and humidity.

   e. Use point-and-click navigation between graphic screens.

   f. Edit setpoints and other specified parameters.

   g. Indicate areas or equipment in an alarm condition using color or other visual indicator.

   h. Add, delete, or change dynamic objects consisting of:

      1) Analog and binary values.

      2) Dynamic text.

      3) Static text.

      4) Animation files.

   i. Display graphic file, text, and dynamic object data together on a single graphic. Display all measured and commanded data, setpoints, calculated values, and input and output control points with appropriate engineering units associated with each system schematic.

j. Dynamic Data Displays: 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.

k. Dynamic Data Displays shall be capable of including point data from multiple ASC's.

6. Include at least one graphic for each of the following:

a. Each piece of equipment.

b. Occupied zone.

c. Hydronic system (chilled water, condenser water, hot water, steam, heat pump, etc.)

d. Floor plan displays of the building. Indicate summary conditions for each floor.

e. Indicate thermal comfort on floor plan using dynamic colors to represent zone temperature relative to zone setpoint.

1. Graphic Tree Structure:

f. Structure graphic system tree to allow access to individual graphic screens from a macro to a micro level.

g. Allow each level of graphic direct access to the graphic screen above and below the graphic screen in the system tree.

h. Allow direct access to the main summary graphic screen/map from any individual graphic screen.

7. Sequence of Operation Graphics:

a. Display the complete Sequence of Operation or include a link to a separate text file that contains the sequence of operation, as submitted by the Contractor and approved by the Engineer with each system schematic view. The Sequence of Operation text shall be in a separate frame above, below, or to the side of the graphic as appropriate for the graphic size and content.

8. Custom Graphics Generation Package:

a. Allow operator to create, delete, modify, and save custom graphic files and displays. File format of graphics shall be compatible with BAS software.

b. Web-based Graphics: HTML graphics to support web browser compatible formats.

c. The BAS Contractor shall provide libraries of pre-engineered screens and symbols depicting standard components with which custom graphics may be built. Standard components include but are not limited to

1) Air handling unit components (e.g., fans, cooling coils, filters, dampers, etc.).

2) Complete mechanical systems (e.g., constant volume-terminal reheat, VAV, etc.).

3) Hydronic system components (e.g., chillers, boilers, pumps, piping, valves, etc.).

4) Electrical symbols.

d. 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.

8) Capture or convert graphics from AutoCAD.

e. Graphical displays shall be capable of representing a group of objects. Groups shall be capable of representing 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 building.

2. Standard HVAC Graphics Library: Furnish a complete library of standard HVAC equipment graphics and standard symbols for ancillary equipment in a file format compatible with the graphics generation package program. Graphics shall include, but not be limited to, the following:

a. HVAC Equipment:

1) Chillers.

2) Boilers.

3) Air Handlers.

4) Terminal HVAC Units.

5) Fan Coil Units.

6) Unit Ventilators.

7) Heat Exchangers.

b. Ancillary Equipment:

1) Fans.

2) Pumps.

3) Coils.

4) Valves.

5) Piping.

6) Dampers.

7) Ductwork.

F. Workstation System Applications:

1. General Application Functions:

a. All applications shall be capable of being executed automatically without the need for operator intervention, and shall be flexible enough to allow user customization.

b. Allow BAS configuration and future changes or additions by operators with password protection.

c. Execute configured processes defined by the user to automatically perform calculations and control routines.

d. Process Inputs and Variables: It shall be possible to use any of the following in a configured process:

1) Any system-measured point data or status

2) Any calculated data

3) Any results from other processes

4) Boolean logic operators (and, or)

e. Process Triggers: Configured processes may be triggered based on any combination of the following:

1) Time of day

2) Calendar Date

3) Other processes

4) Events (e.g., point alarms)

f. Data Access: A single process shall be able to incorporate measured or calculated data from any and all other ASC's. In addition, a single process shall be able to issue commands to points in any and all other ASC's on the local network.

2. Network Configuration:

a. Allow for configuration of the BAS network.

b. Provide alarm when a break in communication between devices is detected.

c. Enable the operator to add, delete, or modify the following:

1) Building controllers and ASC's.

2) Points of any type, point parameters, and tuning constants.

d. Provide automatic reconfiguration if any station is added or lost.

3. Save and Restore:

a. Automatic System Database Save and Restore Functions:

1) Store current database copy of each Building Controller on hard disk or server.

2) Backup database on a user adjustable frequency basis. Default frequency shall be monthly.

3) Automatically update upon change in any system panel.

4) In the event of database loss in any system panel, the first workstation to detect the loss automatically restores the database for that panel unless disabled by the operator.

b. Manual System Database Save and Restore Functions by Operator with Password Clearance:

1) Save database from any system panel.

2) Clear a panel database.

3) Initiate a download of a specified database to any system panel.

4. On-line Help:

a. Include context-sensitive system to assist operator in operation and editing.

b. Include topics available for all applications.

c. Include relevant screen data provided for particular screen display.

d. Include additional help via hypertext.

5. Security:

a. Require user name and password for Operator log-on to view, edit, add, or delete data.

b. Include selectable system security for each operator. Support a minimum of five levels of access:

1) Level 1 = Read-only data access and display.

2) Level 2 = Level 1 + scheduling.

3) Level 3 = Level 2 + operator overrides and commands.

4) Level 4 = Level 3 + database generation and modification.

5) Level 5 = Level 4 + Audit trail management.

6) Operators shall be able to perform only those commands available for their respective passwords. Menu selections displayed at any operator device shall be limited to only the items defined as accessible for the user.

7) Support a minimum of 4 passwords at each Building Controller.

c. Allow system supervisor to set passwords and security levels for all other operators.

d. Allow operator passwords to restrict functions accessible to viewing and/or changing system applications, editor, and object.

e. Include automatic, operator log-off results from keyboard or mouse inactivity during user-adjustable, time period.

f. Store all system security data in encrypted format.

g. Log all user actions and store data for audit with permission access by system administrator only.

1) Include the modified system.

2) Include the value modified.

3) Include the time of modification.

6. System Diagnostics:

a. Operations Automatically Monitored:

1) Workstations.

2) Printers.

3) Network connections.

4) Building management panels.

5) Controllers.

b. Device failure is annunciated to the operator.

7. Alarm Management:

a. Allow alarm prioritizing to minimize nuisance reporting and to speed operator response to critical alarms.

1) Provide a minimum of three, user definable priority levels.

2) Enable users to manually inhibit alarm reporting for each point.

3) Enable users to manually inhibit nuisance alarm reporting for maintenance or repair work that is scheduled to be performed.

4) Enable user to define conditions under which point changes need to be acknowledged by an operator, and/or logged for analysis at a later date.

5) Allow alarm prioritization to lock out or circumvent other alarms that may be generated as a result of primary alarm.

b. Prohibit interference with the ability of the system software to report alarms by either operator activity at the local I/O device, or communications with other system controllers on the network.

c. Allow all system objects that are configurable to "alarm in" and "alarm out" of normal state.

d. Configurable Objects:

1) Alarm limits.

2) Alarm limit differentials.

3) States.

4) Reactions for each object.

5) Alarm delay.

e. Alarm Messages:

1) Descriptor: English language. Acronyms or mnemonics for objects in alarm are not acceptable.

2) Recognizable Features:

a) Source.

b) Location.

c) Nature.

d) Time and Date.

e) Alarm message box to more fully describe the alarm condition or direct operator response.

f) Each Alarm messages shall be assignable to any point in the BAS. Alarm messages shall be assignable to multiple points.

a) Notification of an alarm override.

f. Configurable Alarm Reactions by Workstation and Time of Day:

1) Logging.

2) Printing.

3) Starting programs.

4) Displaying messages.

5) Phone text message.

6) Email.

7) Providing audible annunciation.

8) Displaying specific system graphics.

8. Custom Trend Logs:

a. Maintain trend information for minimum 365 days.

b. Definable for any data object in the system including interval, start time, and stop time.

1) Resolution: Interval periods shall be adjustable down to one minute.

2) Multiple Interval Period: Each trended point shall have the ability to be trended at a different trend interval.

c. Trend Data:

1) Sampled and stored on the building controller panel.

2) Auto-Delete Period: Software shall be capable of automatically deleting stored trend data after a user-adjustable period of time. Each trended point shall have the ability to have a different auto-delete interval period.

3) Archivable on hard disk or server.

4) Retrievable for use in reports, spreadsheets and standard database programs.

5) Protected and encrypted format to prevent manipulation or editing of historical data and event logs.

d. Trend Graph Display:

1) Group Trend Time Series Plots:

a) Provide user-selectable Y-axis points.

b) Provide user editable titles, point names, and Y-axis titles.

c) Individual trended points shall be able to be grouped into groups of up to four points per plot with up to four plots per page.

2) X-Y Trend Plots:

a) User selectable X and Y trend inputs.

b) User editable titles, point names, and X and Y-axis titles.

c) User selectable time period options:

i) 1-day 24-hour period.

ii) 1-week 7-day period.

iii) 1-month period with appropriate days for the month selected.

iv) 1-year period.

v) User shall be able to select the beginning and ending period for each X-Y chart, within the time domain of the database being used.

vi) User selectable display up to 6 plots per screen in 2 columns.

3) Automatic Scaling: System shall automatically scale the axis on which trends are displayed when multiple points with different trend interval periods are selected for graphical display.

4) Dynamic Update: Trends shall be able to dynamically update at operator-defined intervals.

5) Zoom: Software shall allow zoom-in function for detailed examination of trends.

e. Numeric Value Display: Software shall display value of any sample on a trend when picked.

9. Alarm and Event Log:

a. View all system alarms and change of states from any system location.

b. List events chronologically.

c. List alarm priority.

c. Allow operator with proper security to acknowledge and clear alarms. Log operator and time when alarm is acknowledged.

d. Archive alarms not cleared by operator to the workstation.

10. Object, Property Status, and Control:

    a. Provide a method to view, edit if applicable, the status of any object and property in the system.

    b. Status Available by the Following Methods:

        1) Menu.

        2) Graphics.

        3) Custom Programs.

11. Clock Synchronization:

    a. The real-time clocks in all building control panels and workstations shall be able to automatically synchronize daily from any operator-designated device in the system.

    b. The system shall automatically adjust for daylight savings and standard time, if applicable.

12. Reports and Logs:

    a. Reporting Package:

        1) Allow operator to select, modify, or create reports.

        2) Definable as to data content, format, interval, and date.

        3) Under no conditions shall the operator need to specify the address of hardware controller to obtain system information.

        4) Provide ability to obtain real-time logs of all objects available by type or status such as alarm, lockout, normal, etc.

        5) Stored on hard disk and readily accessible by standard software applications, including spreadsheets and word processing.

        6) Allow printing on operator command or specific time(s).

    b. Standard Report Format Options:

        1) Objects with current values.

        2) Global modification values.

        3) Current alarms not locked out.

        4) Disabled and overridden objects, points and variables.

        5) Objects in manual or automatic alarm lockout.

        6) Objects in alarm lockout currently in alarm.

7) Objects currently in override status.

8) Objects in Schedules

a) Daily.

b) Weekly.

c) Holiday.

9) Logs:

a) Alarm History.

b) System messages.

c) System events.

d) Trends.

c. Custom Report Format Options:

1) Daily.

2) Weekly.

3) Monthly.

4) Annual.

5) Time and date stamped.

6) Title.

7) Facility name.

8) Point Groups.

a) User-selectable.

b) Group may be comprised of specific points, group of equipment objects, group of groups, or for the entire facility without restriction due to the hardware configuration of the BAS.

d. Electrical, Fuel, and Weather:

1) Electrical Meter(s):

a) Monthly showing daily electrical consumption and peak electrical demand with time and date stamp for each meter.

b) Annual summary showing monthly electrical consumption and peak demand with time and date stamp for each meter.

2) Fuel Meter(s):

a) Monthly showing daily fuel consumption for each meter.

b) Annual summary showing monthly consumption for each meter.

3) Weather:

a) Monthly showing minimum, maximum, average outdoor air temperature and heating/cooling degree-days for the month.

e. Daily Operating Condition of Chiller(s): Program a daily report that shows the operating condition of each chiller as recommended by ASHRAE Standard 147. Reference the control drawings for the points that shall be included in the log report.

13. Global Modify:

a. Allow global modification of all editable data. Similar data shall be grouped into logical objects based on building function, mechanical system, building layout, or any other logical grouping of points.

b. Allow each common type of equipment to be excluded or included within the global editing process.

c. Display status information on all similar points in one global report.

d. Allow modification of the following:

1) Individual data point edited.

2) List of all points within the category.

3) Global change field.

4) Copy feature to assist in downloading the new changes.

5) Verification that all changes were completed.

e. Include a change-all feature to change all selections.

f. Prevent acceptance of changes until an accept icon is acknowledged.

G. Workstation Applications Editors:

1. Provide editing software for each system application at the PC workstation.

2. Edited applications shall be automatically downloaded and executed at the controller panel.

3. Programming Description: Definition of operator device characteristics, ASC's, individual points, applications and control sequences shall be performed through fill-in-the-blank templates.

4. System Definition/Control Sequence Documentation: All portions of system definition shall be self-documenting to provide hard copy printouts of all configuration and application data.

5. System definition and modification procedures shall not interfere with normal system operation and control.

6. Provide consistent text-based displays of all system point and system applications.

7. Point identification, engineering units, status indication, and application naming conventions shall be the same at all operator devices.

8. Full screen editor for each application shall allow operator to view and change:

    a. Configuration.

    b. Name.

    c. Control parameters.

    d. Set-points.

    e. Schedules.

9. Scheduling:

    d. Allow scheduling down to the zone or room level.

    a. Monthly calendar indicates schedules, holidays, and exceptions.

    b. Allows several related objects to be grouped, scheduled, and copied to other objects or dates.

    c. Start and stop times adjustable from master schedule.

    e. Schedule expiration.

    d. Temporary overrides of systems with user adjustable time-out.

    f. Provide minimum three tiers of priorities for scheduling.

        1) Priority 1: Event, temporary, or override.

        2) Priority 2: Calendar.

        3) Priority 3: Default.

    g. Higher priority schedules shall overlay with lower priority schedules without interrupting or deleting them. Upon expiration of a higher priority schedule, schedule shall revert to next lower priority.

h. Expired priority 1 and priority 2 schedules shall be automatically deleted after execution.

10. Custom Application Programming:

a. Create, modify, debug, edit, compile, and download custom application programming during operation and without disruption of all other system applications.

b. Programming Features:

1) English oriented programming language, allowing for free form programming.

2) Alternative language graphically based using appropriate function blocks suitable for all required functions and amenable to customizing or compounding.

3) Insert, add, modify, and delete custom programming code that incorporates word processing features such as cut/paste and find/replace.

4) Allows the development of independently, executing, program modules designed to enable and disable other modules.

5) Debugging/simulation capability that displays intermediate values and/or results including syntax/execution error messages.

6) Support for conditional statements (IF/THEN/ELSE/ELSE-F) using compound Boolean (AND, OR, and NOT) and/or relations (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.

7) Support for floating-point arithmetic utilizing plus, minus, divide, times, square root operators; including absolute value; minimum/maximum value from a list of values for mathematical functions.

8) Language consisting of resettable, predefined, variables representing time of day, day of the week, month of the year, date; and elapsed time in seconds, minutes, hours, and days where the variable values can be used in IF/THEN comparisons, calculations, programming statement logic, etc.

9) Language having predefined variables representing status and results of the system software enables, disables, and changes the set points of the controller software.

H. Energy Display Kiosk/Dashboard:

1. Network kiosk with BAS to obtain real-time energy information.

2. Kiosk dashboard shall be accessible from multiple workstations or displays using simple browser based services (HTML, HTML5, Java, or equal). Multiple dashboards shall be available and configurable by the Owner.

3. Display Features:

a. Dynamic color graphics.

b. Touch screen interface.

c. Configurable display:

4. Trend Data Display:

a. Water Usage.

b. Reduction in carbon dioxide emissions.

c. Outdoor air conditions (temperature, humidity, wind direction/speed).

d. Historical data for energy consumption and outdoor air temperatures, configurable by hour, day, week, month, or year.

e. Historical high and low trends.

f. Total precipitation.

g. Weather trends.

h. Energy costs.

i. Fault detection and diagnostics.

j. Disaggregated energy use among lighting, HVAC, domestic water, plug loads, elevators/escalators, and renewable power sources.

5. Information Display:

a. Coordinate with the Owner for information display.

b. Organization history.

c. Programs.

d. Goals and objectives.

e. Building systems.

f. Building directory.

g. Schedules.

h. Tours.

i. Local resources and amenities.

j. Energy Star.

2.7 CONTROLLER SOFTWARE

A. All applications reside and operate in the system controllers and editing of all applications occurs at the operator workstation.

B. System Security:

1. User access secured via user passwords and user names.

2. Passwords restrict user to the objects, applications, and system functions as assigned by the system manager.

3. User Log On/Log Off attempts are recorded.

4. Automatic Log Off occurs following the last keystroke after a user defined delay time.

C. Object or Object Group Scheduling:

1. Weekly Schedules Based on Separate, Daily Schedules:

a. Include start, stop, optimal stop, and night economizer.

b. 10 events maximum per schedule.

c. Start/stop times adjustable for each group object.

2. Exception Schedules:

a. Based on any day of the year.

b. Defined up to one year in advance.

c. Automatically discarded and replaced with standard schedule for that day of the week upon execution.

3. Holiday or Special Schedules:

a. Capability to define up to 99 schedules.

b. Repeated annually.

c. Length of each period is operator defined.

D. System Coordination: Provide a standard application for equipment coordination. The application shall provide the operator with a method of grouping together equipment based on function and location. Groups shall be capable of being used for scheduling and other applications.

E. Alarms:

1. Binary object is set to alarm based on the operator specified state.

2. Analog object to have high/low alarm limits.

3. All alarming is capable of being automatically or manually disabled.

4. Alarm Reporting:

   a. Operator determines action to be taken for alarm event.

   b. Alarms to be routed to appropriate workstation.

5. Reporting Action Options:

   a. Start Programs.

   b. Print.

   c. Logged.

   d. Custom messaging.

   e. Graphical displays.

   f. Dial out to workstation receivers via system protocol.

F. Demand Limiting:

1. Monitor building power consumption.

2. Demand limit controlled via load shedding or load restoration in a predetermined and predictive manner. Reference the control drawings and sequences of operation for additional information.

3. Demand Reduction Methods:

   a. Supply air temperature reset.

   b. Space temperature set-point reset.

   c. Equipment off/on prioritization.

4. Relevant variables that influence demand limiting control are based on the power company methodology for computing demand charges.

5. Provide demand limiting prediction and control for any individual meter monitored by the system or for the total of any combination of meters.

6. Operator On-Line Changes Allowed:

   a. Addition and deletion of loads controlled.

   b. Changes in demand intervals.

   c. Changes in demand limit for meter(s).

   d. Maximum equipment shutoff time.

e. Minimum equipment shutoff time.

f. Select rotational or sequential shedding and restoring.

g. Shed/restore priority.

7. Information and Reports available Hourly, Daily, and Monthly:

a. Total electric consumption.

b. Peak demand.

c. Date and time of peak demand.

d. Daily peak demand.

G. Maintenance Management: System monitors equipment status and generates maintenance messages based upon user-designated run-time limits.

H. Sequencing: Application software based upon specified sequences of operation on the control drawings.

I. PID Control Characteristics:

1. Provide proportional-integral algorithms.

2. Direct or reverse action.

3. Anti-windup.

4. Calculated, time-varying, analog value, positions an output or stages a series of outputs.

5. User selectable controlled variable, set-point, and PI gains.

J. Staggered Start Application:

1. Prevents all controlled equipment from simultaneously restarting after power outage.

2. Order of equipment startup is user selectable.

K. Anti-Short Cycling:

1. All binary output objects protected from short-cycling.

2. Allows minimum on-time and off-time to be selected.

3. Allows the number of times each piece of equipment may be cycled within any one-hour period.

L. On-Off Control with Differential:

1. Algorithm allows binary output to be cycled based on a controlled variable and set-point.

2. Algorithm to be direct-acting or reverse-acting incorporating an adjustable differential.

M. Trending: Building controllers shall allow collection and delivery of (time, value) pairs.

N. Totalization:

1. Run-Time Totalization:

a. Totalize run-times for all binary input objects.

b. Provides operator with capability to assign high run-time alarm.

c. Generates unique, user-specified messages when the limit is reached.

d. Resolution: Adjustable down to one minute.

2. Pulse Totalization:

a. Totalize consumption for user-selected analog and binary pulse input-type objects.

b. Configurable for a daily, weekly, or monthly basis.

c. Provide calculation and storage accumulations of up to 9,999,999 units (e.g. KWH, gallons, KBTU, tons, etc.).

d. Resolution: Adjustable down to one minute.

e. Warning Limit: User definable. Generate unique, user-specified messages when the limit is reached.

f. The information available from the Pulse Totalization shall include, but not be limited to, the following:

1) Peak Demand, with date and time stamp

2) 24-hour Demand Log

3) Accumulated KWH for day

4) Sunday through Saturday KWH usage

5) Sunday through Saturday Demand kW

6) Demand kW annual history for past 12 periods

7) KWH annual history for past 12 periods

3. Event Totalization:

a. Count user-selected events, such as the number of times a pump or fan system is cycled on and off.

b. Provide storage accumulations of up to 9,999,999 events before reset.

c. Warning Limit: User definable. Generate unique, user-specified messages when the limit is reached.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify that systems are ready to receive work.

C. Beginning of installation means installer accepts existing conditions.

D. Verify that conditioned power supply is available to the control units and to the operator work station. Verify that field end devices and wiring are installed prior to installation proceeding.

E. Verify the integrity of control wiring, raceways, control panels, sensors, and control devices prior to reusing for the new work.

F. Verify wiring insulation is defect free and test wiring for continuity and ground faults.

3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Coordination:

1. Cooperate with other contractors performing work on this project as necessary to achieve a complete and coordinated installation. Each Contractor shall consult the Drawings and Specifications for all trades to determine the nature and extent of others work.

2. Where the BAS shall share a common network backbone via a VLAN, provide temporary network access for BAS construction, startup, and commissioning. Coordinate transition of network operation to Owner's IT group.

3. Coordinate with the Owner to display additional virtual points on individual schematic graphic screens that are not directly associated with that system. Examples may include outdoor air temperature or global alarm conditions.

B. Web Services Enabled Network:

4. Provide an IP network data drop for connection of BAS into Owner's IP network. Coordinate final location of IP network data drop with the Owners' IT staff.

5. If the Owner has no preference or not indicated on the drawings, locate data drop within the main BAS control panel.

6. Coordinate with the Owner's IT department to implement proper security measures, including secure access to the network data drop and firewalls at all virtual access points to the internet to protect access to the BAS.

C. General Workmanship:

1. Install equipment, piping, and wiring/raceway parallel to building lines wherever possible.

2. Install all equipment in readily accessible locations.

3. Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.

4. All installations shall comply with industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.

7. Control wiring routed in wall cavities shall be installed in conduit.

8. Install control units and other hardware in position on permanent walls where not subject to excessive vibration.

9. Install software in control units and in operator work station. Implement all features of programs to specified requirements and appropriate to sequence of operation.

C. Install energy display kiosk in location as directed by Owner.

D. Controllers:

1. Install controllers in a locked control panel. Provide common keying for all controller covers.

2. Provide a separate controller for each piece of controlled equipment, such as an AHU, FCU, VAV box, etc. A controller may control more than one piece of equipment provided that all points associated with the equipment are assigned to the same BAS controller. Global points used for control loop reset are exempt from this requirement.

3. Select building controllers and custom application controllers to provide the required I/O point capacity required to monitor all of the hardware points listed on the control drawings.

4. Application specific controllers may be used where factory programming is capable of executing all control functions specified in the sequences of operation. Contractor shall add supplemental controllers, devices, and programming as required to execute the specified control function if the ASC cannot.

E. Wiring:

1. All control and interlock wiring shall comply with national and local electrical codes.

5. Wire all safety devices through both hand and auto positions of motor starting device to ensure 100 percent safety shut-off.

2. Provide interlock wiring between devices as indicated on the control drawings.

3. Provide electrical wiring for relays (including power feed) for temperature and pressure indication.

4. All NEC Class 1 (line voltage) wiring shall be UL listed in approved raceway according to NEC and Division 26 requirements.

5. All low-voltage wiring shall meet NEC Class 2 requirements. Low-voltage power circuits shall be sub-fused when required to meet Class 2 current limit.

6. Conceal all low voltage wiring in finished rooms.

7. Conceal all low voltage wiring in unfinished rooms below the elevation of the lights. Low voltage wiring above the elevation of the lights may be exposed.

8. Routing of low voltage wiring above working heights in equipment rooms and above accessible ceilings is acceptable subject to following criteria:

   a. Wiring shall be plenum rated.

   b. Do not lay wiring on ceiling tiles.

6. Where NEC Class 2 (current-limited) wires are in concealed and accessible locations, including ceiling return air plenums, approved cables not in raceway may be used provided that cables are UL listed for the intended applications.

7. All wiring in mechanical, electrical, service rooms, or where subject to mechanical damage, shall be installed in raceway at levels below 10 feet.

8. Do not install Class 2 wiring in raceway containing Class 1 wiring. Boxes and panels containing high voltage wiring and equipment may not be used for low-voltage wiring except for the purpose of interfacing the two wires (e.g., relays and transformers).

9. Where Class 2 wiring is run exposed, wiring shall be run parallel along a surface or perpendicular to it and neatly tied at 10 foot intervals.

10. Where plenum cables are used without raceway, they shall be supported from or anchored to structural members. Cables shall not be supported by or anchored to ductwork, electrical raceways, piping, or ceiling suspension systems.

11. All wire-to-device and wire-to-wire connections shall be made at a terminal block or terminal strip.

12. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.

13. Maximum allowable voltage for control wiring shall be 120 V. If only higher voltages are available, coordinate with Division 26 to provide step-down transformers.

14. All wiring shall be installed as continuous lengths, with no splices permitted between termination points.

15. Install plenum wiring in sleeves where it passes through floors and walls. Maintain fire rating at all penetrations.

16. Size of raceway and size and type of wire shall be the responsibility of the Contractor, in keeping with the manufacturer's recommendations and NEC requirements, except as noted elsewhere.

17. Include one pull string in each raceway 1 inch and larger.

18. Use coded conductors throughout with conductors of different colors.

19. Control and status relays shall be located in designated enclosures only. These enclosures include packaged equipment control panel enclosures unless they also contain Class 1 starters.

20. Conceal all raceways, except within mechanical, electrical, or service rooms. Install raceway to maintain a minimum clearance of 6 inches from high-temperature equipment (e.g., steam pipes or flues).

21. Secure raceways with raceway clamps fastened to the structure and spaced according to code requirements. Raceways and pull boxes may not be hung on flexible duct strap or tie rods. Raceways may not be run on or attached to ductwork.

22. Install insulated bushing on all raceway ends and openings to enclosures. Seal top end of all vertical raceways.

23. Terminate all control and/or interlock wiring and maintain updated (as-built) wiring diagrams with terminations identified at the job site.

24. Terminate BAS sensor input wiring cable shield by taping back at the field device and connect shield to the grounded control panel chassis or sub-panel.

25. Terminate BAS comm bus cable shield between controllers per manufacturer recommendations.

26. Terminate management level/enterprise level network wiring cable shield by wrapping the drain wire around the foil shield and connecting the ground strip to the drain wire.

27. Flexible metal raceways and liquid-tight, flexible metal raceways shall not exceed 3 feet in length and shall be supported at each end. Flexible metal raceway less than 1/2 inch electrical trade size shall not be used. In areas exposed to moisture, including chiller and boiler rooms, liquid-tight, flexible metal raceways shall be used.

28. Raceway shall be rigidly installed, adequately supported, properly reamed at both ends, and left clean and free of obstructions. Raceway sections shall be joined with couplings (according to code). Terminations shall be made with fittings at boxes, and ends not terminating in boxes shall have bushings installed.

F. Communication Wiring:

1. Adhere to the items listed in the "Wiring" article in Part 3 of this specification in addition to the requirements listed below.

2. All cabling shall be installed in a neat and workmanlike manner. Follow manufacturer's installation recommendations for all communication wiring.

3. Do not install communication wiring in raceway and enclosures containing Class 1 or other Class 2 wiring.

4. Do not install power wiring, in excess of 30 Vac RMS, in conduit with communications wiring. In cases where signal wiring is run in conduit with communication wiring, use separate twisted shielded pairs with the shields grounded in accordance with the manufacturer's wiring practice.

5. Communication conduits shall not be installed closer than six feet from high power transformers or run parallel within six feet of electrical high power cables. Care shall be taken to route the cable as far from interference generating devices as possible.

6. Do not exceed maximum pulling, tension, and bend radius for cable installation, as specified by the cable manufacturer during installation.

7. Verify the integrity of the entire network following the cable installation. Use appropriate test measures for each particular cable.

8. When a cable enters or exits a building, install a lightning arrestor between the lines and ground. Install the lightning arrestor according to the manufacturer's instructions.

9. Ground (earth ground) all shields at one point only, to eliminate ground loops.

10. All runs of communications wiring shall be unspliced length when that length is commercially available.

11. Terminate shielded cable splices in accessible locations. Harness cables with cable ties.

12. Make all wire-to-device and wire-to-wire connections at a terminal block or terminal strip.

13. Label all communications wiring to indicate origination and destination data.

14. Ground coaxial cable in accordance with NEC regulations.

15. Install BACnet MS/TP communications wiring in accordance with ASHRAE/ANSI Standard 135

    a. The network shall use shielded, twisted-pair cable with characteristic impedance between 100 and 120 ohms. Distributed capacitance between conductors shall be less than 100 pF per meter (30 pF per foot.)

    b. The maximum length of an MS/TP segment shall be 4000 ft with AWG 22 or 24 cable. The use of greater distances and/or different wire gauges shall comply with the electrical specifications of EIA-485.

    c. The maximum number of nodes per segment shall be 50. Additional nodes may be accommodated by the use of repeaters.

    d. An MS/TP EIA-485 network shall have no T connections.

G. Identification of Hardware and Wiring:

1. Label all wiring and cabling, including that within factory-fabricated panels, at each end within 2 inch of termination with the BAS address or termination number.

2. Permanently label or code each point of field terminal strips to show the instrument or item served.

3. Identify control panels with minimum 1/2 inch letters on laminated plastic nameplates.

4. Identify all other control components with permanent labels. Label all plug-in components such that removal of the component does not remove the label.

5. Identify room sensors related to terminal box or valves with nameplates.

6. Maintain manufacturers' nameplates and UL or CSA labels visible and legible after equipment is installed.

7. Identifiers shall match record documents.

3.3 STARTUP AND DEMONSTRATION

A. Start and commission systems. Allow sufficient time for start-up and commissioning prior to placing the BAS in permanent operation.

B. Contractor shall provide an on-site controls technician or programmer familiar with the project BAS installation and system programming to assist the Commissioning Agent as directed during all phases of system functional testing.

C. Coordinate with Owner the setup of logins, passwords, and security level access for individuals requiring access to the BAS.

D. BAS shall be set up and checked by factory trained technicians skilled in the setting and adjustment of the BAS equipment used in this project. Technicians shall be experienced in the type of HVAC systems associated with this project.

E. Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.

F. Test each control device to ensure that it is operating properly and is calibrated to the appropriate operating requirements. Run each control device through its range of operation and sequence. Verify all normal positions are correct. Adjust and tune PID control constants to achieve proper system operation.

1. As each control input and output is checked, a log shall be completed showing the date, technician's initials, and any corrective action taken or needed.

2. Demand limiting. The Contractor shall supply a trend data output showing the action of the demand limiting algorithm. The data shall document the action on a minute-by-minute basis over at least a 30-minute period. Included in the trend shall be building kW, demand limiting set point, and the status of sheddable equipment outputs.

3. Optimum start/stop. The Contractor shall supply a trend data output showing the capability of the algorithm. The change-of-value or change-of-state trends shall include the output status of all optimally started and stopped equipment, as well as temperature sensor inputs of affected areas.

4. Any tests that fail to demonstrate the operation of the BAS shall be repeated at a later date. The Contractor shall be responsible for any necessary repairs or revisions to the hardware or software to successfully complete all tests.

G. Test and verify control interfaces to other building systems integrated into the network.

H. Verify all alarms and interlocks.

1. Check each alarm separately by including an appropriate signal at a value that will trip the alarm.

2. Interlocks shall be tripped using field contacts to check the logic, as well as to ensure that the fail-safe condition for all actuators is in the proper direction.

3. Interlock actions shall be tested by simulating alarm conditions to check the initiating value of the variable and interlock action.

4. Verify fire/smoke and smoke damper functionality. Verify that they respond to the proper fire alarm system general, zone, and/or detector trips.

I. Document on system equipment schedules the final setting of controller PID constant settings, setpoints, manual reset values, maximum and minimum controller output, and ratio and bias settings in units and terminology specific to the controller. Store documentation with operator workstation.

J. Demonstrate complete and operating system to Owner.

1. Prior to acceptance, the BAS shall undergo a series of performance tests to verify operation and compliance with this specification. These tests shall occur after the Contractor has completed the installation, started up the system, and performed his/her own tests.

2. The tests described in this section are to be performed in addition to the tests that the Contractor performs as a necessary part of the installation, start-up, and debugging process.

3. The Contractor shall demonstrate actual field operation of each control and sensing point for all modes of operation including day, night, occupied, unoccupied, fire/smoke alarm, seasonal changeover, and power failure modes. Any test equipment required to provide the proper operation shall be provided by and operated by the Contractor.

4. Demonstrate compliance with sequences of operation through all modes of operation.

5. Demonstrate complete operation of operator interface.

K. Acceptance:

1. All tests described in this specification shall have been performed to the satisfaction of the Owner prior to the acceptance of the BAS as meeting the requirements of completion. Any tests that cannot be performed due to circumstances beyond the control of the Contractor may be exempt from the completion requirements if stated as such in writing by the Contractor and submitted for approval by the Owner. Such tests shall then be performed as part of the warranty.

2. The BAS shall not be accepted until all forms and checklists completed as part of the demonstration are submitted and approved.

3.4 MAINTENANCE SERVICE

A. Provide service and maintenance of energy management and control systems for one year from Date of Substantial Completion.

3.5 TRAINING

A. General: At a time mutually agreed upon between the Owner and Contractor, provide the services of a factory trained and authorized representative to train Owner's designated personnel for a minimum of eighthours on the operation and maintenance of the equipment provided under this section.

B. Organize the training into sessions or modules for different levels of operators. Owner designated personnel shall be trained based on the level of operator training described below.

C. Day-to-day Operator Training:

1. Overview of the system and/or equipment as it relates to the facility as a whole.

2. Proficiently operate the BAS.

3. Understand BAS architecture and configuration.

4. Understand BAS components.

5. Understand system operation, including BAS control and optimizing routines (algorithms).

6. Operate the workstation and peripherals.

7. Log on and off the system.

8. Access graphics, point reports, and logs.

9. Adjust and change system set points, time schedules, and holiday schedules.

10. Recognize malfunctions of the system by observation of the printed copy and graphical visual signals.

11. Understand BAS drawings and Operation and Maintenance manual.

12. Understand the job layout and location of control components.

13. Access data from BAS controllers and ASCs.

14. Operate portable operator's terminals.

15. Operation and maintenance procedures and schedules related to startup and shutdown, troubleshooting, servicing, preventive maintenance and appropriate operator intervention.

D. Advanced Operator Training:

1. Make and change graphics on the workstation.

2. Create, delete, and modify alarms, including annunciation and routing of these.

3. Create, delete, and modify point trend logs and graph or print these both on an ad-hoc basis and at user-definable time intervals.

4. Create, delete, and modify reports.

5. Add, remove, and modify system's physical points.

6. Create, modify, and delete programming.

7. Add panels when required.

8. Add operator interface stations.

9. Create, delete, and modify system displays, both graphical and others.

10. Perform BAS field checkout procedures.

11. Perform BAS controller unit operation and maintenance procedures.

12. Perform workstation and peripheral operation and maintenance procedures.

13. Perform BAS diagnostic procedures.

14. Configure hardware including PC boards, switches, communication, and I/O points.

15. Maintain, calibrate, troubleshoot, diagnose, and repair hardware.

16. Adjust, calibrate, and replace system components.

E. System Manager/Administrator Training:

1. Maintain software and prepare backups.

2. Interface with job-specific, third-party operator software.

3. Add new users and understand password security procedures.

F. Review data included in the operation and maintenance manuals. Refer to Division 1 Section "Operation and Maintenance Data."

G. Certification: Contractor shall submit to the Engineer a certification letter stating that the Owner's designated representative has been trained as specified herein. Letter shall include date, time, attendees and subject of training. The certification letter shall be signed by the Contractor and the Owner's representative indicating agreement that the training has been provided.

H. Schedule: Schedule training with Owner with at least 7 days' advance notice.

END OF SECTION

SECTION 232113 - HYDRONIC PIPING

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section includes piping systems for hot water heating, chilled water cooling, condenser water, make-up water for these systems, blow-down drain lines, and condensate drain piping. Piping materials and equipment specified in this Section include:

1. Pipes

B. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 3 "Concrete" for concrete, reinforcement and formwork for concrete equipment pads.

2. Division 7 Section "Penetration Firestopping," for materials and methods for fire barrier penetrations.

3. Division 23 Section "Identification for HVAC Piping & Equipment," for labeling and identification of hydronic piping.

4. Division 23 Section "Common Work Results for HVAC" for materials and methods for wall and floor penetrations and equipment pads.

5. Division 23 Section "Basic Piping Material and Methods," for materials and methods for dielectric fittings, and mechanical sleeve seals.

6. Division 23 Section "General Duty Valves for HVAC Piping," for materials and methods for installing hydronic piping valves.

7. Division 23 Section "Hydronic Specialties", for materials and methods for installing hydronic specialties.

8. Division 23 Section "Hangers & Supports for HVAC Piping & Equipment," for insulation shields, saddles and materials and methods for hanging and supporting hydronic piping.

9. Division 23 Section "HVAC Insulation," for materials and methods for insulating hydronic piping.

10. Division 23 Section "HVAC Water Treatment" for water treatment equipment, controls and chemicals.

C. Mechanically Joined Hydronic Piping:

1. The Division 23 Contractor may provide mechanically joined hydronic piping systems as an option in lieu of, in whole or in part, welded, threaded or flanged piping methods for the specific systems indicated in Pipe Applications. Mechanically joined hydronic piping systems, where

used, must be provided in compliance with Division 23 Section "Mechanically Joined Hydronic Piping Systems" and each system shall be of one manufacturer.

1.2 SYSTEM DESCRIPTION

A. General: The hydronic piping systems are the "water-side" of an air-and-water or all-water heating and air conditioning system. Hydronic piping systems specified in this Section include 4-pipe, hot water and chilled water piping system. These systems are classified by ASHRAE as Low Water Temperature, Forced, Recirculating systems.

B. 4-Pipe System: The 4-pipe system includes independent chilled water and hot water supply and return piping mains in a closed loop, connecting the boilers and chillers to the terminal heat transfer units by means of primary/secondary piping loops. Circulation is accomplished by constant or variable volume, primary and/or secondary pumps in parallel or series configuration. Design flow rates and water temperatures are specified in the various equipment specifications and schedules. Control sequences and temperature reset schedules are specified in the temperature control specifications.

1.3 SUBMITTALS

A. Submit in accordance with Division 01 Submittals and Division 23 General Mechanical Requirements.

B. Submit a schedule of proposed materials for each hydronic system. Include the following:

1. Application (e.g., Chilled Water, Hot Water, etc.).

2. Location (e.g., above grade, below grade).

3. Pipe size range.

4. Materials corresponding to the pipe size range.

5. Connection methods (e.g., threaded, flanged, grooved, welded, etc.).

C. Welders' certificates certifying that welders comply meet the quality requirements specified in Quality Assurance below.

D. Certification of compliance with ASTM and ANSI manufacturing requirements for pipe and fittings.

E. Reports specified in Part 3 of this Section.

F. Coordination Drawings:

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

a. Suspended ceiling components.

b. Other building services.

c. Structural members.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: comply with the provisions of the following:

1. ASME B 31.9 "Building Services Piping" for materials, products, and installation.

2. ASME "Boiler and Pressure Vessel Code", Section IX, "Welding and Brazing Qualification" for qualifications for welding processes and operators.

B. Pipe and pipe fittings shall be manufactured in plants located in the United States or certified to meet the specified ASTM and ANSI standards.

1.5 COORDINATION

A. Coordinate the installation of pipe sleeves for foundation wall penetrations.

PART 2 - PRODUCTS AND MATERIALS

2.1 PIPE AND TUBING MATERIALS

A. General: Refer to Part 3 Article "PIPE APPLICATIONS" for identification of where the below materials are used.

B. Copper Tubing:

1. Drawn Temper Tubing: ASTM B88, Type L.

C. Steel Pipe:

1. NPS 2 and Smaller: ASTM A 53, Type E (electric resistance welded) or Type S (seamless), Grade B, Schedule 40, black steel, plain ends.

2. NPS 2-1/2 through NPS 10 ASTM A 53, Type E (electric-resistance welded) or Type S (seamless), Grade B, Schedule 40, black steel, plain ends.

3. Piping used for condensate shall be galvanized on both interior and exterior of the pipe.

D. Plastic Pipe:

1. PVC Plastic Pipe Specifications (sizes through NPS20):

a. ASTM D1784-12454B: Cell Class

b. ASTM D1785: Pipe, Plain ends, Schedule 40

c. PVC piping installed in exterior locations shall be UV resistant.

2.2 FITTINGS

A. Cast-Iron Fittings:

1. Threaded Flanges: ANSI B16.1, Class 125; raised ground face, bolt holes spot faced.

B. Malleable-Iron Threaded Fittings: ANSI B16.3, Class 150, standard pattern, for threaded joints. Threads shall conform to ANSI B1.20.1.

C. Steel Fittings:

1. General: ASTM A 234, seamless or welded, for welded joints.

2. Flanges and Flanged Fittings: ANSI B16.5, Class 150 for low pressure service and Class 300 for high pressure service, including bolts, nuts, and gaskets of the following material group, end connection and facing:

a. Material Group: 1.1.

b. End Connections: Butt Welding.

c. Facings: Raised face.

D. Wrought Copper Fittings:

1. Solder-Joint: ANSI B16.22, streamlined pattern.

E. Cast Bronze Flanges: ANSI B16.24, Class 150; raised ground face, bolt holes spot faced.

F. PVC Plastic Pipe Fittings: Socket-type, ASTM D2466 for Schedule 40 pipe.

G. Unions: ANSI B16.39 malleable-iron, Class 150 for low pressure service and Class 300 for high pressure service; hexagonal stock, with ball-and-socket joints, metal-to-metal bronze seating surfaces; female threaded ends. Threads shall conform to ANSI B1.20.1.

H. Dielectric Unions, Waterway Fittings and Flanges: As specified in Division 23 "Basic Piping Materials and Methods."

2.3 JOINING MATERIALS

A. Reference Section "Basic Piping Materials and Methods" for basic joining materials.

B. Solder Filler Metals: ASTM B 32, 95-5 Tin-Antimony.

C. PVC Joining Materials: ASTM D2564: Solvent Cements for Plastic Pipe and Fittings

2.4 VALVES

A. General duty valves (i.e., gate, globe, check, ball, and butterfly valves) are specified in Division 23 Section "General-Duty Valves for HVAC Piping." Special duty valves are specified in Division 23 Section "Hydronic Specialties".

2.5 ANTIFREEZE

A. Coordinate corrosion inhibitors with Division 23 Section "HVAC Water Treatment" to provide an integrated water treatment and piping protection solution.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install products in accordance with manufacturer's instructions.

3.2 PIPE APPLICATIONS

A. Condensate piping inside the building shall be any of the following:

1. Type M copper tubing with wrought copper fittings and solder joints for condensate piping 1 inch and smaller.

2. Schedule 40 PVC pipe with socket-type fittings and solvent weld joints where allowed by code (Note: PVC piping is not allowed in return air plenums).

B. Condensate piping outside the building shall be any of the following:

1. Type M copper tubing with wrought copper fittings and solder joints for condensate piping 1 inch and smaller.

2. Type DWV copper tubing with wrought copper fittings and solder joints for condensate piping 1-1/4 inches and larger.

C. Minimum condensate pipe size shall be 3/4 inch unless otherwise noted on plans.

D. Terminate condensate piping outside the building to the sump pit area of the nearest roof drain or other location as shown on the plans with air gap.

E. Install Type L copper tubing with wrought copper fittings and solder joints for 2 inch and smaller, above ground, within building. Install Type K, annealed temper copper tubing for 2 inch and smaller without joints, below ground or within slabs.

F. Install steel pipe with threaded joints and fittings for 2 inch and smaller, and with welded joints for 2-1/2 inch and larger.

G. At Contractor's option, install mechanically joined piping with mechanical couplings and fittings for the following piping systems. Refer to Section "Mechanically Joined Hydronic Piping Systems" for requirements.

1. Condenser water
2. Blow-down drain lines
3. Condensate drain piping
4. Chilled water piping
5. Hot water piping

3.3 PIPING INSTALLATIONS

A. Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of piping systems. Locations and arrangements of piping take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated.

B. Use fittings for all changes in direction and all branch connections. Provide long radius elbows with a minimum centerline radius of 1-1/2 times the pipe diameter. Short radius elbows with a minimum centerline radius of 1 times the pipe diameter may be used only where space does not permit the long radius elbows.

C. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.

D. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.

E. Install horizontal piping as high as possible allowing for specified slope and coordination with other components. Install vertical piping tight to columns or walls. Provide space to permit insulation applications, with 1" clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.

F. Locate groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

G. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, 3/4" ball valve, and short 3/4" threaded nipple and cap.

H. Exterior Wall Penetrations: Seal pipe penetrations through exterior walls using sleeves and mechanical sleeve seals. Pipe sleeves smaller than 6 inch shall be steel; pipe sleeves 6 inch and larger shall be sheet metal.

I. Fire Barrier Penetrations: Where pipes pass through fire rated walls, partitions, ceilings, and floors, maintain the fire rated integrity. Refer to Division 7 Section "Penetration Firestopping" for special sealers and materials.

J. Exterior Wall Penetrations: Seal pipe penetrations through exterior wall constructions with sleeves, packing, and sealant. Refer to Division 23 Section "Common Work Results for HVAC" for additional information.

K. Underground Exterior Wall Penetrations: Seal pipe penetrations through underground exterior walls with sleeves and mechanical sleeve seals. Refer to Division 23 Section "Basic Piping Materials and Methods" for additional information.

L. Elevated Floor Penetrations of Waterproof Membrane, Interior Penetrations of Non-Fire Rated Walls and Concrete Slab on Grade Penetrations: Provide sleeves and seal pipes that pass through waterproof floors, non-fire rated walls, partitions and ceilings or concrete slab on grade. Refer to Division 23 Section "Common Work Results for HVAC" for special sealers and materials.

M. Install piping at a uniform grade of 1 inch in 40 feet upward in the direction of flow.

N. Make reductions in pipe sizes using eccentric reducer fitting installed with the level side up.

O. Install branch connections to mains using Tee fittings in main with take-off out the top or side of the main unless otherwise shown on the drawings. Up-feed risers shall have take-off out the top of the main line.

1. Tee-drilling is prohibited as a means for connecting branch taps into any main.

P. Bull-head tees are prohibited. Do not install tee fittings in such a way that the flow through the branch leg equals the sum of the flows through the two main legs.

Q. Install unions in pipes 2 inch and smaller, adjacent to each valve, at final connections each piece of equipment, and elsewhere as indicated. Unions are not required on flanged devices.

R. Install flanges on valves, apparatus, and equipment having 2-1/2 inch and larger connections.

S. Install flexible connectors at inlet and discharge connections to pumps (unless otherwise indicated) and other vibration producing equipment. Omit flexible connectors if replaced by series of three grooved couplings on projects where grooved pipe is used.

T. Install strainers on the supply side of each pressure reducing valve, pressure regulating valve, pump, and elsewhere as indicated. Install nipple and ball valve in blow down connection of strainers 2 inch and larger.

U. Anchor piping to ensure proper direction of expansion and contraction.

3.4 HANGERS AND SUPPORTS

A. General: Hanger, supports, and anchors devices are specified in Division 23 Section "HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT." Conform to the table below for maximum spacing of supports:

1. Pipe attachments shall be copper-plated or have nonmetallic coating for electrolytic protection where attachments are in direct contact with copper tubing.

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet in length.
2. Adjustable roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
3. Pipe roller complete - MSS Type 44 for multiple horizontal runs, 20 feet or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Provide insulation saddles and protection shields as specified in Section "Hangers & Supports for HVAC Piping & Equipment". Provide insulation inserts as specified in Section "HVAC Insulation".

C. Install hangers with the following minimum rod sizes and maximum spacing:

Nom. Pipe Size - In.	Steel Pipe Max. Span - Ft.	Copper Tube Max. Span - Ft.	Min. Rod Dia. - In.
Up to 3/4	7	5	3/8
1	7	6	3/8
1-1/4	7	7	3/8
1-1/2	9	8	3/8
2	10	8	1/2
2-1/2	11	9	1/2
3	12	10	1/2
4	14	12	5/8 (1/2 for copper)
5	16	13	5/8 (1/2 for copper)
6	17	14	3/4 (5/8 for copper)

D. Install PVC and CPVC supports and hangers per manufacturer's recommendations.

E. Support vertical runs at roof, at each floor, and at maximum 15-foot intervals between floors.

F. Install a support within one foot of each change of direction.

G. Space supports not more than five feet apart at valves, strainers or piping accessories in piping larger than 2".

3.5 PIPE JOINT CONSTRUCTION

A. Soldered Joints: Comply with the procedures contained in the AWS "Soldering Manual."

B. Threaded Joints: Conform to ANSI B1.20.1, tapered pipe threads for field cut threads. Join pipe fittings and valves as follows:

1. Note the internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.

2. Align threads at point of assembly.

3. Apply appropriate tape or thread compound to the external pipe threads (except where dry seal threading is specified).

4. Assemble joint wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.

a. Damaged Threads: Do not use pipe with threads which are corroded or damaged. If a weld opens during cutting or threading operations, that portion of pipe shall not be used.

C. Welded Joints: Comply with the requirement in ASME Code B31.9-"Building Services Piping."

D. Flanged Joints: Align flanges surfaces parallel. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench.

3.6 VALVE APPLICATIONS

A. General Duty Valve Applications: The Drawings indicate valve types to be used. Where specific valve types are not indicated the following requirements apply:

1. Shut-off duty: use gate, ball, and butterfly valves.

2. Throttling duty: use globe, ball, and butterfly valves.

3. Install shut-off duty valves at each branch connection to supply mains, at supply connection to each piece of equipment, and elsewhere as indicated.

4. Install throttling duty valves at each branch connection to return mains, at return connections to each piece of equipment, elsewhere as indicated.

B. Special Duty Valve Applications: Special duty valve applications are specified in Division 23 Section "Hydronic Specialties".

3.7 FIELD QUALITY CONTROL

A. Preparation for testing: Prepare hydronic piping in accordance with ASME B 31.9 and as follows:

1. Leave joints including welds uninsulated and exposed for examination during the test.

2. Provide temporary restraints for expansion joints which cannot sustain the reactions due to test pressure. If temporary restraints are not practical, isolate expansion joints from testing.

3. Isolate equipment that is not to be subjected to the test pressure from the piping. If a valve is used to isolate the equipment, its closure shall be capable of sealing against the test pressure without damage to the valve. Flanged joints at which blinds are inserted to isolate equipment need not be tested.

4. Install relief valve set at a pressure no more than 1/3 higher than the test pressure, to protect against damage by expansion of liquid or other source of overpressure during the test.

B. Pressure Testing: Test hydronic piping as follows:

1. Use ambient temperature water as the testing medium, except where there is a risk of damage due to freezing. Another liquid may be used if it is safe for workmen and compatible with the piping system components.

2. Use vents installed at high points in the system to release trapped air while filling and prevent vacuum while draining the system. Use drains installed at low points for complete removal of the liquid.

3. Examine system to see that equipment and parts that cannot withstand test pressures are properly isolated. Examine test equipment to ensure that it is tight and that low pressure filling lines are disconnected.

4. Subject piping systems other than ground source heat pump loop systems to a hydrostatic test pressure which at every point in the system is 1.5 times the maximum system design pressure but not less than 100 psi. The test pressure shall not exceed the maximum pressure for any vessel, pump, valve, or other component in the system under test. Make a check to verify that the stress due to pressure at the bottom of vertical runs does not exceed either 90 percent of specified minimum yield strength, or 1.7 times the "SE" value in Appendix I of ASME B31.9, Code For Pressure Piping, Building Services Piping.

5. After the hydrostatic test pressure has been applied for at least 15 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components as appropriate, and repeat hydrostatic test until there are no leaks.

6. Subject ground source heat pump loop systems to water test pressure of 100 psi for 30 minutes. Testing shall be implemented prior to trench backfilling. Compare actual flow and pressure drop to design values and make system corrections as required to bring actual values to within 10% of design.

7. Provide test reports summarizing the test procedures and results of the tests.

C. Flushing:

1. After satisfactory pressure test is obtained, flush piping system using a minimum velocity of 4 FPS through all portions of the system.

2. Make all provisions required to isolate HVAC equipment, coils, control valves, automatic flow control valves, pressure independent control valves, and balance valves during flushing.

3. Provide temporary valves, connections, and bypasses where required.

4. System pumps may be used for flushing. Where system pumps are not used, provide temporary pumps with temporary connections.

5. Continue flushing until discharge water shows no discoloration and strainers are no longer collecting dirt and other foreign materials.

6. Upon completion of flushing, drain all water from system at low points, and remove, clean, and replace strainers.

7. Open vents installed at high points in the system to release trapped air while filling and prevent vacuum while draining the system.

3.8 ADJUSTING AND CLEANING

A. Cleaning Agent Concentration:

1. As recommended by manufacturer.

B. Hot Water Heating Systems:

1. Apply heat while circulating, slowly raising temperature to 160 F and maintain for 12 hours minimum.

2. Remove heat and circulate to 100 F or less, drain systems as quickly as possible.

3. Refill with clean water and repeat until system cleaner is removed.

C. Chilled Water and Closed Loop Condenser Water Systems:

1. Circulate for 48 hours, then drain systems as quickly as possible.

2. Refill with clean water, circulate for 24 hours, then drain.

3. Refill with clean water and repeat until system cleaner is removed.

D. Use neutralizer agents on recommendation of system cleaner supplier and approval of Engineer.

E. Flush open systems and glycol filled closed systems with clean water for one hour minimum. Drain completely and refill. Open vents installed at high points in the system to release trapped air while filling and prevent vacuum while draining the system.

F. Remove and clean or replace strainer screens.

G. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.

H. After cleaning system, but before balancing, remove disposable fine mesh strainers in pump suction diffusers.

I. Mark calibrated name plates of pump discharge valves after hydronic system balancing has been completed, to permanently indicate final balanced position.

3.9 STARTUP

A. Fill system and perform initial chemical treatment.

B. Check expansion tanks to determine that they are not air bound and that the system is completely full of water.

C. Before operating the system perform these steps:

1. Open valves to full open position. Close coil bypass valves.

2. Remove and clean strainers.

3. Check pump for proper direction of correct improper wiring.

4. Set automatic fill valves for required system pressure.

5. Check air vents at high points of systems and determine if all are installed and operating freely (automatic type) or to bleed air completely (manual type).

6. Set temperature controls so all coils are calling for full flow.

7. Check operation of automatic bypass valves.

8. Check and set operating temperatures of boilers, chillers, and cooling towers to design requirements.

9. Lubricate motors and bearings.

END OF SECTION

SECTION 232116 - HYDRONIC SPECIALTIES

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section includes hydronic specialties for hot water heating, chilled water cooling, condenser water, make-up water for these systems, blow-down drain lines, and condensate drain piping. Equipment specified in this Section include:

1. Special Duty Valves:

a. Circuit Balancing Valves

b. Pressure Reducing Valves

2. Hydronic Specialties:

a. Air Vents (Manual and Automatic)

b. Diaphragm/Bladder Type Expansion Tanks

c. Air Separators

d. Pump Suction Diffusers

e. Diverting Fittings

f. Y-Pattern Strainers

g. Basket Strainers

h. Metal Flexible Connectors

B. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 3 "Concrete" for concrete, reinforcement and formwork for concrete equipment pads.

2. Division 23 Section "Common Work Results for HVAC" for materials and methods for wall and floor penetrations and equipment pads.

3. Division 23 Section "Basic Piping Material and Methods," for materials and methods for mechanical sleeve seals.

4. Division 23 Section "Common Motor Requirements for HVAC Equipment" for motors related to chemical feeding equipment.

5. Division 23 Section "Hydronic Piping" for material and methods for installation of hydronic piping systems.

6. Division 23 Section "General Duty Valves for HVAC Piping," for materials and methods for installing hydronic piping valves.

7. Division 23 Section "Hangers & Supports for HVAC Piping & Equipment," for insulation shields, saddles and materials and methods for hanging and supporting hydronic piping.

8. Division 23 Section "HVAC Insulation," for materials and methods for insulating hydronic piping.

9. Division 23 Section "HVAC Water Treatment" for water treatment equipment, controls and chemicals.

10. Division 23 Section "Instrumentation and Control Devices for HVAC" for control valves.

1.2 SUBMITTALS

A. Submit in accordance with Division 01 Submittals and Division 23 General Mechanical Requirements.

B. Product Data, including rated capacities of selected models, weights (shipping, installed, and operating), furnished specialties and accessories, and installation instructions for each hydronic specialty and special duty valve specified.

1. Furnish flow and pressure drop curves for diverting fittings and circuit balancing valves, based on manufacturer's testing.

C. Maintenance Data for hydronic specialties and special duty valves, for inclusion in operating and maintenance manual specified in Division 1 and Division 23 Section "General Mechanical Requirements."

D. Welders' certificates certifying that welders comply meet the quality requirements specified in Quality Assurance below.

E. Certification of compliance with ASTM and ANSI manufacturing requirements for hydronic specialties.

1.3 QUALITY ASSURANCE

A. ASME B 31.9 "Building Services Piping" for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label.

B. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1 - Rules for Construction of Pressure Vessels; The American Society of Mechanical Engineers; Current Eedition.

C. ASME "Boiler and Pressure Vessel Code", Section IX, "Welding and Brazing Qualification" for qualifications for welding processes and operators.

D. Pipe specialties shall be manufactured in plants located in the United States or certified to meet the specified ASTM and ANSI standards.

E. AWWA Standards for governing filter media; American Water Works Association, Current Edition.

F. NSF Standards for governing filter media; National Sanitation Foundation (NSF) International, Current Edition.

1.4 COORDINATION

A. Coordinate the size and location of concrete equipment pads. Cast anchor bolt inserts into pad. Concrete, reinforcement, and formwork requirements are specified in Division 3.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide hydronic piping system products from one of the following:

1. Circuit Balancing Valves:

a. American Wheatley.

b. Armstrong Fluid Technology.

c. Bell & Gossett; Xylem.

d. Caleffi.

e. Griswold Controls.

f. Hays Fluid Controls.

g. IMI Hydronic Engineering.

h. Nexus Valve.

i. Nibco Inc.

j. Oventrop.

k. Pro Hydronic Specialties.

l. Taco, Inc.

m. Victaulic (TA Series).

2. Pressure Reducing Valves:

a. American Wheatley.

b. Armstrong International.

c. Bell & Gossett; Xylem.

d. Caleffi.

e. Keckley.

f. Spence Engineering Company, Inc.

g. Watts Water Technologies.

3. Air Vents (manual and automatic):

a. American Wheatley.

b. Amtrol, Inc.

c. Armstrong International.

d. Bell & Gossett; Xylem.

e. John Wood Company.

f. Nexus Valves.

g. Spirax Sarco.

h. Taco, Inc.

4. Diaphragm/Bladder Type Expansion Tanks:

a. American Wheatley.

b. Amtrol, Inc.

c. Armstrong Fluid Technology.

d. Bell & Gossett; Xylem.

e. Caleffi.

f. Grundfos Pumps Corp.

g. John Wood Company.

h. Patterson Pump Co.

i. Taco, Inc.

j. Wessels.

5. Air Separators:

a. American Wheatley.

b. Amtrol, Inc.

c. Armstrong Fluid Technology.

d. Bell & Gossett; Xylem.

e. Caleffi.

f. John Wood Company.

g. Patterson Pump Co.

h. Spirotherm.

i. Taco, Inc.

j. Thrush.

k. Wessels.

6. Pump Suction Diffusers:

a. American Wheatley.

b. Armstrong Fluid Technology.

c. Keckley.

d. PACO; Grundfos Pumps Corp.

e. Patterson Pump Co.

f. Taco, Inc.

7. Diverting Fittings:

a. Amtrol, Inc.

b. Armstrong Fluid Technology.

c. Bell & Gossett; Xylem.

d. Taco, Inc.

8. Y-Pattern Strainers:

a. American Wheatley.

b. Armstrong International.

c. Hoffman Specialty; Xylem.

d. Keckley.

e. Metraflex Co.

f. Mueller Steam Specialties.

g. Spirax Sarco.

h. Nexus Valve.

i. Watts Water Technologies.

9. Basket Strainers:

a. American Wheatley.

b. Keckley.

c. Metraflex Co.

d. Spirax Sarco.

10. Metal Flexible Connectors:

a. American Wheatley.

b. Duraflex.

c. Hyspan Precision Products.

d. Mason Industries, Inc.

e. Flexicraft Industries.

f. Metraflex Co.

g. Unaflex, Inc.

2.2 GENERAL DUTY VALVES

A. General duty valves (i.e., gate, globe, check, ball, and butterfly valves) are specified in Division 23 Section "General-Duty Valves for HVAC Piping." Special duty valves are specified below by their generic name; refer to Part 3 Article "VALVE APPLICATION" for specific uses and applications for each valve specified.

2.3 SPECIAL DUTY VALVES

A. Circuit Balancing Valves: Valve shall be rated for 125 psig water working pressure, 250 deg F maximum operating temperature and shall be bronze body with plug or globe style valve and calibrated orifice. Provide with connections for portable differential pressure meter with integral check valves and seals. Valve shall have integral pointer and calibrated scale to register degree of valve opening. Valve shall have position indication readout and built-in memory stop for repeatable regulation and control. Valves 2 inch and smaller shall have threaded connections and 2-1/2 inch valves shall have flanged connections.

B. Pressure Reducing Valves: Valve shall be diaphragm operated, cast-iron or brass body valve, with low inlet pressure check valve, inlet strainer removable without system shut-down, and non-corrosive valve seat and stem. Select valve size, capacity, and operating pressure to suit system. Valve shall be factory-set at operating pressure and have the capability for field adjustment.

2.4 HYDRONIC SPECIALTIES

A. Manual Air Vent: Manual air vents at heat transfer coils shall be bronze body and nonferrous internal parts; 150 psig working pressure, 225 deg F operating temperature; manually operated with screwdriver or thumbscrew; and having 1/8 inch discharge and inlet connections. Manual air vents in piping mains shall consist of a tee fitting, 1/2" ball valve, threaded nipple and cap.

B. Automatic Air Vent: Automatic air vents shall be designed to vent automatically with float principle; bronze body and nonferrous internal parts; 150 psig working pressure, 240 deg F operating temperature; and having 1/4 inch discharge connection and 1/2 inch inlet connection.

C. Diaphragm/Bladder-Type Expansion Tanks: Provide size and number as indicated; constructed of welded carbon steel and rated for scheduled working pressure, 240 deg F maximum operating temperature. Separate air charge from system water to maintain design expansion capacity, by means of a flexible diaphragm or bladder securely sealed into tank. Provide taps for pressure gauge and air charging fitting, and drain fitting. Support vertical tanks with steel legs or base; support horizontal tanks with steel saddles. Tank, with taps and supports, shall be constructed, tested, and labeled in accordance with ASME Pressure Vessel Code, Section VIII, Division 1.

D. Air Separator: Provide welded black steel air separator; ASME rated for maximum scheduled working pressure and 375 F operating temperature. Provide perforated stainless steel air collector tube designed to direct released air into expansion tank or automatic air vent as indicated on the drawings. Provide inline inlet and outlet connections; screwed connections up to and including 2" NPS; flanged connections for 2-1/2" NPS and above; threaded blowdown connection; sized as indicated for full system flow capacity.

E. Pump Suction Diffusers: Diffusers shall have cast-iron body with threaded connections for 2 inch and smaller, flanged connections for 2-1/2 inch and larger; shall be rated for 175 psig working pressure, 300 deg F maximum operating temperature; and shall be complete with the following features:

1. Inlet vanes with length 2-1/2 times pump suction diameter or greater.

2. Cylinder strainer with 3/16 inch diameter openings with total free area equal to or greater than 5 times cross-sectional area of pump suction, designed to withstand pressure differential equal to pump shutoff head.

3. Provide disposable fine mesh, stainless steel strainer to fit over cylinder strainer for cleaning during startup procedures.

4. Adjustable foot support, designed to carry weight of suction piping.

5. Blowdown tapping in bottom; gauge tapping in side

6. Connect gauge piping to inlet and outlet pressure ports.

F. Diverting Fittings: Diverting fittings shall have cast iron body with threaded ends, or wrought copper with solder ends; and shall be rated for 125 psig working pressure, 250 deg F maximum operating temperature. Indicate flow direction on fitting.

G. Y-Pattern Strainers: Strainers shall be rated for 125 psig working pressure and shall have perforated Type 304 stainless steel basket and bottom drain connection. For general piping strainers, screen openings shall be 0.062" perforations for 4" and smaller and 1/8" perforations for larger than 4". For strainers upstream of automatic flow control valves, screen openings shall be 20 mesh. Strainers, 2" and smaller, shall have cast bronze body (ASTM B-62), threaded connections and screwed cover. Strainers, larger than 2", shall have cast-iron body (ASTM A 126, Class B), flanged or grooved ends and bolted cover.

H. Basket Strainers:; Strainer shall have high tensile cast-iron body (ASTM A 126, Class B) rated for 125 psig working pressure, flanged end connections, bolted cover, perforated Type 304 stainless steel basket, and bottom drain connection.

I. Flexible Connectors: Fabricated from materials suitable for system fluid and that will provide flexible pipe connections.

1. Metal Flexible Connectors:

a. Connections 4 inches and larger: Stainless-steel bellows with woven, flexible, stainless steel, wire-reinforcing protective jacket; 150-psig minimum working pressure and 250 deg F maximum operating temperature. Connectors shall have flanged or threaded-end connections to match equipment connected and shall be capable of ¾-inch (20-mm) misalignment.

b. Connections smaller than 4 inches: Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include stainless-steel nipples or flanges, welded to hose.

PART 3 - EXECUTION

3.1 VALVE APPLICATIONS

A. General Duty Valve Applications: General duty valve applications are specified in Division 23 Section "Hydronic Piping".

B. Circuit Balancing Valves:

1. Constant Volume Pumping Systems:

a. Install circuit balancing valves where shown on the drawings and elsewhere as required to facilitate system balancing.

2. Variable Volume Pumping Systems:

a. Install circuit balancing valves where shown on the drawings sized for the smaller of the following:

1) Line size.

2) A minimum pressure drop of 1 psi at the design flow rate.

C. Install drain valves at low points in mains, risers, branch lines, and elsewhere as required for system drainage.

D. Install check valves on each pump discharge and elsewhere as required to control flow direction.

E. Install pump discharge valves with stem in upward position; allow clearance above stem for check mechanism removal.

F. Install safety relief valves on hot water generators, and elsewhere as required by ASME Boiler and Pressure Vessel Code. Pipe discharge to floor without valves. Comply with ASME Boiler and Pressure Vessel Code Section VIII, Division 1 for installation requirements.

G. Install pressure reducing valves on hot water generators, and elsewhere as required to regulate system pressure.

3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install manual air vents at high points in the system, at heat transfer coils, and elsewhere as required for system air venting.

C. Install automatic air vents at air separator outlets, expansion tank connections, high points in outlet piping of boilers and hot water heat exchangers and elsewhere as required for system air venting. Pipe outlet of automatic air vents to discharge at floor drains.

D. Install combination air separator/strainer in pump suction lines with isolation valves on the inlet and outlet piping. Install automatic air vent at air outlet and run piping to floor drain. Install blowdown piping with gate valve; extend to nearest drain.

E. Install pump suction diffusers on pump suction inlet, adjust foot support to carry weight of suction piping. Install nipple and ball valve in blowdown connection.

1. Do not include strainer in suction diffusers installed with pumps serving open condenser water systems, such as cooling towers.

2. Provide clearance for strainer maintenance.

F. Install diaphragm/bladder-type expansion tanks on floor or support from structure as indicated on the drawings. Vent and purge air from hydronic system, charge tank with proper air charge to suit system design requirements.

1. Support tank as detailed on the Drawings. In the absence of details provide support from the floor or structure above sufficient for the weight of the tank, piping connections, and fittings, plus weight of water assuming a full tank of water. Do not overload building components and structural members.

G. Install air on floor or support from structure as indicated on the drawings.

1. Support tank as detailed on the Drawings. In the absence of details provide support from the floor or structure above sufficient for the weight of the tank, piping connections, and fittings, plus weight of water assuming a full tank of water. Do not overload building components and structural members.

H. Install flexible connectors at inlet and discharge connections to pumps (unless otherwise indicated) and other vibration producing equipment. Omit flexible connectors if replaced by series of three grooved couplings on projects where grooved pipe is used.

I. Install strainers on the supply side of each pressure reducing valve, pressure regulating valve, pump, and elsewhere as indicated. Install nipple and ball valve in blow down connection of strainers 2 inch and larger.

3.3 STARTUP

A. Start up and commissioning of water filtration unit shall be performed by a factory authorized representative.

B. Start up and commissioning of glycol makeup unit shall be performed by a factory authorized representative.

3.4 TRAINING

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain water filtration equipment and/or glycol makeup equipment.

B. Training for Owner's personnel shall include but not be limited to:

1. Overview of the system and /or equipment as it relates to the facility as a whole.

2. Operation and maintenance procedures and schedules related to startup and shutdown, troubleshooting, servicing, preventive maintenance and appropriate operator intervention.

C. Review manufacturer's safety data sheets for handling of chemicals.

D. Review data in maintenance manuals, especially data on recommended parts inventory and supply sources and on availability of parts and service. Refer to Division 1 and Division 23 Section "General Mechanical Requirements."

E. Schedule at least four hours of training with Owner, through Architect, with at least seven days' advance notice.

F. Certification: Contractor shall submit to the Engineer a certification letter stating that the Owner's designated representative has been trained as specified herein. Letter shall include date, time, attendees and subject of training. The certification letter shall be signed by the Contractor and the Owner's representative indicating agreement that the training has been provided.

END OF SECTION

SECTION 232123 - HYDRONIC PUMPS

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section includes the following types of HVAC pumps:

1. Vertical, close-coupled, inline pumps.

2. Base-mounted, close-coupled, end-suction pumps.

1.2 RELATED REQUIREMENTS

A. Section 230548 Seismic Controls for Mechanical, for seismic controls.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 specification sections.

1. Product data including certified performance curves of selected models indicating selected pump's operating point, weights (shipping, installed, and operating), furnished specialties, and accessories. For pumps furnished with starter or variable frequency drive, include short circuit current rating of electrical equipment.

2. Shop drawings showing layout and connections for HVAC pumps. Include setting drawings with templates, and directions for installation of foundation bolts and other anchorages.

3. Wiring diagrams detailing wiring for power, signal, and control systems, differentiating between manufacturer-installed wiring and field-installed wiring.

4. Maintenance data for HVAC pumps for inclusion in Operation and Maintenance Data specified in Division 1 and Division 23 Section "General Mechanical Requirements."

1.4 QUALITY ASSURANCE

A. UL Compliance: Fabricate and label pumps to comply with UL 778, "Motor-Operated Water Pumps," for construction requirements.

B. Product Options: Drawings indicate size, profiles and connections requirements of pumps and are based on the specific types and models indicated. Other manufacturers' pumps with equal performance characteristics may be considered. Refer to Division 1 Section "Substitutions."

C. Regulatory Requirements: Fabricate and test pumps to comply with HI 1.1-1.5, "Centrifugal Pumps for Nomenclature, Definitions, Application and Operation," and HI 1.6, "Centrifugal Pump Tests."

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

B. Store pumps in dry location.

C. Retain protective covers for flanges and protective coatings during storage.

D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.

E. Comply with pump manufacturer's written rigging instructions.

1.6 SPARE PARTS

A. Furnish spare parts described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Mechanical Seals: One mechanical seal for each pump.

1.7 WARRANTY

A. Warranty on Pumps: Provide written warranty, signed by manufacturer, agreeing to replace/repair, within warranty period, pumps with inadequate or defective materials and workmanship, including leakage, breakage, improper assembly, or failure to perform as required; provided manufacturer's instructions for handling, installing, protecting, and maintaining units have been adhered to during warranty period. Replacement includes both parts and labor for removal and reinstallation.

1. Warranty Period: One year from date of substantial completion.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide one of the following:

1. Vertical Inline Close-Coupled Pumps:

a. American Marsh PumpsArmstrong Pumps, Inc.

b. Aurora Pumps.

c. Bell & Gossett, ITT.

d. Grundfos Pumps Corp.

e. Paco Pumps.

f. Patterson Pump Co.

g. Taco, Inc.

2. Base-Mounted, Close-Coupled, End-Suction Pumps:

a. American Marsh Pumps.

b. Armstrong Pumps, Inc.

c. Aurora Pumps.

d. Bell & Gossett ITT.

e. Paco Pumps.

f. Patterson Pump Co.

g. Taco, Inc.

2.2 PUMPS, GENERAL

A. Pumps and Circulators: Factory-assembled and factory-tested. Fabricate casings to allow removal and replacement of impellers without necessity of disconnecting piping. Type, sizes, and capacities shall be as indicated.

B. Preparation for Shipping: After assembly and testing, clean flanges and exposed machined metal surfaces and treat with an anticorrosion compound. Protect flanges, pipe openings, and nozzles.

C. Motors: Conform to NEMA Standard MG-1, general purpose, continuous duty, Design B, except Design C where required for high starting torque; single, multiple, or variable speed with type of enclosure and electrical characteristics as indicated; have built-in thermal-overload protection, and grease-lubricated ball bearings. Select motors that are non-overloading within the full range of the pump performance curve. Refer to Section "Common Motor Requirements for HVAC Equipment" for additional requirements.

D. Efficiency:

1. Motors shall have a minimum efficiency meeting the requirements of the Energy Policy Act of 1992 as defined in NEMA MG-1 when tested in accordance with IEEE Standard 112, Test Method B.

2. Motor Frame: NEMA Standard 48 or 54; use pump manufacturer's standard.

3. Department of Energy Pump Energy Index (PEI): Less than or equal to 1.00 or less than the maximum value scheduled, whichever is less.

E. Apply factory finish paint to assembled, tested units prior to shipping.

2.3 VERTICAL INLINE CLOSE-COUPLED PUMPS

A. General Description: Pumps shall be centrifugal, close-coupled, single-stage, bronze-fitted, radially split case design, with mechanical seals, and rated for 175 psig working pressure and 225 deg F continuous water temperature.

B. Casings Construction: Cast iron, with threaded companion flanges for piping connections smaller than 2-1/2 inches, and threaded gauge tappings at inlet and outlet connections.

C. Impeller Construction: Statically and dynamically balanced, closed, overhung, single-suction, cast bronze, conforming to ASTM B 584, and keyed to shaft.

D. Wear Rings: Removable, bronze.

E. Pump Shaft and Sleeve: Ground and polished steel shaft, with bronze sleeve and integral thrust bearing. Provide flinger on motor shaft between motor and seals to prevent liquid that leaks past pump seals from entering the motor bearings.

F. Seals: Mechanical Seals consisting of carbon steel rotating ring, stainless steel spring, ceramic seat, and flexible bellows and gasket.

G. Motor: Direct-mounted to pump casing; with lifting and supporting lugs in top of motor enclosure.

2.4 BASE-MOUNTED, CLOSE-COUPLED, END-SUCTION PUMPS

A. General Description: Pumps shall be base-mounted, centrifugal, close-coupled, end-suction, single-stage, bronze-fitted, radially split case design, and rated for 175 psig minimum working pressure and 225 deg F continuous water temperature.

B. Casings Construction: Cast iron, with flanged piping connections, and threaded gauge tappings at inlet and outlet flange connections.

C. Impeller Construction: Statically and dynamically balanced, closed, overhung, single-suction, fabricated from cast bronze conforming to ASTM B 584, keyed to shaft and secured by a locking capscrew.

D. Wear Rings: Replaceable, bronze.

E. Pump Shaft and Sleeve Bearings: Steel shaft, with bronze sleeve. Provide neoprene slinger on motor shaft between motor and seals to prevent liquid that leaks past pump seals from entering the motor bearings.

F. Seals: Mechanical seals consisting of flushed seals consisting of carbon steel rotating ring, stainless steel spring, ceramic seat, and flexible bellows and gasket.

G. Motor: Direct-mounted to the pump casing with supporting legs as an integral part of motor enclosure.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Comply with the manufacturer's written installation and alignment instructions.

B. Install pumps in locations and arranged to provide access for periodic maintenance, including removal of motors, impellers, couplings, and accessories.

C. Support pumps and piping separately so that the weight of the piping system does not rest on the pump.

D. Suspend inline pumps using all-thread hanger rod and vibration isolation hangers of sufficient size to support the weight of the pump independent from the piping system. Install seismic bracing according to the requirements specified in section 230548 "Seismic Controls for Mechanical" and as required by authorities having jurisdiction.

E. Set base-mounted pumps on concrete foundation. Disconnect coupling halves before setting. Do not reconnect couplings until the alignment operations have been completed.

1. Support pump base plate on rectangular metal blocks and shims, or on metal wedges having a small taper, at points near the foundation bolts to provide a gap of 3/4 to 1-1/2 inches between the pump base and the foundation for grouting.

2. Adjust the metal supports or wedges until the shafts of the pump and driver are level. Check the coupling faces and suction and discharge flanges of the pump to verify that they are level and plumb.

3.2 EQUIPMENT BASES

A. Construct concrete equipment pads in accordance with Section "Common Work Results for HVAC". Color shall be as selected by the Architect.

3.3 ALIGNMENT

A. General: Comply with pump and coupling manufacturer's written instruction.

B. Align pump and motor shafts and piping connections after setting on foundations, after grout has been set and foundations bolts have been tightened, and after piping connections have been made.

1. Adjust alignment of pump and motor shafts for angular and parallel alignment by one of the two methods specified in the Hydraulic Institute "Centrifugal Pumps - Instructions for Installation, Operation and Maintenance."

C. After alignment is correct, tighten the foundation bolts evenly, but not too firmly. Fill the base plate completely with non-shrink, nonmetallic grout, with metal blocks and shims or wedges in place. After grout has cured, fully tighten foundation bolts.

1. Alignment tolerances shall meet manufacturer's recommendations.

3.4 CONNECTIONS

A. General: Install valves that are same size as the piping connecting the pump.

B. Install suction and discharge pipe sizes equal to or greater than the diameter of the pump nozzles.

C. Install a non-slam check valve, balance valve and shutoff valve on the discharge side of inline pumps.

D. Install a triple-duty valve on the discharge side of base-mounted, end-suction pumps.

E. Install a shutoff valve and strainer on the suction side of inline pumps.

F. Install a pump suction diffuser with strainer with blowdown valve and shutoff valve on the suction side of base-mounted, end-suction pumps.

G. Install flexible connectors on the suction and discharge side of each base-mounted pump. Install flexible connectors between the pump casing and the discharge valves, and upstream from the pump suction diffuser

H. Install pressure gauges and gauge cocks on the suction and discharge of each pump at the integral pressure gauge tappings provided

I. Electrical wiring and connections are specified in Division 26 sections. Ground equipment. Tighten electrical connectors and terminals in accordance with manufacturer's written instructions or those specified in UL486A and UL486B.

J. Control wiring and connections are specified in other Division 23 sections.

3.5 STARTUP

A. Final Checks Before Start-Up: Perform the following preventative maintenance operations and checks before start-up:

1. Lubricate oil-lubricated bearings.

2. Remove grease-lubricated bearing covers and flush the bearings with kerosene and thoroughly clean. Fill with new lubricant in accordance with the manufacturer's recommendations.

3. Disconnect coupling and check motor for proper rotation. Rotation shall match direction of rotation marked on pump casing.

4. Check that pump is free to rotate by hand. For pumps handling hot liquids, pump shall be free to rotate with the pump hot and cold. If the pump is bound or even drags slightly, do not operate the pump until the cause of the trouble is determined and corrected.

5. Clean strainers.

6. Check piping connections for tightness.

B. Starting procedure for pumps with shutoff power not exceeding the safe motor power:

1. Prime the pump, opening the suction valve, closing the drains, and prepare the pump for operation.

2. Open the valve in the cooling water supply to the bearings, where applicable.

3. Open the cooling water supply valve if the stuffing boxes are water-cooled.

4. Open the sealing liquid supply valve if the pump is so fitted.

5. Open the warm-up valve of a pump handling hot liquids if the pump is not normally kept at operating temperature.

6. Open the recirculating line valve if the pump should not be operated against dead shutoff.

7. Start the motor.

8. Open the discharge valve slowly.

9. Observe the leakage from the stuffing boxes and adjust the sealing liquid valve for proper flow to ensure the lubrication of the packing. Do not tighten the gland immediately, but let the packing run in before reducing the leakage through the stuffing boxes.

10. Check the general mechanical operation of the pump and motor.

11. Close the recirculating line valve once there is sufficient flow through the pump to prevent overheating.

C. If the pump is to be started against a closed check valve with the discharge gate valve open, the steps are the same, except that the discharge gate valve is opened some time before the motor is started.

D. Retouch any marred or scratched surfaces of factory-finished surfaces, using finish materials furnished by manufacturer.

E. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for detailed requirements for testing, adjusting, and balancing hydronic systems.

3.6 TRAINING

A. General: At a time mutually agreed upon between the Owner and Contractor, provide the services of a factory trained and authorized representative to train Owner's designated personnel for a minimum of four hours on the operation and maintenance of the equipment provided under this section.

B. Content: Training shall include but not be limited to:

1. Overview of the system and/or equipment as it relates to the facility as a whole.

2. Operation and maintenance procedures and schedules related to startup and shutdown, troubleshooting, servicing, preventive maintenance and appropriate operator intervention.

3. Review data included in the operation and maintenance manuals. Refer to Division 1 Section "Operation and Maintenance Data."

C. Certification: Contractor shall submit to the Engineer a certification letter stating that the Owner's designated representative has been trained as specified herein. Letter shall include date, time, attendees and subject of training. The certification letter shall be signed by the Contractor and the Owner's representative indicating agreement that the training has been provided.

D. Schedule: Schedule training with Owner with at least 7 days' advance notice.

END OF SECTION

SECTION 232300 - REFRIGERANT PIPING

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section includes refrigerant piping used for air conditioning applications. This Section includes:

1. Pipes, tubing, fittings, and specialties.

2. Special duty valves.

3. Refrigerants.

B. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 02 Section "Earthwork," for trenching and backfilling materials and methods for underground piping installations.

2. Division 07 Section "Penetration Firestopping," for materials and methods for fire barrier penetrations.

3. Division 07 Section "Joint Sealers," for materials and methods for sealing pipe penetrations through basement and foundation walls.

4. Division 23 Section "Identification for HVAC Piping & Equipment," for labeling and identification of refrigerant piping.

5. Division 23 Section "Common Work Results for HVAC" for materials and methods for wall and floor penetrations and equipment pads.

6. Division 23 Section "Basic Piping Material and Methods," for materials and methods for mechanical sleeve seals.

7. Division 23 Section "Hangers & Supports for HVAC Piping & Equipment," for insulation shields, saddles and materials and methods for hanging and supporting refrigerant piping.

8. Division 23 Section "HVAC Insulation," for materials and methods for insulating refrigerant piping.

1.2 SUBMITTALS

A. Product data for the following products:

1. Each type valve specified.

2. Each type refrigerant piping specialty specified.

B. Shop Drawings showing layout of refrigerant piping, specialties, and fittings including, but not necessarily limited to, pipe and tube sizes, valve arrangements and locations, slopes of horizontal runs, wall and floor penetrations, and equipment connection details. Show interface and spatial relationship between piping and proximate to equipment.

C. Brazer's Certificates signed by Contractor certifying that brazers comply with requirements specified under "Quality Assurance" below.

D. Test reports specified in Part 3 below.

E. Maintenance data for refrigerant valves and piping specialties, for inclusion in Operation and Maintenance Data specified in Division 01 and Division 23 Section "General Mechanical Requirements."

1.3 QUALITY ASSURANCE

A. Qualify brazing processes and brazing operators in accordance with ASME "Boiler and Pressure Vessel Code," Section IX, "Welding and Brazing Qualifications".

B. Regulatory Requirements: Comply with provisions of the following codes:

1. ASME/ANSI B16.22: Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings

2. ASME/ANSI B31.5: ASME Code for Pressure Piping - Refrigerant Piping.

3. ANSI/ASHRAE Standard 15: Safety Code for Mechanical Refrigeration.

4. Mechanical Code.

C. Pipe, pipe fittings and pipe specialties shall be manufactured in plants located in the United States or certified to meet the specified ASTM and ANSI standards.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

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

1. Refrigerant Valves and Specialties:

a. Alco Controls Div, Emerson Electric.

b. Danfoss Electronics, Inc.

c. EATON Corporation, Control Div.

d. Henry Valve Company.

e. Parker-Hannifin Corporation, Refrigeration and Air Conditioning Division.

f. Sporlan Valve Company.

2.2 PIPE AND TUBING MATERIALS

A. General: Refer to Part 3, Article "PIPE APPLICATION" for identification of systems where the below specified pipe and fitting materials are used.

B. Copper Tubing:

1. ASTM B280, Type ACR, seamless, hard-drawn straight lengths and soft-annealed coils. Tubing shall be factory cleaned, ready for installation, and have ends capped to protect cleanliness of pipe interiors prior to shipping.

2. ASTM B88, Type L, seamless, hard-drawn straight lengths and soft-annealed coils.

3. ASTM B88, Type K, seamless, hard-drawn straight lengths and soft-annealed coils.

C. Refrigerant Line Kits:

1. Type ACR seamless copper roll of refrigerant tubing with pipe diameters as recommended by the manufacturer and of length as required for the installation.

2. Factory or field installed flexible unicellular insulation:

a. Minimum thickness as required per Division 23 section "HVAC Insulation".

3. Quick-connect flare tubing compression fittings or solder connections as required to match the connections of the condensing unit and evaporator coil.

2.3 FITTINGS

A. Wrought-Copper Fittings for Solder-joint: ANSI B16.22, streamlined pattern.

B. Mechanical Flared Fittings: ASME B16.26, Cast Copper Alloy Fittings for Flared Copper Tube.

2.4 JOINING MATERIALS

A. Solder Filler Metals: ASTM B 32, 95-5 Tin-Antimony.

B. Brazing Filler Metals:

1. AWS A5.8, Classification BAg-5.

a. Silver (Ag) 44.0 – 46.0%

b. Zinc (Z) 23.0 – 27.0%

c. Copper (Cu) 29.0 – 31.0%.

2. AWS A5.8, Classification BCuP – 5.

   a. Phosphorus (P) 4.8 - 5.2%

   b. Silver (Ag) 14.5 - 15.5%

   c. Copper (Cu) remainder.

2.5 VALVES

A. General: Complete valve assembly shall be UL-listed and designed to conform to AHRI 760. Where insulation is indicated or specified, provide extended stems arranged to receive insulation.

B. Globe: 450 psig maximum operating pressure, 275 deg. F maximum operating temperature; cast bronze body, with cast bronze or forged brass wing cap and bolted bonnet; replaceable resilient seat disc; plated steel stem. Valve shall be capable of being repacked under pressure. Valve shall be straight through or angle pattern, with solder-end connections.

C. Check Valves - Smaller Than 7/8 inch: 500 psig maximum operating pressure, 300 deg. F maximum operating temperature; cast brass body, with removable piston, Teflon seat, and stainless steel spring; straight through globe design. Valve shall be straight through pattern, with solder-end connections.

D. Check Valves - 7/8 inch and Larger: 450 psig maximum operating pressure, 300 deg. F maximum operating temperature; cast bronze body, with cast bronze or forged brass bolted bonnet; floating piston with mechanically retained Teflon seat disc. Valve shall be straight through or angle pattern, with solder-end connections.

E. Solenoid Valves: 250 deg. F temperature rating, 400 psig working pressure; forged brass, with Teflon valve seat, two-way straight through pattern, and solder end connections. Provide manual operator to open valve. Furnish complete with NEMA 1 solenoid enclosure with 1/2 inch conduit adapter, and 24 volt, 60 Hz. normally closed holding coil.

F. Evaporator Pressure Regulating Valves: pilot-operated, forged brass or cast bronze; complete with pilot operator, stainless steel bottom spring, pressure gage tappings, 24 volts DC, 50/60 Hz, standard coil; and wrought copper fittings for solder end connections.

G. Thermal Expansion Valves: thermostatic adjustable, modulating type; size as required for specific evaporator requirements, and factory set for proper evaporator superheat requirements. Valves shall have copper fittings for solder end connections; complete with sensing bulb, a distributor having a side connection for hot gas bypass line, and an external equalizer line.

H. Hot Gas Bypass Valve: adjustable type, sized to provide capacity reduction beyond the last step of compressor unloading; and wrought copper fittings for solder end connections.

2.6 REFRIGERANT PIPING SPECIALTIES

A. General: Complete refrigerant piping specialty assembly shall be UL-listed and designed to conform to AHRI 760.

B. Strainers: 500 psig maximum working pressure; forged brass body with Monel 80-mesh screen, and screwed cleanout plug; Y-pattern, with solder end connections.

C. Moisture/liquid Indicators: 500 psig maximum operation pressure, 200 deg. F maximum operating temperature; forged brass body, with replaceable polished optical viewing window, and solder end connections.

D. Filter-driers: 500 psig maximum operation pressure; steel shell, flange ring, and spring, ductile iron cover plate with steel capscrews, and wrought copper fittings for solder end connections. Furnish complete with replaceable filter-drier core kit, including gaskets, as follows:

1. Standard capacity desiccant sieves to provide micronic filtration.

2. High capacity desiccant sieves to provide micronic filtration and extra drying capacity.

E. Suction Line Filter-Drier: 350 psig maximum operation pressure, 225 deg. F maximum operating temperature; steel shell, and wrought copper fittings for solder end connections. Permanent filter element shall be molded felt core surrounded by a desiccant for removal of acids and moisture for refrigerant vapor.

F. Suction Line Filters: 500 psig maximum operation pressure; steel shell, flange ring, and spring, ductile iron cover plate with steel capscrews, and wrought copper fittings for solder end connections. Furnish complete with replaceable filter core kit, including gaskets, as follows:

G. Flanged Unions: 400 psig maximum working pressure, 330 deg. F maximum operating temperature; two brass tailpiece adapters for solder end connections to copper tubing; flanges for 7/8 inch through 1-5/8 inch unions shall be forged steel, and for 2-1/8 inch through 3-1/8 inch shall be ductile iron; four plated steel bolts, with silicon bronze nuts and fiber gasket. Flanges and bolts shall have factory-applied rust-resistant coating.

H. Flexible Connectors: 500 psig maximum operating pressure; seamless tin bronze or stainless steel core, high tensile bronze braid covering, solder connections, and synthetic covering; dehydrated, pressure tested, minimum 7 inch in length.

2.7 REFRIGERANT

A. Refrigerant No. 134A, in accordance with ASHRAE Standard 34.

PART 3 - EXECUTION

3.1 PIPE APPLICATIONS

A. Above Grade:

1. Type L or Type ACR tubing.

3.2 PIPING INSTALLATIONS

A. General: Install refrigerant piping in accordance with ASHRAE Standard 15 - "The Safety Code for Mechanical Refrigeration" and the equipment manufacturer's installation requirements.

B. Install piping in as short and direct arrangement as possible to minimize pressure drop.

C. Install piping for minimum number of joints using as few elbows and other fittings as possible.

D. Arrange piping to allow normal inspection and servicing of compressor and other equipment. Install valves and specialties in accessible locations to allow for servicing and inspection.

E. Provide adequate clearance between pipe and adjacent walls and hanger, or between pipes for insulation installation. Use sleeves through floors, walls, or ceilings, sized to permit installation of full thickness insulation.

F. Insulate piping per Division 23 Section "HVAC Insulation."

1. Do not install insulation until system testing has been completed and all leaks have been eliminated.

G. Install branch tie-in lines to parallel compressors equal length, and pipe identically and symmetrically.

H. Install copper tubing in rigid or flexible conduit in locations where copper tubing will be exposed to mechanical injury.

I. Slope refrigerant piping as follows:

1. Install horizontal hot gas discharge piping with 1/2" per 10 feet downward slope away from the compressor.

2. Install horizontal suction lines with 1/2 inch per 10 feet downward slope to the compressor, with no long traps or dead ends which may cause oil to separate from the suction gas and return to the compressor in damaging slugs.

3. Install traps and double risers where indicated, and where required to entrain oil in vertical runs.

4. Liquid lines may be install level.

J. Use fittings for all changes in direction and all branch connections.

K. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.

L. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.

M. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, unless indicated to be exposed to view.

N. Install horizontal piping as high as possible allowing for specified slope and coordination with other components. Install vertical piping tight to columns or walls. Provide space to permit insulation

applications, with 1 inch clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.

O. Locate groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

P. Exterior Wall Penetrations: Seal pipe penetrations through exterior walls using sleeves and mechanical sleeve seals. Pipe sleeves smaller than 6 inch shall be steel; pipe sleeves 6 inch and larger shall be sheet metal. Refer to Division 23 Section "Basic Piping Materials and Methods" for additional information.

Q. Fire Barrier Penetrations: Where pipes pass through fire rated walls, partitions, ceilings, and floors, maintain the fire rated integrity. Refer to Division 07 Section "Penetration Firestopping" for special sealers and materials.

R. Elevated Floor Penetrations of Waterproof Membrane, Interior Penetrations of No-Fire Rated Walls and Concrete Slab on Grade Penetrations: Provide sleeves and seal pipes that pass through waterproof floors, non-fire rated walls, partitions and ceilings or concrete slab on grade. Refer to Division 23 Section "Common Work Results for HVAC" for special sealers and materials.

S. Make reductions in pipe sizes using eccentric reducer fittings installed with the level side down.

T. Install unions to allow removal of solenoid valves, pressure regulating valves, expansion valves, and at connections to compressors and evaporators.

3.3 HANGERS AND SUPPORTS

A. General: Hanger, supports, and anchors are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment." Conform to the table below for maximum spacing of supports:

1. Pipe attachments shall be copper-plated or have nonmetallic coating for electrolytic protection where attachments are in direct contact with copper tubing. Provide plastic galvanic isolators for copper tubing where indicated.

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet in length.

2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.

3. Pipe rollers complete supports for multiple horizontal runs, 20 feet or longer supported by a trapeze.

4. Spring hangers to support vertical runs.

5. Provide insulation saddles and protection shields as specified in Section "Hangers & Supports for HVAC Piping & Equipment". Provide insulation inserts as specified in Section "HVAC Insulation".

C. Install hangers with the following minimum rod sizes and maximum spacing:

NOM. PIPE SIZE	MAX. SPAN-FT	MIN. ROD SIZE – INCHES

Up to 3/4	5	3/8
1	6	3/8
1-1/4	7	3/8
1-1/2	8	3/8
2	8	3/8
2-1/2	9	1/2
3	10	1/2
4	12	1/2
6	14	5/8

D. Support vertical runs at each floor.

E. Install a support within one foot of each change of direction.

F. Vibration Isolation:

1. Resiliently support piping within 50 feet of connected rotating equipment that has scheduled capacity greater than 50 tons of cooling.

a. Suspend pipe using Type SPNM or Type SPNH isolators. Provide vibration isolation anchors and guides for pipe. The first isolator both upstream and downstream of equipment on springs shall have a static deflection equal to 1.5 times that of the equipment isolators, up to a maximum of 2 inches. The static deflection of the remaining pipe isolators shall be 1 inch.

b. Reference section "Vibration Isolation for HVAC Piping and Equipment" for isolator definition.

3.4 PIPE JOINT CONSTRUCTION

A. Brazed Joints: Comply with the procedures contained in the AWS "Brazing Manual."

1. WARNING: Some filler metals contain compounds which produce highly toxic fumes when heated. Avoid breathing fumes. Provide adequate ventilation.

2. CAUTION: When solenoid valves are being installed, remove the coil to prevent damage. When sight glasses are being installed, remove the glass. Remove stems, seats, and packing of valves, and accessible internal parts of refrigerant specialties before brazing. Do not apply heat near the bulb of the expansion valve.

B. Copper-to-copper joints shall be made using BCuP-5 brazing filler metal without flux.

C. Dissimilar metals such as copper and brass shall be joined using an appropriate flux with either BCuP-5 or BAg-5 brazing filler metal. Apply flux sparingly to the clean tube only and in a manner to avoid leaving any excess inside the completed joint.

D. Continuously purge the pipe and fittings during brazing, with an inert gas (i.e., dry nitrogen or carbon dioxide) to prevent formation of scale. Maintain purge until the joint is cool to the touch.

E. Heat joints using oxy-acetylene torch. Heat to proper and uniform brazing temperature.

3.5 VALVE AND PIPING SPECIALTIES INSTALLATIONS

A. General: Install refrigerant valves where indicated, and in accordance with manufacturer's instructions.

B. Install globe valves on each side of strainers and driers, in liquid and suction lines at evaporators, and elsewhere as indicated.

C. Install a full sized, 3-valve bypass around each drier.

D. Install solenoid valves ahead of each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at the top.

1. Electrical wiring for solenoid valves is specified in Division 26. Coordinate electrical requirements and connections.

E. Thermostatic expansion valves may be mounted in any position, as close as possible to the evaporator.

1. Where refrigerant distributors are used, mount the distributor directly on the expansion valve outlet.

2. Install the valve in such a location so that the diaphragm case is warmer than the bulb.

3. Secure the bulb to a clean, straight, horizontal section of the suction line using two bulb straps. Do not mount bulb in a trap or at the bottom of the line.

4. Where external equalizer lines are required make the connection where it will clearly reflect the pressure existing in the suction line at the bulb location.

F. Install pressure regulating and relieving valves as required by ASHRAE Standard 15.

G. Install strainers immediately ahead of each expansion valve, solenoid valve, hot gas bypass valve, compressor suction valve, and as required to protect refrigerant piping system components.

H. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.

1. Install moisture/liquid indicators in lines larger than 2-1/8 inch OD, using a bypass line.

I. Install flexible connectors at the inlet and discharge connection of compressors.

3.6 EQUIPMENT CONNECTIONS

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

B. Install piping adjacent to machine to allow servicing and maintenance.

3.7 FIELD QUALITY CONTROL

A. Inspect, test, and perform corrective action of refrigerant piping in accordance with ASME Code B31.5, Chapter VI. Provide test report summarizing the test procedures and results of the tests.

B. Repair leaking joints using new materials, and retest for leaks.

C. Field Test: Every refrigerant-containing part of every system that is erected on the premises, except safety devices, pressure gauges, control mechanisms, compressors, evaporators, and systems that are factory-tested, shall be tested and proved tight after complete installation and before operation. The high side and low side of each system shall be tested and proved tight at not less than the lower of the design pressure or the setting of the pressure-relief device protecting the high side and low side of the system, respectively.

D. Testing Procedure: Tests shall be performed with dry nitrogen. The means used to build up the test pressure shall have either a pressure-limiting device or a pressure-reducing device and a gage on the outlet side. The pressure-relief device shall be set above the test pressure but low enough to prevent permanent deformation of the system's components.

3.8 CLEANING

A. Before installation of copper tubing other than Type ACR tubing, clean the tubing and fitting using following cleaning procedure:

1. Remove coarse particles of dirt and dust by drawing a clean, lintless cloth through the tubing by means of a wire or an electrician's tape.

2. Draw a clean, lintless cloth saturated with trichloroethylene through the tube or pipe. Continue this procedure until cloth is not discolored by dirt.

3. Draw a clean, lintless cloth, saturated with compressor oil, squeezed dry, through the tube or pipe to remove remaining lint. Inspect tube or pipe visually for remaining dirt and lint.

4. Finally, draw a clean, dry, lintless cloth through the tube or pipe.

3.9 ADJUSTING AND CLEANING

A. Verify actual evaporator applications and operating conditions, and adjust thermostatic expansion valve to obtain proper evaporator superheat requirements.

B. Clean and inspect refrigerant piping systems in accordance with requirements of Division 23 Basic Mechanical Materials and Methods section "Pipes and Pipe Fittings".

C. Adjust controls and safeties. Replace damaged or malfunctioning controls and equipment with new materials and products.

3.10 STARTUP

A. Charge system using the following procedure:

1. Install core in filter dryer after leak test but before evacuation.

2. Evacuate refrigerant system with vacuum pump; until temperature of 35 deg F is indicated on vacuum dehydration indicator.

3. During evacuation, apply heat to pockets, elbows, and low spots in piping.

4. Maintain vacuum on system for minimum of 5 hours after closing valve between vacuum pump and system.

5. Break vacuum with refrigerant gas, allow pressure to build up to 2 psi.

6. Complete charging of system, using new filter dryer core in charging line. Provide full operating charge.

B. Train Owner's maintenance personnel on procedures and schedules related to start-up and shut-down, troubleshooting, servicing, and preventative maintenance of refrigerant piping valves and refrigerant piping specialties.

C. Review data in Operating and Maintenance Manuals. Refer to Division 01 section "Closeout Procedures."

D. Schedule training with Owner through the Architect, with at least 7 days advance notice.

END OF SECTION

SECTION 232500 - HVAC WATER TREATMENT

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. Extent of water treatment system work required by this Section is indicated on drawings and schedules and by requirements of this Section.

B. Types of water treatment systems specified in this section include the following:

1. Heating, hot-water piping (closed-loop system).

2. Chilled-water piping (closed-loop system).

C. Related Sections include the following:

1. Division 22 Section "Water Softeners" for treatment of makeup water to hydronic and steam and condensate piping.

2. Division 23 Section "Common Motor Requirements for HVAC Equipment" for motors related to chemical feeding equipment.

3. Division 23 Section "HVAC Water Treatment System – Silica Based" for silica based water filtration systems.

1.2 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who is an authorized representative of the chemical treatment manufacturer for both installation and maintenance of chemical treatment equipment required for this Project.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.3 SUBMITTALS

A. Product Data: Include rated capacities; water-pressure drops; shipping, installed, and operating weights; and furnished products listed below:

1. Pumps.

2. Control equipment and devices.

3. Test equipment.

4. Chemicals.

5. Filters.

6. Chemical feeders.

B. Shop Drawings: Detail equipment assemblies indicating dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Detail power and control wiring and differentiate between manufacturer-installed and field-installed wiring.

C. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.

D. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

E. Maintenance Data: Provide data for pumps, agitators, filters, system controls, and accessories to include in maintenance manuals specified in Division 1.

1.4 CHEMICAL FEED SYSTEM DESCRIPTION

A. Closed-Loop System: One bypass feeder on each system with isolating and drain valves downstream from circulating pumps, unless otherwise indicated.

1. Introduce chemical treatment through bypass feeder when required or indicated by test.

1.5 PERFORMANCE REQUIREMENTS

A. Maintain water quality for HVAC systems that controls corrosion and build-up of scale and biological growth for maximum efficiency of installed equipment without posing a hazard to operating personnel or the environment.

B. Base chemical treatment performance requirements on quality of water available at Project site, HVAC system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.

C. Coordinate the use of oxidizing agents supplemented with non-oxidizers sequentially to ensure organisms do not become immune to treatment per ASHRAE Guideline 12-2000.

1.6 MAINTENANCE

A. Scope of Service: Provide chemicals and service program for maintaining optimum conditions in the circulating water for inhibiting corrosion, scale, and organic growths in the chilled-water piping and theheating, hot-water piping and equipment. Services and chemicals shall be provided for a period of one year from date of Substantial Completion, including the following:

1. Initial water analysis and recommendations.

2. Startup assistance.

3. Periodic field service and consultation.

4. Customer report charts and log sheets.

5. Laboratory technical assistance.

6. Analyses and reports of all chemical items concerning safety and compliance with government regulations.

1.7 WARRANTY

A. Warranty: Submit written warranty, signed by Manufacturer and countersigned by Installer and Contractor, agreeing to adjust or replace system or portions thereof, as required to achieve required performances, during 3-year period following final start-up for continued operation of condenser water system.

B. Agreement to Maintain: Prior to time of final acceptance, manufacturer of condenser water treatment shall submit 4 copies of "Agreement for continued Service and Maintenance" for condenser water treatment system, for Owner's possible acceptance. Offer terms and conditions for furnishing chemicals and providing continued testing and servicing, and including replacement of materials and equipment, for one-year with option for renewal of Agreement by Owner.

1.8 SPARE PARTS

A. Chemicals, Water Treatment: Furnish 6 month supply of chemicals recommended by water treatment system manufacturer for treating water to meet specified water quality.

1. Ascertain from water piping system Installer, what materials are used for pump seals. Provide only chemicals that are compatible with these materials.

PART 2 - PRODUCTS AND MATERIALS

2.1 GENERAL

A. Provide water treatment system sized and equipped to treat raw make-up water available at project site.

B. Except as otherwise indicated, provide water treatment system manufacturer's standard materials and components as indicated by published product information, and as recommended by Manufacturer for application indicated.

C. Chemical Treatment Controller: Provide the following type of control:

1. Biocide Control.

2. PH Control.

3. Corrosion Inhibitor.

2.2 MANUFACTURERS

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

1. Chemical Feeding Equipment:

a. American Wheatley

b. Cleaver Brooks

c. Culligan USA.

d. John Wood Company

e. MAC Water Technologies.

f. Mogul; Div. of the Dexter Corp.

g. Neptune Chemical Pump Co., Inc.

h. Vulcan Laboratories, Subsidiary of Clow Corp.

i. York-Shipley, Inc.

2.3 CHEMICAL FEEDING EQUIPMENT

A. Bypass Feeder: Cast iron or steel, for introducing chemicals into system; with funnel shutoff valve on top, air-release valve on top, drain valve on bottom, gage glass tappings in side, and recirculating shutoff valves on sides. Feeder should not be located more than 30" AFF.

1. Capacity: 1.8 gal..

2. Working Pressure: 175 psig.

3. Specialties: Provide 1/2" funnel with hinged cover and globe valve in fill opening, 3/8" drain valve in drain opening, and gage glass with flow regulator and vent petcock in gage glass openings.

4. Manufacturer: Subject to compliance with requirements, provide bypass feeders of one of the following;

a. Precision Boilers

b. York-Shipley, Inc.

2.4 CHEMICAL TREATMENT TEST EQUIPMENT

A. Test Kit: Manufacturer recommended equipment and chemicals, in a carrying case, for testing pH, total dissolved solids, dissolved oxygen, biocount, chloride, and total alkalinity and for calcium hardness field tests.

B. Corrosion Test Coupon Assembly: Constructed of corrosion material, complete with piping, valves, and mild steel and copper coupons. Locate copper coupon downstream from mild steel coupon in the test coupon assembly.

1. Two station rack for closed-loop systems.

2.5 CHEMICALS

A. Furnish chemicals of type and quantity as recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment.

B. System Cleaner: Liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products.

C. Closed-Loop, Water Piping Chemicals: Sequestering agent to reduce deposits and adjust pH, corrosion inhibitors, and conductivity enhancers.

PART 3 - EXECUTION

3.1 WATER ANALYSIS

A. Perform an analysis of supply water to determine the type and quantities of chemical treatment needed to maintain the water quality as specified in "Performance Requirements" Article.

3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install treatment equipment level and plumb.

C. Add cleaning chemicals as recommended by manufacturer.

D. Chemical Feeders shall not be installed higher than 30" above finished floor.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

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

C. Confirm applicable electrical requirements in Division 26 Sections for connecting electrical equipment.

D. Ground equipment.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

A. Engage a factory-authorized service representative to perform startup service.

1. Inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.

2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.

3. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of HVAC systems' startup procedures.

B. Test chemical feed piping as follows:

1. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.

2. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

3. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.

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 test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.

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

6. Prepare test reports, including required corrective action.

3.5 ADJUSTING

A. Sample boiler water at one-week intervals after boiler startup for a period of five weeks, and prepare certified test report for each required water performance characteristic. Where applicable, comply with ASTM D 3370 and the following standards:

1. Silica: ASTM D 859.

2. Steam System: ASTM D 1066.

3. Acidity and Alkalinity: ASTM D 1067.

4. Iron: ASTM D 1068.

5. Water Hardness: ASTM D 1126.

B. Occupancy Adjustments: Within 12 months of Substantial Completion, perform two separate water analyses to prove that automatic chemical feed systems are maintaining water quality within performance requirements specified in this Section. Perform analyses at least 60 days apart. Submit written reports of water analysis.

3.6 TRAINING

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment.

B. Training for Owner's personnel shall include but not be limited to:

1. Overview of the system and /or equipment as it relates to the facility as a whole.

2. Operation and maintenance procedures and schedules related to startup and shutdown, troubleshooting, servicing, preventive maintenance and appropriate operator intervention.

C. Review manufacturer's safety data sheets for handling of chemicals.

D. Review data in maintenance manuals, especially data on recommended parts inventory and supply sources and on availability of parts and service. Refer to Division 1 and Division 23 Section "General Mechanical Requirements."

E. Schedule at least four hours of training with Owner, through Architect, with at least seven days' advance notice.

F. Certification: Contractor shall submit to the Engineer a certification letter stating that the Owner's designated representative has been trained as specified herein. Letter shall include date, time, attendees and subject of training. The certification letter shall be signed by the Contractor and the Owner's representative indicating agreement that the training has been provided.

END OF SECTION

SECTION 233113 - METAL DUCTS

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section includes:

1. Rectangular, round, and flat-oval metal ducts and plenums for heating, ventilating, and air conditioning systems in pressure classes from minus 2 inches to plus 10 inches water gauge.

2. Duct liner.

3. Wire rope hanging system.

B. Related Sections:

1. Division 7 Section "Penetrations Firestopping," for materials and methods for fire barrier penetrations.

2. Division 7 Section "Joint Sealers," for materials and methods for sealing duct penetrations through basement and foundation walls.

3. Division 23 Section "Identification for HVAC Piping & Equipment," for labeling and identification of metal ducts.

4. Division 23 Section "Common Work Results for HVAC," for materials and methods for wall penetrations and equipment pads.

5. Division 23 Section "Particulate Air Filtration" for filter requirements.

1.2 DEFINITIONS

A. Sealing Requirements Definitions: For the purposes of duct systems sealing requirements specified in this Section, the following definitions apply:

1. Seams: A seam is defined as joining of two longitudinally (in the direction of airflow) oriented edges of duct surface material occurring between two joints. All other duct surface connections made on the perimeter are deemed to be joints.

2. Joints: Joints include girth joints; branch and subbranch intersections; so-called duct collar tap-ins; fitting subsections; louver and air terminal connections to ducts; access door and access panel frames and jambs; duct, plenum, and casing abutments to building structures.

1.3 SYSTEM PERFORMANCE REQUIREMENTS

A. The duct system design, as indicated, has been used to select and size air moving and distribution equipment and other components of the air system. Changes or alterations to the layout or configuration of the duct system must be specifically approved in writing. Accompany requests for layout modifications with calculations showing that the proposed layout will provide the original design results without increasing the system total pressure.

1.4 SUBMITTALS

A. Product data including details of construction relative to materials, dimensions of individual components, profiles, and finishes for the following items:

1. Duct Liner.

2. Sealing Materials.

3. Fire-Stopping Materials.

B. Shop drawings from duct fabrication shop, drawn to a scale not smaller than 1/4 inch equals 1 foot, on drawing sheets same size as the Contract Drawings, detailing:

1. Fabrication, assembly, and installation details, including plans, elevations, sections, details of components, and attachments to other work.

2. Duct layout, indicating pressure classifications, duct gauge and sizes in plan view. For exhaust ducts systems, indicate the classification of the materials handled as defined in this Section.

3. Fittings.

4. Reinforcing details and spacing.

5. Seam and joint construction details.

6. Penetrations through fire-rated and other partitions.

7. Terminal heating and cooling unit, coil, humidifier and duct silencer installations.

8. Locations of fire and fire/smoke dampers and associated duct access doors.

9. Location of manual balancing dampers.

10. Duct smoke detector locations. Refer to electrical drawings for general locations and coordinate locations with the electrical contractor.

11. Hangers and supports, including methods for building attachment, vibration isolation, and duct attachment.

C. Coordination drawings for ductwork installation in accordance with Division 23 Section "General Mechanical Requirements." In addition to the requirements specified in "General Mechanical Requirements" show the following:

1. Coordination with ceiling suspension members.

2. Spatial coordination with other systems installed in the same space with the duct systems.

3. Coordination of ceiling- and wall-mounted access doors and panels required to provide access to dampers and other operating devices.

4. Coordination with ceiling-mounted lighting fixtures and air outlets and inlets.

D. Record drawings including duct systems routing, fittings details, reinforcing, support, and installed accessories and devices, in accordance with Division 23 Section "General Mechanical Requirements" and Division 1.

E. Welding certificates including welding procedures specifications, welding procedures qualifications test records, and welders' qualifications test records complying with requirements specified in "Quality Assurance" below.

F. Leak test report for ducts specified to be leak tested in Part 3.

1.5 QUALITY ASSURANCE

A. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel" for hangers and supports and AWS D9.1 "Sheet Metal Welding Code."

B. Qualify each welder in accordance with AWS qualification tests for welding processes involved. Certify that their qualification is current.

C. NFPA Compliance: Comply with the following NFPA Standards:

1. NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems," except as indicated otherwise.

2. NFPA 90B, "Standard for the Installation of Warm Air Heating and Air Conditioning Systems.

3. NFPA 96, "Standard for the Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors for Commercial Cooking Equipment," Chapter 3, "Duct System," for kitchen hood duct systems, except as indicated otherwise.

D. Sheet Metal and Air Conditioning Contractors' National Association, Inc. (SMACNA): Provide ductwork systems in conformance with "HVAC Duct Construction Standards – Metal and Flexible," latest edition.

E. Underwriter's Laboratories (UL): Comply with the UL standards listed within this section. Provide mastic and tapes that are listed and labeled in accordance with UL 181A and marked according to type.

F. National Air Duct Cleaners Association, Inc. (NADCA): Clean ductwork systems in accordance with the standard Assessment, Cleaning and Restoration of HVAC Systems (ACR 2002).

1.6 PROTECTION AND REPLACEMENT

A. Protect ductwork during shipping and storage from dirt, debris and moisture damage. Provide plastic covers over ends of ductwork during shipping, storage and installation.

B. Replace duct liner that is damaged and cannot be repaired satisfactorily, including insulation with vapor barrier damage and insulation that has been exposed to moisture during shipping, storage, or installation. Drying the insulation is not acceptable. Dry surfaces prior to installing new duct liner.

PART 2 - PRODUCTS AND MATERIALS

2.1 SHEET METAL MATERIALS

A. Sheet Metal, General: Provide sheet metal in thickness indicated (minimum 26 gauge), packaged and marked as specified in ASTM A 700.

B. Galvanized Sheet Steel: Lock-forming quality, ASTM A 653, Coating Designation G 90. Provide mill phosphatized or galvanealed finish for surfaces of ducts exposed to view that is to be field painted. Provide bright galvanized finish for ductwork that is exposed to view and not field painted.

C. PVC-Coated Galvanized Steel: UL-181 Class 1 Listing. Lock-forming quality galvanized sheet steel with ASTM A 653, Coating Designation G 90. Provide with factory-applied, 4-mil, PVC coating on the exposed surfaces of ducts and fittings (exterior of ducts and fittings for underground applications, and the interior of ducts and fittings for fume-handing applications) and 2-mil PVC coating on the reverse side of the ducts and fittings.

D. Carbon Steel Sheets: ASTM A 366, cold-rolled sheets, commercial quality, with oiled, exposed matte finish.

E. Stainless Steel: ASTM A 480, Type 316, sheet form, with No. 4 finish on exposed surface for ducts exposed to view; Type 304, sheet form, with No. 1 finish for concealed ducts.

F. Aluminum Sheets: ASTM B 209, Alloy 3003, Temper H14, sheet form; with standard, one-side bright finish where ducts are exposed to view, and mill finish for concealed ducts.

G. Reinforcement Shapes and Plates: Unless otherwise indicated, provide galvanized steel reinforcing where installed on galvanized sheet metal ducts. For aluminum and stainless steel ducts provide reinforcing of compatible materials.

H. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for 36-inch length or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.2 DUCT LINER

A. General:

1. Comply with NFPA Standard 90A and North American Insulation Manufacturers Association (NAIMA) Standard AHC-101.

2. Liner shall have a flame spread rating of not more than 25 without evidence of continued progressive combustion and a smoke developed rating of no higher than 50, when tested in accordance with ASTM E84.

3. Duct sizes on mechanical plans indicate clear inside airflow dimensions. Sheet metal sizes for ductwork with duct liner shall be increased accordingly to account for liner thickness.

B. Fiberglass: ASTM C 1071, Type I or II, glass fibers firmly bonded together with a thermosetting resin with surface exposed to airstream coated to prevent erosion of glass fibers. Liner surface shall serve as a barrier against infiltration of dust and dirt, shall meet ASTM C 1338 for fungi resistance and shall be cleanable using duct cleaning methods and equipment outlined by NAIMA Duct Cleaning Guide. Duct liner shall be rated for air velocity of 6,000 fpm.

1. Rectangular fiberglass duct liner shall be Owens Corning QuietR HD or approved equal for 1" thickness. Rectangular 1-1/2" and 2" thickness fiberglass duct liner shall be Certainteed ToughGard T, JohnsManville Linacoustic RC, Knauf Atmosphere, Owens Corning QuietR or approved equal.

   a. Thickness and Density:

      1) 1 inch, 3 pounds.

      2) 1-1/2 inch, 1-1/2 pounds.

      3) 2 inch, 1-1/2 pounds.

2. Round fiberglass duct liner shall be Certainteed ToughGard UltraRound, JohnsManville Spiracoustic Plus, Owens Corning QuietZone Spiral, or approved equal.

   a. Thickness and Density:

      1) 1 inch, 4 pound.

3. Thermal Performance: Meet minimum "K-Factor" equal to 0.23 (Btu·in/h·sq ft·F) or better, at a mean temperature of 75°F and rated in installed condition in accordance with ASTM C518 and/or ASTM C177.

4. Noise Reduction Coefficient (NRC): Meet the following minimum NRC in accordance with ASTM C423 Type A Mounting:

   a. 1 Inch Thick: NRC 0.65.

   b. 1-1/2 Inch Thick: NRC 0.80.

   c. 2 Inch Thick: NRC 0.85.

5. Liner Adhesive: Comply with NFPA Standard 90A /UL 181 classified with flame spread/smoke development less than 25/50 and ASTM C 916. Adhesive shall be a minimum 50% solid content, water-based, non-oxidizing and have a service temperature of –20 to 200 F. Water-based adhesive shall be one of the following:

   a. Armacell LLC Armsflex 520 BLV low VOC.

b. Design Polymerics DP 2502.

c. Duro Dyne WIT.

d. Foster 85-60.

e. Childers CP-127.

f. Johns Manville SuperSeal HV.

g. Hardcast 951.

h. United McGill Uni-Tack.

6. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct.

a. Fastener Pin Length: As required for thickness of insulation, and without projecting more than 1/8 inch into the airstream.

b. Adhesive For Attachment of Mechanical Fasteners: Comply with the "Fire Hazard Classification" of duct liner system.

C. Flexible Elastomeric Duct Liner: Insulation material shall be a flexible, closed cell, elastomeric insulation in sheet form that complies with ASTM C534. Material shall have a maximum thermal conductivity of 0.27 Btu-in/h-sf-F and a minimum water vapor transmission of 0.08 perm-inches. Liner shall be 1 inch thick or greater to meet local code requirements.

1. Manufacturers:

a. Aeroflex USA, Inc Aerocel Sheet.

b. Armacell LLC Armaflex SA.

c. K-Flex USA Liner Gray.

D. Flexible elastomeric acoustical and conformable duct liner: Flexible elastomeric thermal, acoustical and conformable insulation. Compliance with ASTM C 534 Grade 1, Type II or ASTM C 1534, NFPA 90A or NFPA 90B, Thickness: 1/2 inch and 1 inch, Thermal Conductivity: 0.25 BTU-in/hr sq ft F at 75 F mean temp, ASTM C 518, Noise Reduction Coefficient: 0.6, ASTM C 423, Sound Transmission Class (STC) 25, ASTM E 90, EPA registered anti-microbial additive to inhibit mold and mildew, ASTM G21.

1. Manufacturers:

a. Aeroflex USA, Inc PLUS Acoustical Duct Liner.

b. Armacell LLC AP Coilflex.

c. Approved equal.

2.3 SEALING MATERIALS

A. Joint and Seam Sealants, General:

1. The term sealant used here is not limited to materials of adhesive or mastic nature, but also includes tapes and combinations of open weave fabric strips and mastics.

2. Duct tape shall not be used as a sealant on any ducts.

3. Sealants shall be ASTM E84 or UL 723 listed with a flame spread index not more than 25 and a smoke-developed index not more than 50.

B. Joint and Seam Tape: 2 inches wide, glass-fiber-reinforced fabric.

C. Tape Sealing System: Woven-fiber tape impregnated with a gypsum mineral compound and a modified acrylic/silicone activator to react exothermically with the tape to form a hard, durable, airtight seal.

D. Solvent-Based Joint and Seam Sealant: One-part, non-sag, solvent-release-curing, polymerized butyl sealant complying with FS TT-S-001657, Type I; formulated with a minimum of 70 percent solids.

1. Manufacturers:

a. Childers CP-140.

b. Duro Dyne SGD.

c. Fosters 32-14.

d. Approved equal.

E. Water-Based Joint and Seam Sealant, Non-Fibrated: UL 181 listed. Sealant shall be rated to ±15 inches w.g. Sealant shall have a service temperature of –25 to 200 F and be freeze/thaw stable through 5 cycles.

1. Manufacturers:

a. Childers CP-146.

b. Design Polymerics DP 1010.

c. Ductmate Proseal/Fiberseal.

d. Duro Dyne Duroseal.

e. Fosters 32-19

f. United Duct Sealer (Water Based).

g. Hardcast 601.

F. Flanged Joint Mastics: One-part, acid-curing, silicone elastomeric joint sealants, complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.

G. Flanged Gasket Tapes: Butyl gasket shall be UL 181 classified. Gasket size shall be minimum 5/8 inch x 3/16 inch and have nominal 100 percent solid content. It shall be non-oxidizing, non-skinning and have a service temperature of –25 to 180 F.

1. Manufacturers:

a. Design Polymerics DP 1040.

b. Ductmate 440.

c. Hardcast 1902.

H. Aerosolized Sealant: Aerosolized sealant shall comply with UL 1381 and shall be a stable, non-toxic, non-flammable emulsion of water and vinyl acetate polymer that will be aerosolized into 4-10 micron sized particles. Sealant shall be rated to ±10 inches w.g. Sealant shall have a service temperature of –20 to 480 F.

1. Manufacturers:

a. Aeroseal AERO-006B.

2.4 FIRE-STOPPING

A. Fire-Resistant Sealant: Two-part, foamed-in-place, fire-stopping silicone sealant formulated for use in a through-penetration fire-stop system for filling openings around duct penetrations through walls and floors, having fire-resistance ratings indicated as established by testing identical assemblies per ASTM E 814 by Underwriters Laboratory, Inc. or other testing and inspecting agency acceptable to authorities having jurisdiction.

B. Fire-Resistant Sealant: One-part elastomeric sealant formulated for use in a through-penetration fire-stop system for filling openings around duct penetrations through walls and floors, having fire-resistance ratings indicated as established by testing identical assemblies per ASTM E 814 by Underwriters Laboratory, Inc. or other testing and inspecting agency acceptable to authorities having jurisdiction.

C. Products: Subject to compliance with requirements, provide one of the following:

1. "3M Fire Stop Foam"; 3M Corp.

2. "SPECSEAL Pensil 200 Silicone Foam"; Specify Technology, Inc.

3. 3M Fire Stop Sealant"; 3M Corp.

4. "3M Fire Barrier Caulk CP-25"; Electrical Products Div./3M.

5. "Fyre Putty"; Standard Oil Engineered Materials Co.

6. "FS-ONE", Hilti, Inc.

2.5 HANGERS AND SUPPORTS

A. Building Attachments: Concrete inserts, powder actuated fasteners, or structural steel fasteners appropriate for building materials. Do not use powder actuated concrete fasteners for lightweight aggregate concrete or for slabs less than 4 inches thick.

B. Hangers: Galvanized sheet steel, or round, uncoated steel, threaded rod.

1. Hangers Installed In Corrosive Atmospheres: Electro-galvanized, all-thread rod or hot-dipped-galvanized rods with threads painted after installation.

2. Straps and Rod Sizes: Conform with SMACNA HVAC Duct Construction Standards, 2005 Edition, for sheet steel width and gauge and steel rod diameters.

C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

D. Trapeze and Riser Supports: Steel shapes conforming to ASTM A 36.

1. Where galvanized steel ducts are installed, provide hot-dipped-galvanized steel shapes and plates.

2. For stainless steel ducts, provide stainless steel support materials.

3. For aluminum ducts, provide aluminum support materials, except where materials are electrolytically separated from ductwork.

E. Wire Rope Hanging Systems:

1. Manufacturers:

a. Ductmate Industries, Inc; Clutcher Cable Hanging System.

b. Duro Dyne.

c. Gripple.

2. General: Wire rope hanger system shall have a minimum 5 to 1 safety factor based upon the applied working load being supported.

3. Source Limitations: Furnish associated fittings, accessories, and hardware produced by a single manufacturer.

4. Wire Rope: Zinc coated or galvanized steel, with wire thread type as required to support the applied working load being supported. Provide same size wire for all applications based on worst case loading.

5. Cable Lock: Cast zinc housing with steel spring with wedge grip, selected to meet the vertical load applied to the hanging system and wire thread. Do not exceed the working load limit.

6. Accessories: Hanger attachments and structural attachments shall be compatible with wire rope hanger system and shall be by the same manufacturer as the wire rope hanger system.

7. Seismic Applications: Wire rope hanger systems used for seismic supports shall be seismically tested according to ICC code guidelines EG284 with UL and SMACNA seismic approvals. Reference Division 23 Section "Seismic Controls for Mechanical Systems" for additional requirements.

2.6 RECTANGULAR DUCT FABRICATION

A. General: Except as otherwise indicated, fabricate rectangular ducts with galvanized sheet steel, in accordance with SMACNA "HVAC Duct Construction Standards," 2005 Edition, Tables 2-1 through 2-28, including their associated details. Conform to the requirements in the referenced standard for metal thickness, reinforcing types and intervals, tie rod applications, and joint types and intervals.

1. Fabricate rectangular ductwork of minimum 26 gauge sheet metal.

2. Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure classification.

3. Provide materials that are free from visual imperfections such as pitting, seam marks, roller marks, stains, and discolorations.

B. Crossbreaking or Cross Beading: Crossbreak or bead duct sides that are 19 inches and larger and are 20 gauge or less, with more than 10 sq. ft. of unbraced panel area, as indicated in SMACNA "HVAC Duct Construction Standards," 2005 Edition, Figure 2-9, unless they are lined or are externally insulated.

C. Exterior Ductwork: Ductwork installed exterior to the building without weather-proof jacket or cladding shall be minimum #18 gauge with longitudinal and transverse joints welded or sealed airtight as specified under Paragraph "Seam and Joint Sealing".

D. Field Painted Ductwork: Provide mill phosphatized finish on exposed surfaces of rectangular ductwork and duct fittings to be field painted.

2.7 RECTANGULAR DUCT FITTINGS

A. Fabricate elbows, transitions, offsets, branch connections, and other duct construction in accordance with SMACNA "HVAC Metal Duct Construction Standard," 2005 Edition, Figures 4-1 through 4-8. Unless otherwise noted on drawings, provide prefabricated 45 degree, high efficiency, rectangular/round branch duct takeoff fittings with manual balancing damper, 3/8 inch square shaft, U-bolt, nylon bushings, locking quadrant, and 2 inch insulation build-out for branch duct connections and take-offs to individual diffusers, registers and grilles. 45 degree, high efficiency, rectangular/round branch duct takeoff fittings shall be Flexmaster STO with model BO3 damper or equal.

B. Provide radius elbows, turns, and offsets with a minimum centerline radius of 1-1/2 times the duct width. Where space does not permit full radius elbows, provide short radius elbows with a minimum of two continuous splitter vanes. Vanes shall be the entire length of the bend. The use of square throat, radius heel elbows is prohibited. Remove and replace all installed elbows of this type with an approved elbow at no additional cost to the owner.

C. Provide mitered elbows where space does not permit radius elbows, where shown on the drawings, or at the option of the contractor with the engineer's approval. The contractor shall obtain approval to substitute mitered elbows in lieu of radius elbows prior to fitting fabrication. Mitered elbows less than

45 degrees shall not require turning vanes. Mitered elbows 45-degrees and greater shall have single thickness turning vanes of same material and gauge as ductwork, rigidly fastened with guide strips in ductwork. Vanes for mitered elbows shall be provided in all supply and exhaust ductwork and in return and outside air ductwork that has an air velocity exceeding 1000 fpm. Do not install vanes in grease ductwork. Refer to Section "Ductwork Accessories" for turning vane construction and mounting.

D. Provide full radius elbows for ductwork installed in noise critical spaces. Refer to Section "Basic Mechanical Materials and Methods" for noise critical spaces. Where space does not permit the installation of radius elbows, provide mitered elbows with sound attenuating, acoustical turning vanes. Refer to Section "Ductwork Accessories" for acoustical turning vanes.

2.8 SHOP APPLICATION OF LINER IN RECTANGULAR DUCTS

A. Adhere a single layer of indicated thickness of duct liner with 90 percent coverage of adhesive at liner contact surface area. Multiple layers of insulation to achieve indicated thickness is prohibited.

B. Apply a coat of adhesive to liner facing in direction of airflow not receiving metal nosing.

C. Butt transverse joints without gaps and coat joint with adhesive.

D. Fold and compress liner in corners of rectangular ducts or cut and fit to assure butted edge overlapping.

E. Longitudinal joints in rectangular ducts shall not occur except at corners of ducts, unless the size of the duct and standard liner product dimensions make longitudinal joints necessary.

1. Apply an adhesive coating on longitudinal seams in ducts exceeding 2,500 FPM air velocity.

F. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely around perimeter; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.

G. Secure transversely oriented liner edges facing the airstream with metal nosings that are either channel or "Z" profile or are integrally formed from the duct wall at the following locations:

1. Fan discharge.

2. Intervals of lined duct preceding unlined duct.

3. Upstream edges of transverse joints in ducts where duct velocity is greater than 2,500 FPM.

H. Secure insulation liner with perforated sheet metal liner of the same gauge specified for the duct, secured to ducts with mechanical fasteners that maintain metal liner distance from duct without compressing insulation. Provide 3/32-inch-diameter perforations, with an overall open area of 23 percent.

I. Terminate liner with duct buildouts installed in ducts to attach dampers, turning vane assemblies, and other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to the duct wall with bolts, screws, rivets, or welds. Terminate liner at fire dampers at connection to fire damper sleeve through fire separation.

2.9 ROUND AND FLAT OVAL DUCT FABRICATION

A. General: "Basic Round Diameter" as used in this article is the diameter of the size of round duct that has a circumference equal to the perimeter of a given sized of flat oval duct. Except where interrupted by fittings, provide round and flat oval ducts in lengths not less than 12 feet.

1. Fabricate round and flat oval ductwork of minimum 26 gauge sheet metal.

B. Round Ducts: Fabricate round supply ducts using seam types identified in SMACNA "HVAC Duct Construction Standards," 2005 Edition, Figure 3-2, RL-1, RL-4, or RL-5 except where diameters exceed 72 inches. Seam Types RL-2 or RL-3 may be used for ducts smaller than 72 inches in diameter if spot-welded on 1-inch intervals. Fabricate ducts having diameters greater than 72 inches with longitudinal butt-welded seams. Comply with SMACNA "HVAC Duct Construction Standards," 2005 Edition, Table 3-5 through 3-13 for galvanized steel gauges. For round duct with static pressure classification of 2 inches water gauge or lower, round supply ducts may be fabricated using snaplock seam types identified in SMACNA "HVAC Duct Construction Standards," 2005 Edition, Figure 3-2, RL-6A, RL-6B, RL-7 or RL-8.

C. Flat Oval Ducts: Fabricate flat oval supply ducts with standard spiral lockseams (without intermediate ribs) or with butt-welded longitudinal seams in gauges listed in SMACNA "HVAC Duct Construction Standards," 2005 Edition, Table 3-15.

D. Double-Wall (Insulated) Ducts: Fabricate double-wall insulated ducts with an outer shell, insulation, and an inner liner as specified below. Dimensions indicated on internally insulated ducts are nominal inside dimensions.

1. Outer Shell: Base outer shell gauge on actual outer shell dimensions. Provide outer shell lengths 2 inches longer than inner shell and insulation, and in gauges specified above for single-wall duct.

2. Insulation: Duct liner shall be 1" thick and 1-1/2 pound density with a thermal performance that meets a minimum "K-Factor" equal to 0.27 (Btu·in/h·sq ft·F) or better, at a mean temperature of 75°F and rated in installed condition in accordance with ASTM C518 and/or ASTM C177. Otherwise, the duct insulation shall meet the performance criteria as specified in paragraph "Duct Liner" above. Provide insulation ends where internally insulated duct connects to single-wall duct or non-insulated components. The insulation end shall terminate the insulation and reduce the outer shell diameter to the inner liner diameter.

3. Solid Inner Liner: Construct round and flat oval inner liners with solid sheet metal of the gauges listed below. For flat oval ducts, the diameter indicated in the table below is the "basic round diameter."

4. Maintain concentricity of liner to outer shell by mechanical means. Retain insulation from dislocation by mechanical means.

E. Field Painted Ductwork: All round and flat oval ductwork and duct fittings to be field painted shall have galvanized metal primer applied in the shop after fabrication and prior to shipping.

2.10 ROUND AND FLAT OVAL SUPPLY AND EXHAUST FITTINGS FABRICATION

A. 90-Degree Tees and Laterals and Conical Tees: Fabricate to conform to SMACNA "HVAC Duct Construction Standards," 2005 Edition, Figures 3-5, 3-6 and 3-7 and with metal thickness specified for longitudinal seam straight duct.

B. Diverging-Flow Fittings: Fabricate with a reduced entrance to branch taps with no excess material projecting from the body onto branch tap entrance.

C. Elbows: Unless elbow construction type is indicated, provide elbows meeting the following requirements:

1. Fabricate in die-formed, gored, pleated, or mitered construction. Fabricate the bend radius of die-formed, gored, and pleated elbows 1.5 times the elbow diameter.

a. Elbows in Round Duct: Provide full radius elbows.

b. Elbows in Flat Oval Duct: Provide full radius elbows. Where space limits the installation of full radius elbows, short radius elbows with a minimum of two continuous splitter vanes shall be installed. Vane length shall be the entire length of the bend or 36 inches whichever is greater.

c. The use of square throat, radius heel elbows is prohibited. Remove and replace all installed elbows of this type with an approved elbow at no additional cost to the owner.

d. Provide full radius elbows for ductwork installed in noise critical spaces or where shown on the drawings. Refer to Section "Basic Mechanical Materials and Methods" for noise critical spaces.

2. Mitered Elbows: Fabricate mitered elbows with welded construction in gauges specified below.

a. Mitered Elbows Radius and Number of Pieces: Unless otherwise indicated, construct elbow to comply with SMACNA "HVAC Duct Construction Standards," 2005 Edition, Table 3-1.

b. Round Mitered Elbows: Solid welded and with metal thickness listed below for pressure classes from minus 2 inches to plus 2 inches:

1) 3 to 26 inches: 24 gauge.

2) 27 to 36 inches: 22 gauge.

3) 37 to 50 inches: 20 gauge.

4) 52 to 60 inches: 18 gauge.

5) 62 to 84 inches: 16 gauge.

c. Round Mitered Elbows: Solid welded and with metal thickness listed below for pressure classes from 2 inches to 10 inches:

1) 3 to 14 inches: 24 gauge.

2) 15 to 26 inches: 22 gauge.

3) 27 to 50 inches: 20 gauge.

4) 52 to 60 inches: 18 gauge.

5) 62 to 84 inches: 16 gauge.

d. Flat Oval Mitered Elbows: Solid welded and with the same metal thickness as longitudinal seam flat oval duct.

e. 90-Degree, 2-Piece, Mitered Elbows: Use only for supply systems, or exhaust systems for material handling classes A and B; and only where space restrictions do not permit the use of 1.5 bend radius elbows. Fabricate with a single-thickness turning vane.

3. Round Elbows - 8 Inches and Smaller: Die-formed elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 degrees only. Fabricate nonstandard bend angle configurations or 1/2-inch-diameter (e.g. 3-1/2- and 4-1/2-inch) elbows with gored construction.

4. Round Elbows - 9 Through 14 Inches: Gored or pleated elbows for 30, 45, 60, and 90 degrees, except where space restrictions require a mitered elbow. Fabricate nonstandard bend angle configurations or 1/2-inch-diameter (e.g. 9-1/2- and 10-1/2-inch) elbows with gored construction.

5. Round Elbows - Larger Than 14 Inches and All Flat Oval Elbows: Gored elbows, except where space restrictions require a mitered elbow.

6. Die-Formed Elbows for Sizes Through 8 Inches and All Pressures: 20 gauge with 2-piece welded construction.

7. Round Gored Elbows Gauges: Same as for non-elbow fittings specified above.

8. Flat Oval Elbows Gauges: Same as longitudinal seam flat oval duct.

9. Pleated Elbows Sizes Through 14 Inches and Pressures Through 10 Inches: 26 gauge.

D. Double-Wall (Insulated) Fittings: Fabricate double-wall insulated fittings with an outer shell, insulation, and an inner liner as specified below. Dimensions indicated on internally insulated ducts are nominal inside dimensions.

1. Outer Shell: Base outer shell gauge on actual outer shell dimensions. Provide outer shell lengths 2 inches longer than inner shell and insulation. Gauges for outer shell shall be same as for uninsulated fittings specified above.

2. Insulation: Unless otherwise indicated, provide 1-inch-thick fiber-glass insulation with thermal conductivity performance of 0.27 Btu/sq.ft./°F/inch-thickness at 75°F mean temperature. Provide insulation ends where internally insulated duct connects to single-wall duct or non-insulated components. The insulation end shall terminate the insulation and reduce the outer shell diameter to the nominal single-wall size.

3. Solid Inner Liner: Construct round and flat oval inner liners with solid sheet metal of the gauges listed below. For flat oval ducts, the diameter indicated in the table below is the "basic round diameter."

4. Maintain concentricity of liner to outer shell by mechanical means. Retain insulation from dislocation by mechanical means.

E. PVC-Coated Elbows and Fittings: Fabricate elbows and fittings as follows:

1. Round Elbows 4 to 8 Inches: 2-piece, die stamped, with longitudinal seams spot welded, bonded, and painted with a PVC aerosol spray.

2. Round Elbows 9 to 26 Inches: Standing seam construction.

3. Round Elbows 28 to 60 Inches: Standard gore construction, riveted and bonded.

4. Other Fittings: Riveted and bonded joints.

5. Couplings: Slip-joint construction with a minimum of a 2-inch insertion length.

2.11 FACTORY-MANUFACTURED DUCTWORK

A. Manufacturers:

1. Hercules Industries.

2. Lewis & Lambert.

3. Lindab Safe.

4. Linx Industries, Inc.

5. Semco.

6. Approved equal.

B. General: At the Contractor's option, factory-manufactured ductwork can be provided instead of fabricated ductwork for round and oval ductwork. The round duct system shall consist of fittings that are factory fitted with a sealing gasket and spiral duct which, when installed according to the manufacturer's instructions, will seal the duct joints without the use of duct sealer.

C. Duct Construction

1. Unless otherwise noted, all duct and fittings shall be constructed from galvanized steel in accordance with SMACNA's Duct Construction Standards for +10" water gauge pressure with thickness as shown in the following tables:

Single Wall Round Duct:

Diameter (Inches)	Galvanized Spiral Duct	Galvanized Fittings
3-14	28	24
15-24	26	24
26-42	24	22
42-60	22	20

Double Wall Round Duct:

Diameter (Inches)	Galvanized Spiral Duct		Galvanized Fittings	
	Inner	Outer	Inner	Outer
3-14	28	28	24	24
16-24	26	26	24	24
26-42	24	24	22	22
44-60	22	22	20	20

Oval Duct:

Major Axis (Inches)	Galvanized Spiral Duct (ga)	Galvanized Fittings (ga)
3-24	24	20
25-38	22	20
37-48	22	18
49-60	20	18
61-70	20	16
71 and large	18	16

2. Duct shall be calibrated to manufacturer's published dimensional tolerance standard.

3. Spiral seam slippage shall be prevented by means of a flat seam and a mechanically formed indentation evenly spaced along the spiral seam.

4. Ducts shall be constructed using spiral lock seam sheet metal construction.

5. Ductwork to be installed in exposed locations shall have the surface prepared in the factory for field painting.

D. Fittings:

1. All fitting ends for round duct and transitions and divided flow fittings smaller than 50" diameter that convert oval duct to round duct shall come factory equipped with a double lipped, U-profile, EPDM rubber gasket. Gasket shall be manufactured to gauge and flexibility so as to insure that system will meet all of the performance criteria set forth in the manufacturer's literature. Gasket shall be classified by Underwriter's Laboratories to conform to ASTM E84-91a and NFPA 90A flame spread and smoke developed ratings of 25/50.

2. All fittings shall be calibrated to manufacturer's published dimensional tolerance standard and associated spiral duct.

3. All fitting ends from 5" to 60" diameter shall have rolled over edges for added strength and rigidity.

4. All elbows from 5" to 12" diameter shall be 2 piece die stamped and continuously stitch welded.

5. The radius of all 90° and 45° elbows shall be 1.5 times the elbow diameter, unless otherwise noted on the contract documents to be 1.0. The radius of all 15°, 30° and 60° elbows shall be 1.0 times the elbow diameter.

6. All fittings that are of either spot welded or button punched construction shall be internally sealed. When contract documents require divided flow fittings, only full body fittings will be accepted. The use of duct taps is unacceptable except for retrofit installations.

7. Double wall duct and fittings shall consist of a perforated or solid inner liner, a 1 inch, 1.50 lb/ft3 (unless otherwise specified) layer of fiberglass insulation and a solid outer pressure shell. Perforated inner liner shall have a retaining fabric wrapped between the perforated inner and the fiberglass insulation. This fabric shall provide fiberglass tear retention while maintaining the desired acoustical properties. For 1 inch thick insulation, the outer pressure shell diameter shall be 2 inches larger than the inner liner.

8. All double wall fittings for round duct shall be furnished with the Lindab Safe gasket on the outer shell. The inner shell on all double wall fittings shall extend a minimum of 1 inch past the outer shell.

9. Double wall to single wall transitions shall be provided where insulated duct connects to non-insulated, single wall duct. Transitions shall also act as insulation ends reducing the double wall outer shell diameter to the inner shell diameter.

10. All double wall duct and fittings shall be furnished with both an inner liner and an outer pressure shell coupling. The inner liners shall not be fastened tighter to allow for expansion and contraction.

11. All volume dampers shall be Lindab Safe type DRU, DSU or DTU or approved equal. Damper shall be fitting sized to slip into spiral duct. Damper shall be clearly visible and adjustable outside of duct wrap. Damper shall have the following features:

    a. Locking quadrant with blade position indicator.

    b. 2" sheet metal insulation stand-off.

    c. Integral shaft/blade assembly.

    d. Shaft mounted, load bearing bushings.

    e. Gasketed shaft penetrations to minimize leakage.

PART 3 - EXECUTION

3.1 DUCT MATERIAL APPLICATION

A. All ducts shall be galvanized steel except as follows:

1. Grease Hood Exhaust Ducts: Comply with NFPA 96.

    a. Concealed: Carbon-steel sheet, minimum 16 gauge.

b. Exposed:

1) Interior to the Building: Type 304, stainless steel, minimum 18 gauge, with finish to match kitchen equipment and range hood.

2) Exterior to the Building:

a) Type 304, stainless steel, minimum 18 gauge.

b) Carbon-steel sheet, minimum 16 gauge, coated with an exterior rated, high temperature corrosion resistant paint.

c. Weld and flange seams and joints.

d. At Contractor's option, a UL listed concentric ductwork package may be used in lieu of the welded carbon steel duct for connecting hood to exhaust fan. Provide manufacturers UL listing number and verification certificate as a part of the shop drawing submittal. Install duct package in strict conformance with manufacturer's instructions and recommendations.

2. Dishwasher Hood Exhaust Ducts:

a. Type 304, stainless steel, minimum 18 gauge, with finish to match kitchen equipment and range hood. Provide continuously welded seams on top or sides of duct and flanged joints with watertight EPDM gaskets.

b. Aluminum, with longitudinal seams and laps arranged on top of duct. Seal joints with silicone sealant to provide watertight joint.

3. Dryer Vent Ducts: Rigid, smooth wall, aluminum duct, minimum 26 gauge.

4. Acid-Resistant (Fume-Handling) Ducts: Provide factory-fabricated ducts and fittings only; no shop or field fabrication will be allowed.

a. Type 304, stainless-steel sheet with No. 4 finish for exposed surfaces and No. 1 for concealed surfaces.

5. Exterior Ductwork: Ductwork installed exterior to the building shall be minimum #18 gauge with longitudinal and transverse joints welded or sealed airtight as specified under Paragraph "Seam and Joint Sealing".

3.2 DUCT LINER INSTALLATION

A. Fiberglass Duct Liner:

1. Attach fiberglass duct liner using fasteners that do not damage the liner when applied as recommended by the manufacturer, that do not cause leakage in the duct, and will indefinitely sustain a 50-pound tensile dead load test perpendicular to the duct wall.

B. Flexible Elastomeric Duct Liner:

1. Attach flexible elastomeric duct liner to clean, oil-free sheet metal surfaces with adhesive as recommended by the liner manufacturer.

2. Seal all seams with adhesive and install compression joints in accordance with manufacturer's instructions.

C. Polyester Duct Liner:

1. Install polyester duct liner per SMACNA Manual, "HVAC Duct Construction Standards, Metal and Flexible," unless otherwise specified.

2. Attach polyester duct liner using a non flammable, low VOC water based adhesive.

3. Apply a non flammable, low VOC water based lagging adhesive to the exposed leading edge of the insulation.

4. Install fasteners per SMACNA HVAC Duct Liner installation instructions.

D. Application: Provide duct liner on the following interior air ducts and where specified on the drawings.

1. Supply Ductwork:

a. Asindicated on the plans for sound attenuation.

b. Exposed rectangular ductwork..

c. Exposed round ductwork.

d. First 15 feet of ductwork downstream of equipment outlets.

2. Return Ductwork.

a. All ductwork within 10 feet of air handling equipment.

b. Return and transfer air boots

c. Exposed rectangular ductwork.

d. Exposed round ductwork.

e. First 15 feet of ductwork upstream of equipment outlets.

3. Outside Air Ductwork

a. Exposed outside air ductwork where indicated on plans.

3.3 DUCT INSTALLATION, GENERAL

A. Install products in accordance with manufacturer's instructions.

B. Duct System Pressure Class: Construct and install each duct system except factory-manufactured ductwork for the specific duct pressure classification indicated. For factory-manufactured ductwork, refer to Paragraph "Factory-Manufactured Ductwork".

1. Primary Supply Air Ducts (upstream of terminal boxes): 4 inches water gauge.

2. Secondary Supply Air Ducts (downstream of terminal boxes): 2 inches water gauge

3. Return and Outdoor Air Ducts: 2 inches water gauge, negative pressure.

4. Exhaust Air Ducts: 2 inches water gauge, negative pressure.

C. Install ducts with the fewest possible joints.

D. Seal duct joints with the appropriate sealing material.

E. Use fabricated fittings for all changes in directions, changes in size and shape, and connections.

F. Install couplings tight to duct wall surface with projections into duct at connections kept to a minimum.

G. Locate ducts, except as otherwise indicated, vertically and horizontally, parallel and perpendicular to building lines; avoid diagonal runs. Install duct systems in shortest route that does not obstruct useable space or block access for servicing building and its equipment.

H. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

I. Cover ducts openings during construction with duct caps or three-mil plastic to protect inside of (installed and delivered) ductwork from exposure to dust, dirt, paint and moisture. Do not use duct tape on ducts that will be exposed or painted.

J. Provide clearance of 1 inch where furring is shown for enclosure or concealment of ducts, plus allowance for insulation thickness, if any.

K. Install insulated ducts with 1-inch clearance outside of insulation.

L. Conceal ducts from view in finished and occupied spaces by locating in mechanical shafts, hollow wall construction, or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as specifically shown.

M. Coordinate layout with suspended ceiling and lighting layouts and similar finished work.

N. Exposed Ductwork: Exposed ductwork shall be free of defects, dents or blemished surfaces to provide a smooth, finished appearance. Any damaged material shall be replaced with new material. Ductwork that is to be field painted shall have surfaces wiped clean of lubricant, dirt, or fil prior to priming and painting. Apply primer and paint of type as recommended by paint manufacturer for duct material and finish.

O. Electrical Equipment Spaces: Route ductwork to avoid passing through transformer vaults and electrical equipment spaces and enclosures.

P. Non-Fire-Rated Partition Penetrations: Where ducts pass interior partitions and exterior walls, and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same gauge as duct. Overlap opening on 4 sides by at least 1-1/2 inches.

Q. Acoustical Barrier Penetrations: Where a duct passes through a wall, ceiling or floor slab of a noise critical space, provide a clear annular space of 1-inch between the duct and the structure. Refer to Section "Common Work Results for HVAC" for noise critical spaces. The Contractor shall check the clearance and, if clearance is acceptable, shall install the duct and pack the voids full depth with mineral fiber batt insulation. Contractor shall caulk both ends with a non-aging, non-hardening sealant backed by a polyethylene foam rod or permanently flexible firestop material. Where there is insufficient clearance space, Contractor shall place a short stub duct in the wall, pack and caulk around it and then attach the inlet and outlet ducts to each end.

3.4 UNDERSLAB DUCT INSTALLATIONS

A. Verify undamaged conditions of duct prior to enclosure with fill or encasement.

B. Install underslab ducts in accordance with SMACNA "HVAC Metal Duct Construction Standards," 2005 Edition, Figures 10-3 and 10-4, and as indicated.

C. Protect ducts from damage by powered vibrators and other equipment used in placement of concrete on or around ducts.

D. Provide temporary protection for duct openings. Protect duct openings from damage and prevent entrance of foreign materials

3.5 KITCHEN HOOD EXHAUST DUCT INSTALLATIONS

A. Provide for thermal expansion of ductwork through 2,000°F temperature range.

B. Install without dips or traps that may collect residues, except where traps have continuous or automatic residue removal.

C. Horizontal Ducts:

1. Provide at least one opening that is minimum size of 20 inches by 20 inches for personnel entry. Where an opening of this size is not possible, provide access openings at each change in direction and at 12-foot intervals. Locate openings on sides of duct 1-1/2 inches minimum from bottom, and fit with grease-tight covers of same material as duct. Support systems for ducts 24 inch and larger in any dimension shall be designed for the weight of the duct plus 800 pounds at any point in the duct system.

2. Slope horizontal ductwork serving a Type I hood back toward the hood or local grease reservoir a minimum of 1/4 inch per foot. Horizontal ducts that exceed 75 feet in length shall be sloped not less than 1 inch per foot.

D. Vertical Ducts:

1. For ducts larger than 24 inches by 24 inches, provide a 20 inch by 20 inch access opening for personnel entry at the top of the vertical riser.

2. For ducts smaller than 24 inches by 24 inches, provide an access opening at each floor level in a location that is accessible and not higher than 12 feet above finished floor.

3. Supports for ducts large enough for personnel entry shall be designed for the weight of the duct plus 800 lbs at any point in the duct system.

E. Provide transition at connection to fan with opening size equal to or greater than the venturi opening of the fan inlet. Provide gasket at flanged connection to fan rated for 1500 F and grease applications.

F. Do not penetrate fire-rated assemblies.

3.6 DISHWASHER EXHAUST DUCT INSTALLATIONS

A. Install dishwasher exhaust duct systems in accordance with SMACNA "HVAC Duct Construction Standards," 2005 Edition, Figure 10-2.

B. Slope horizontal ductwork back towards dishwasher hood a minimum of 1/4" per foot.

3.7 DRYER VENT DUCTS

A. Install dryer vent exhaust ducts in accordance with dryer manufacturer's installation instructions.

B. Install dryer vent ducts without kinks. Install duct joints with overlap, with the male end extending in the direction of airflow. Make connections with metal clamps adjustable using phillips/hex head screws. Do not penetrate duct with sheet metal screws.

C. Install vertical risers with a means for cleanout.

D. Install a backdraft damper at termination of the dryer vent duct.

3.8 SEAM AND JOINT SEALING

A. General: Seal duct seams and joints as follows:

1. All transverse joints, longitudinal seams, and duct wall penetrations shall be sealed to meet SMACNA Seal Class A.

2. Seal class shall apply to all supply, return, outdoor air, and exhaust ductwork, regardless if the duct is positively or negatively pressurized.

B. Seal externally insulated ducts prior to insulation installation.

C. Ductwork installed exterior to the building shall have longitudinal and transverse joints welded or sealed airtight with weatherproof heavy liquid sealant applied according to manufacturer's instructions.

D. Aerosolized Duct Sealing:

1. Application must be performed by a manufacturer approved service provider and the procedure shall be done as per manufacturer's recommendations.

2. Duct Preparation:

   a. Inspect air distribution system for major leakage and repair major leakage greater than ½ inch externally using mastic and tapes per SMACNA standards.

   b. Inspect air distribution system for significant accumulation of dust, dirt and debris and remove all debris and significant dust and dirt by duct cleaning method.

   c. Temporarily remove or protect from aerosol particles building instrumentation and control devices, humidifier dispersion tubes, and fire and smoke sensors. Temporarily isolate air moving equipment and block off air inlets and outlets.

3. Duct Sealing:

   a. Seal air distribution system from the inside using automated aerosolized sealant injection.

   b. Repair all injection and test holes in existing ductwork sealed tight as per SMACNA standards.

3.9 HANGING AND SUPPORTING

A. Install rigid round, rectangular, and flat oval metal duct with support systems indicated in Chapter 5 of the SMACNA "HVAC Duct Construction Standards", 2005 Edition.

B. Installation of Wire Roper Hanger Systems:

   1. Install in accordance with manufacturer's instructions.

   2. Wire rope hanger spacing shall not exceed 8 feet. Supported load shall not exceed manufacturer's recommended load rating.

   3. Where approved by local code authority, the loop system may be swaged directly on to a seismic approved bracket or appropriate end fixing.

C. Support horizontal ducts within 2 feet of each elbow and within 4 feet of each branch intersection.

D. Support vertical ducts at a maximum interval of 16 feet and at each floor.

E. Upper attachments to structures shall have an allowable load not exceeding 1/4 of the failure (proof test) load but are not limited to the specific methods indicated. Hangers and supports shall be fastened to building joists or beams. Do not attach hangers and supports to the above floor slab or roof with sheet metal screws.

F. Install concrete insert prior to placing concrete.

G. Installation of Pre-Engineered Roof Duct Supports:

   1. Install pre-engineered roof duct supports to rest on the roofing membrane without attachment to the roof structure or penetration through the roofing assembly.

3.10 PENETRATIONS

A. Fire Barrier Penetrations: Where ducts pass though fire-rated walls, partitions, ceilings, and floors, maintain the fire-rated integrity.

B. Exterior Wall Penetrations: Seal duct penetrations through exterior wall constructions with sleeves, packing, and sealant. Refer to Division 23 Section "Basic Mechanical Materials and Methods" for additional information.

C. Underground Exterior Wall Penetrations: Seal duct penetrations through underground exterior walls with sleeves, packing, and sealant. Refer to Division 23 Section "Basic Piping Materials and Methods" for additional information.

D. Elevated Floor Penetrations of Waterproof Membrane, Interior Penetrations of No-Fire Rated Walls and Concrete Slab on Grade Penetrations: Seal ducts that pass through waterproof floors, non-fire rated walls, partitions and ceilings or concrete slab on grade. Refer to Division 23 Section "Basic Mechanical Materials and Methods" for special sealers and materials.

3.11 CONNECTIONS

A. Equipment Connections: Connect equipment with flexible connectors in accordance with Division 23 Section "Air Duct Accessories."

B. Branch Connections: Comply with SMACNA "HVAC Duct Construction Standards," 2005 Edition, Figures 4-5 and 4-6.

C. Outlet and Inlet Connections: Comply with SMACNA "HVAC Duct Construction Standards," 2005 Edition, Figures 7-6 and 7-7. Where a 90-degree elbow is required at the connection to air devices, provide a rigid duct elbow or, at Contractor's option, a flexible elbow assembly as specified in Division 23 Section "Air Duct Accessories."

D. Fan Connections: Comply with SMACNA "HVAC Duct Construction Standards," 2005 Edition, Figure 7-8.

3.12 LEAKAGE TESTING BY CONTRACTOR

A. Grease Duct Leakage Test: All portions of grease duct systems shall be tested for leakage in accordance with Chapter 5, Section 506 of the locally adopted IMC. Leakage tests shall be by light or other equivalent test methods as approved by the local code official to verify that all joints are liquid tight. Tests shall be performed in the presence of the local code official. Any joints found defective shall be repaired and retested until satisfactory results are obtained. The contractor shall submit a copy of the grease duct leakage test report to the Architect and Engineer complete with the approval signature of the local code official.

3.13 FIELD QUALITY CONTROL

A. Remove temporary protection devices over ductwork prior to starting equipment and turning the system over to the owner.

B. If permanent HVAC equipment is used during the construction period, provide temporary filters at all openings in the ductwork and at inside equipment to protect the system from dust, dirt, paint, and moisture. Replace and maintain filters when needed, but not less than every month. On the day of substantial completion, clean the duct system and provide a new set of filters in the HVAC unit.

1. Refer to Division 23 Section 234100 Particulate Air Filtration for filter requirements.

3.14 CLEANING NEW SYSTEMS

A. Contractor shall clean the HVAC systems in accordance with NADCA if ductwork is not protected at each end (whether installed or in storage) with airtight, protective covering.

B. Mark position of dampers and air-directional mechanical devices before cleaning, and perform cleaning before air balancing.

C. Use service openings, as required, for physical and mechanical entry and for inspection.

1. Create other openings to comply with duct standards.

2. Disconnect flexible ducts as needed for cleaning and inspection.

3. Remove and reinstall ceiling sections to gain access during the cleaning process.

D. Vent vacuuming system to the outside. Provide filtration and/or containment systems to keep debris removed from HVAC systems from contaminating other spaces. Locate exhaust down wind and away from air intakes and other points of entry into building.

E. Clean the following metal duct systems by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).

2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.

3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.

4. Coils and related components.

5. Return air ducts, dampers, and actuators except in ceiling plenums and mechanical equipment rooms.

6. Supply and outdoor air ducts, dampers, actuators, and turning vanes.

F. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.

2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.

3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.

4. Clean fibrous-glass duct liner with HEPA vacuuming equipment while the system is under negative pressure; do not permit duct liner to get wet.

5. Clean coils and coil drain pans according to ACR 2002. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.

G. Disposal: Debris collected from the HVAC system shall be disposed of in accordance with applicable federal, state and local requirements.

H. Cleanliness Verification:

1. Visually inspect metal ducts for contaminants.

2. Where contaminants are discovered, re-clean and re-inspect ducts.

END OF SECTION

SECTION 233300 - AIR DUCT ACCESSORIES

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. Extent of ductwork accessories work is indicated on drawings and in schedules, and by requirements of this Section.

B. Types of ductwork accessories required for project include the following:

1. Dampers.
    a. Low pressure manual dampers.
    b. Counterbalanced backdraft dampers.
2. Cable operated damper systems.
3. Fire and smoke dampers.
4. Ceiling radiation dampers.
5. Smoke Detectors
6. Turning vanes.
7. Duct hardware.
8. Duct access doors.
9. Flexible ductwork.
10. Flexible elbow assembly.
11. Metal duct connectors.
12. Flexible duct connectors.
13. Grease exhaust duct wrap.
14. Duct wrap for rated shaft enclosure protection.
15. Duct silencers.

C. Refer to other Division 23 Sections for testing, adjusting, and balancing of ductwork accessories; not work of this Section.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of ductwork accessories, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 3 years.

B. Codes and Standards:

1. SMACNA Compliance: Comply with applicable portions of SMACNA "HVAC Duct Construction Standards, Metal and Flexible", 2005 Edition.

2. Industry Standards: Comply with ASHRAE recommendations pertaining to construction of ductwork accessories, except as otherwise indicated.

3. UL Compliance:

a. Construct, test, and label fire dampers in accordance with current edition of UL Standard 555 "Fire Dampers". Construct, test, and label smoke dampers in accordance with current edition of UL Standard 555S "Smoke Dampers".

b. Construct flexible ductwork in compliance with UL Standard 181 "Factory-Made Air Ducts and Connections".

c. Duct tape shall be labeled in accordance with UL Standard 181B and marked 181B-FX.

d. Duct clamps shall be labeled in accordance with UL Standard 181B and marked 181B-C.

e. Grease exhaust duct wrap shall meet the fire protection requirements defined by UL Standard 1479 "Fire Tests of Through-Penetration Firestops.".

f. Fire rated duct wrap shall meet the fire protection requirements defined by UL Standard 1479 "Fire Tests of Through-Penetration Firestops.".

4. NFPA Compliance:

a. Comply with applicable provisions of NFPA 90A "Air Conditioning and Ventilating Systems", pertaining to installation of ductwork accessories. Comply with NFPA 90B "Standard for the Installation of Warm Air Heating and Air-Conditioning Systems.

b. Comply with NFPA 96 "Ventilation Control and Fire Protection of Commercial Cooking Operations" for fire-rated grease exhaust ducts.

5. ASTM Compliance: Products shall have flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84 "Surface Burning Characteristics" (NFPA 255) method.

a. Duct silencers shall be tested for performance in accordance with ASTM E477 "Test Method for Measuring Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers."

b. Grease exhaust duct wrap shall be tested for performance in accordance with ASTM E 2336 "Standard Test Methods for Fire Resistive Grease Duct Enclosure Systems" and

ASTM E814 "Standard Test Methods of Fire Resistance of Through-Penetration Fire Stops".

c. Fire rated duct wrap shall be tested in accordance with ASTM E814 "Standard Test Methods of Fire Resistance of Through-Penetration Fire Stops".

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data for each type of ductwork accessory including dimensions, capacities and materials of construction; and installation instructions. Submit performance data for duct silencers including insertion loss performance in octave bands from 63 Hz to 8,000 Hz and pressure drop at specified airflow.

B. Shop Drawings: Submit manufacturer's assembly-type shop drawings for each type of ductwork accessory showing interfacing requirements with ductwork, method of fastening or support, and methods of assembly of components.

C. Maintenance Data: Submit manufacturer's maintenance data including parts lists for each type of duct accessory. Include this data, product data, and shop drawings in maintenance manual; in accordance with requirements of Division 1.

1.4 SPARE PARTS

A. Furnish extra fusible links to Owner, one link for every 10 installed of each temperature range; obtain receipt.

PART 2 - PRODUCTS AND MATERIALS

2.1 DAMPERS

A. Low Pressure Manual Dampers: Provide dampers of single blade type or multi-blade type, constructed in accordance with SMACNA "HVAC Duct Construction Standards".

1. Material: Galvanized steel for standard air systems, aluminum for wet or natatorium environments and stainless steel for corrosive environments.

2. Construction: Bearings shall be corrosion resistant, molded synthetic and axles shall positively lock into the damper blade. Extended shafts and standoff bracket for insulation clearance shall be metal material. Provide with locking quadrant.

3. Blade Seals: Where dampers are used for shutoff duty, provide Neoprene seals for round dampers and silicone for rectangular dampers.

4. Dampers shall be Greenheck Model MBD Series, or approved equal.

B. Control Dampers: Refer to Division 23 section Instrumentation and Control Devices for HVAC for control dampers; not work of this section.

C. Counterbalanced Backdraft Dampers: Provide dampers with parallel blades, counterbalanced and factory-set to open at indicated static pressure. Construct frames and blades of minimum 16-ga aluminum. Provide minimum 1/2" diameter, corrosion-resistant bearings and 1/2" diameter, galvanized or stainless steel axles. Blade edge seals shall be mechanically locked into blade edge. Blade seals shall be neoprene for round dampers. Blade seals shall be silicone or vinyl for rectangular dampers.

D. Manufacturer: Subject to compliance with requirements, provide dampers of one of the following:

1. Air Balance, Inc.
2. Arrow United Industries.
3. Cesco
4. Greenheck
5. Louvers & Dampers, Inc.
6. Nailor Industries, Inc.
7. Pottorff
8. Ruskin Mfg. Co.
9. TAMCO
10. Vent Products

2.2 CABLE OPERATED DAMPER SYSTEMS

A. General: Where access to dampers through a hard ceiling is required, provide a concealed, cable operated volume damper with remote operator.

1. Damper shall be adjustable through the diffuser face or frame with standard 1/4" nutdriver or flat screwdriver.
2. Cable assembly shall attach to damper as one piece with no linkage adjustment.
3. Positive, direct, two-way damper control shall be provided with no sleeves, springs or screw adjustments to come loose after installation.
4. Provide cable length as required to span the distance from the damper to the remote operator location.
5. Support cable assembly to avoid bends and kinks in cable.

B. Where approved by Architect, a ceiling cup with cover plate can be used for access to cable operator.

C. Manufacturer: Subject to compliance with requirements, provide cable operated damper systems of one of the following:

1. Metropolitan Air Technology, Inc. (Reference model is RT-250 for round ducts, RT-200 for rectangular ducts, with RT-WGA operator).

2. Young Regulator Co. (Reference model is 5020-1200 for round ducts, 820-1200 for rectangular ducts, with RT-270-275 operator).

2.3 FIRE AND SMOKE DAMPERS

A. General: Provide fire, smoke, and fire/smoke dampers at locations indicated on the drawings. Damper ratings shall be as required to maintain the fire and/or smoke ratings noted on the architectural drawings. Provide duct access door for inspection and service to each fire, smoke, and fire/smoke damper and fusible link as required. Provide sleeves of length as required to meet the installed location. Damper assemblies shall be provided as a single unit from the manufacturer.

B. Fire Dampers: Comply with UL 555. Construct casings of minimum 22-ga galvanized steel or as required to maintain applicable UL classification. Construct casings of 20 gauge stainless steel where installed in corrosive or moisture laden airstreams or where noted on the drawings. Fire dampers shall be dynamic-rated for closure under pressure. Provide fusible link rated at 160 to 165 degrees F unless otherwise indicated. Provide damper with positive lock in closed position and with the following additional features:

1. Damper Blade Assembly: Curtain type with blades out of the airstream.

2. Blade Material: Match casing material.

3. Open-closed indication switch.

C. Fire/Smoke Dampers: Provide fire/smoke dampers, of types and sizes indicated, and with actuator as specified herein.

1. Dampers: Dampers shall be UL555 (current edition) classified fire damper of rating required for location installed, UL555S (current edition) classified smoke damper for leakage class II and rated for dual directional airflow. Fire/smoke dampers shall be rated for closure in ducts up to minimum velocity of 2,000 fpm and static pressure of 4" w.g. Construct casings of 16-ga galvanized steel. Construct casings of 16 gauge stainless steel where installed in corrosive or moisture laden airstreams or where noted on the drawings. Construct blades of minimum 22 gauge thickness with airfoil or longitudinal grooved shape for airflow velocities up to 2,000 fpm and airfoil shape for airflow velocities greater than 2,000 fpm. Bearings shall be self-lubricating, turning in extruded hole in the frame. Jamb seals shall be flexible, stainless steel. Blade edge seals shall be silicone rubber and galvanized steel mechanically locked in to the blade edge. Linkage shall be concealed in the frame. Provide resettable temperature device rated at 160 to 165 degrees F (71 to 74 degrees C) unless otherwise indicated. Provide stainless steel spring loaded leakage seals in sides of casing, and 36" long wire leads for connecting smoke link to smoke detectorand the following additional features:

a. Damper Blade Assembly: Single-blade type.

b. \

c. Blade Material: Match casing material.

2. Motor-Driven Actuators: Comply with UL 555S. Actuators shall be factory installed. All actuators shall open in 15 seconds or less and close in 15 seconds or less after alarm or smoke detection has occurred. Actuators shall be rated for a minimum of 20,000 cycles of operation. Provide motor-driven fire/smoke dampers in types and sizes indicated, with 120 Volt, two-position, fail close, electric motor designed to close and/or open damper between 7 and 15 seconds, motor mounting bracket, and with the following construction features:

    a. Unit Assembly: Motor mounted outside air stream.

    b. Motor shall be designed for power return open/spring closed operation.

    c. Provide automatic reset of damper upon cessation of detector (test or actual smoke detection), and normalization of duct air temperature.

    d. Provide with integral end switch.

D. Smoke Dampers: Provide Smoke dampers, of types and sizes indicated, and with actuator as specified herein.

1. Dampers: Dampers shall be UL555S (current edition) classified smoke damper for leakage class II and rated for dual directional airflow. Smoke dampers shall be rated for a minimum velocity of 2,000 fpm and pressure of 4" w.g. Construct casings of 16-ga galvanized steel. Construct casings of 16 gauge stainless steel where installed in corrosive or moisture laden airstreams or where noted on the drawings. Construct blades of minimum 22 gauge thickness with airfoil or longitudinal grooved shape for airflow velocities up to 2,000 fpm and airfoil shape for airflow velocities greater than 2,000 fpm. Bearings shall be self-lubricating, turning in extruded hole in the frame. Jamb seals shall be flexible, stainless steel. Blade edge seals shall be silicone rubber mechanically locked in to the blade edge. Linkage shall be concealed in the frame. Provide stainless steel spring loaded leakage seals in sides of casing, and terminal block for connection to the building fire alarm systemand the following additional features:

    a. Damper Blade Assembly: Single-blade type.

    b. Damper Blade Assembly: Multi-blade type.

    c. Blade Material: Match casing material.

    d. Open closed indication switches.

    e. Test switch.

2. Motor-Driven Actuators: Actuators shall be factory installed. Comply with UL 555S Provide motor-driven smoke dampers in types and sizes indicated, with 120 Volt, two-position, fail close, 24 Vac, two position, fail close, 24 Vac, modulating, electric motor designed to close and/or open damper between 7 and 15 seconds, motor mounting bracket, and with the following construction features:

    a. Unit Assembly: Motor mounted outside air stream.

    b. Motor shall be designed for power return open/spring closed operation.

c. Provide automatic reset of damper upon cessation of detector (test or actual smoke detection), and normalization of duct air temperature.

d. Provide with integral end switch.

E. Manufacturer: Subject to compliance with requirements, provide fire and smoke dampers of one of the following:

1. Air Balance, Inc.

2. Cesco Products.

3. Greenheck

4. Louvers & Dampers, Inc.

5. Nailor Industries, Inc.

6. Pottorff

7. Prefco Products, Inc.

8. Ruskin Mfg. Co.

2.4 SMOKE DETECTORS

A. Manufacturers:

1. Notifier.

2. SimplexGrinnell.

3. Siemens-Cerberus Division.

4. Kidde/Edwards.

5. Gamewell-FCI.

6. Fike.

7. Silent Knight.

B. Duct Smoke Detectors: Photoelectric type complying with UL 268A with a standard, relay or isolator detector mounting base. Provide manufacturer's standard housing to protect the measuring chamber from damage and insects. Provide drilling templates and gaskets to facilitate locating and mounting the housing.

1. Provide for variations in duct air velocity between 100 and 4,000 feet per minute.

2. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied. Provide an air exhaust tube and an air sampling inlet tube that extends into the duct air stream up to ten feet.

3. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.

4. Relay Fan Shutdown: Fully programmable relay rated to interrupt fan motor control circuit.

5. Contacts: Include low voltage supervisory and alarm contacts.

2.5 TURNING VANES

A. Manufactured Turning Vanes: Provide turning vanes and runners fabricated from galvanized sheet metal, lock-forming quality, ASTM A 653, minimum Coating Designation G 60, of the same gauge thickness or greater as the ductwork in which they are installed. Vanes shall be rigidly fastened with guide strips to minimize noise and vibration. Vanes in ductwork over 30" deep shall be installed in multiple sections with vanes not over 30" long and shall be rigidly fastened. Turning vanes shall be constructed per SMACNA Duct Construction Standards Metal and Flexible – 2005 Edition, Figure 4-3 and set into side strips suitable for mounting in ductwork.

B. Acoustical Turning Vanes: Provide acoustical turning vanes constructed of airfoil shaped aluminum extrusion with perforated faces and fiberglass fill in systems serving noise critical spaces. Refer to Section "Common Work Results for HVAC".

C. Manufacturer: Subject to compliance with requirements, provide turning vanes of one of the following:

1. Aero Dyne Co.

2. Anemostat Products Div.; Dynamics Corp. of America.

3. Ductmate Industries.

4. Duro Dyne Corp.

5. Elgen Manufacturing Co., Inc.

6. Hart & Cooley Mfg. Co.

7. Register & Grille Mfg. Co., Inc.

8. Sheet Metal Connectors, Inc.

2.6 DUCT HARDWARE

A. General: Provide duct hardware, manufactured by one manufacturer for all items on project, for the following:

1. Test Holes: Provide in ductwork at fan inlet and outlet, and elsewhere as indicated, duct test holes, consisting of slot and cover, for instrument tests.

2. Quadrant Locks: Provide for each damper, quadrant lock device on one end of shaft; and end bearing plate on other end for damper lengths over 12". Provide extended quadrant locks and end extended bearing plates for externally insulated ductwork.

B. Manufacturer: Subject to compliance with requirements, provide duct hardware of one of the following:

1. Ductmate Industries.

2. Elgen Manufacturing Co., Inc.

3. Ventfabrics, Inc.

4. Young Regulator Co.

2.7 DUCT ACCESS DOORS

A. General: Provide, where indicated on the drawings or where specified in Part 3 of this section, duct access doors of size allowable by duct dimensions with, unless otherwise noted on the drawings, minimum size of 10" by 10" and maximum size of 24" by 24". Provide removable section of duct where duct size is too small for a 10" by 10" access door. Construct access doors in accordance with SMACNA "HVAC Duct Construction Standards – Metal and Flexible" and as specified herein. Label access doors for fire and smoke dampers as specified in Paragraph "Installation of Ductwork Accessories.

B. Construction: Construct of same or greater gage as ductwork served, provide insulated doors for insulated ductwork. Provide flush frames for uninsulated ductwork, extended frames for externally insulated duct. Provide one size hinged, other side with one handle-type latch for doors 12" high and smaller, 2 handle-type latches for larger doors.

C. Manufacturer: Subject to compliance with requirements, provide duct access doors of one of the following:

1. Air Balance Inc.

2. Ductmate Industries.

3. Duro Dyne Corp.

4. Greenheck.

5. Register & Grille Mfg. Co., Inc.

6. Ruskin Mfg. Co.

7. Ventifabrics, Inc.

8. Vent Products.

9. Zurn Industries, Inc.; Air Systems Div.

2.8 FLEXIBLE DUCT.

A. Construction: Provide flexible ductwork conforming to UL 181-Class I, NFPA 90A and NFPA 90B and as follows. Duct types of manufacturers are indicated for reference in regards to required quality of construction and materials. Flexible duct shall have fire retardant polyethylene or reinforced metalized protective vapor barrier as follows:

1. Low pressure (duct pressure class up to and including 2" w.g.) and medium pressure (duct pressure class greater than 2" up to and including 6" w.g.)

a. Fire retardant polyethylene vapor barrier

1) ATCO 80 Series

2) Flexmaster Type 5B

3) JPL Type PR Series

4) Thermaflex Type G-KM

b. Reinforced metalized vapor barrier

1) ATCO 30 Series

2) Flexmaster Type 5M

3) JPL Type MHP Series

4) Thermaflex Type M-KE

2. High pressure (duct pressure class over 6" w.g.)

a. Fire retardant polyethylene vapor barrier

1) Flexmaster Type 3B

b. Reinforced metalized vapor barrier

1) Flexmaster Type 3M

2) Thermaflex Type M-KC

3. Flexible ductwork shall have CPE liner with steel wire helix mechanically locked or permanently bonded to the liner.

4. Provide acoustical, fiberglass insulated duct with minimum R-value of R-6.0.

B. Manufacturer: Subject to compliance with requirements, provide flexible ductwork of one of the following:

1. ATCO Rubber Products.

2. Flexmaster.

3. JPL (J.P. Lamborn Co)

4. Thermaflex.

2.9 FLEXIBLE ELBOW ASSEMBLY

A. General: At Contractors option, in lieu of rigid sheet metal elbows at connections to air inlets and outlets in concealed spaces, provide flexible elbow assembly to air devices requiring a 90 degree elbow connection.

B. Flexible elbow assembly shall be constructed of durable composite material and UL listed for use in return air plenums with a turning radius of not less than 3 inches.

C. Flexible elbow assembly shall be FlexFlow Elbow as manufactured by Flexible Technologies, Inc., FlexRight Elbow as manufactured by Build Right Products or approved equal.

2.10 METAL DUCT CONNECTORS

A. Description: Factory-fabricated, slide-on transverse flange connectors, corners, cleats, gaskets, and components. Material, gauge, and shape shall match the connecting ductwork.

B. Manufacturers: Subject to compliance with requirements, provide duct connectors by one of the following or approved equal:

1. Ductmate Industries.

2. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

2.11 FLEXIBLE DUCT CONNECTORS

A. Fabric Material: Flame-retardant or noncombustible fabrics compliant with NFPA 701.

1. Metal-Edged Connectors: Factory fabricated with a fabric strip minimum 3-1/2 inches wide attached to two strips of minimum 24 gauge galvanized sheet steel or 0.032-inch- thick aluminum sheets. Provide metal compatible with connected ducts.

2. Indoor System, Flexible Connector Fabric: Glass fabric coated with neoprene.

a. Minimum Weight: 26 oz./sq. yd.

b. Minimum Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.

c. Service Temperature: Minus 40 to plus 200 deg F.

3. Outdoor System, Flexible Connector Fabric: Glass fabric coated with weatherproof, synthetic rubber resistant to UV rays and ozone.

a. Minimum Weight: 24 oz./sq. yd.

b. Minimum Tensile Strength: 225 lbf/inch in the warp and 300 lbf/inch in the filling.

c. Service Temperature: Minus 40 to plus 250 deg F.

B. Coatings and Adhesives: Comply with UL 181, Class 1.

C. Flexible connectors shall have flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E 84 (NFPA 255) method.

D. Manufacturer: Subject to compliance with requirements, provide flexible connections of one of the following:

1. Ductmate Industries.

2. Duro Dyne Corp.

3. Elgen Manufacturing Co., Inc.

4. Ventfabrics, Inc.

2.12 FIRE RATED DUCT WRAP

A. Grease Exhaust Ducts: Provide minimum two-hour rated duct wrap insulation for Type I hood grease exhaust duct applications. Insulation shall be two layers of 1-1/2 inch thick, minimum 6 lb. per cubic foot density, flexible wrap enclosure rated for minimum 2000 F and for zero clearance to combustibles. Insulation shall be non-mineral wool, passive, low biopersistant fiber totally encapsulated on all sides with aluminum foil reinforced with scrim. Fire-rated grease duct wrap material and installation shall be UL Listed in accordance with ASTM E2336. For ducts smaller than 24" by 24" in size, provide stainless steel bands at insulation seams and on maximum 12 inch centers to hold the outer layer of the blanket enclosure in place. For ducts larger than 24" by 24" in size, provide pins to hold the outer layer in place. Joints at insulation seams, banding, pins, and fire stop systems shall be installed as per manufacturers UL Listing and manufacturers published installation instructions. Insulation shall be tested for intended use in accordance with all applicable codes and shall be approved by the local code official. Provide factory built access doors by same manufacturer as fabricated for use specifically with the insulation system. Reference manufacturer and model number is Unifrax FyreWrap Elite 1.5.

B. Dryer Vent Exhaust Ducts in Plenums: Provide one-hour rated duct wrap insulation specifically designed as a means to separate dryer vent exhaust ducts from an air plenum by preventing flame propagation and smoke development in the plenum area. This system may be used as an alternative to a gypsum enclosure where allowed by the AHJ. Insulation shall be 1-1/2 inch thick, minimum 6 lb. per cubic foot density, flexible wrap enclosure rated for minimum 2000 F and for zero clearance to combustibles. Insulation shall be non-mineral wool, passive, low biopersistant fiber totally encapsulated on all sides with aluminum foil reinforced with scrim. Fire-rated duct wrap material and installation shall be UL Listed in accordance with ISO 6944 and UL 1479, and as acceptable to the Authority Having Jurisdiction. Reference manufacturer and model number is Unifrax FyreWrap DPS.

C. General for HVAC Ducts: Provide duct wrap insulation for HVAC ducts required to be in rated enclosure construction where dampers are restricted. Provide one, two or three hour-rating as required for the installation. Insulation shall be 1-1/2 inch thick, minimum 6 lb. per cubic foot density, flexible

wrap enclosure rated for minimum 2000 F and for zero clearance to combustibles, and applied in one or more layers to achieve the hourly rating requirement. Insulation shall be non-mineral wool, passive, low biopersistant fiber totally encapsulated on all sides with aluminum foil reinforced with scrim. Fire-rated duct wrap material and installation shall be UL Listed in accordance with ISO 6944 and UL 1479, and as acceptable to the Authority Having Jurisdiction. Reference Manufacturer and Model Number is Unifrax FyreWrap Elite 1.5.

D. Access Doors: Duct access door to be tested and listed in accordance with UL1978, with liquid tight and minimum 1500F rated gaskets. Duct access to be provided with 2-hour and zero clearance insulation cover tested and UL Listed per ASTM E2336 by same manufacturer and as fabricated for use specifically with the insulation system. FastDoor XL FlameGard, Ultimate or equivalent.

E. Manufacturer: Subject to compliance with requirements, provide fire rated duct wrap of one of the following:

1. 3M.

2. Pyroscat

3. Thermal Ceramics

4. Unifrax Corporation

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which ductwork accessories will be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF DUCTWORK ACCESSORIES

A. Install ductwork accessories in accordance with manufacturer's installation instructions, with applicable portions of details of construction as shown in SMACNA standards, and in accordance with recognized industry practices to ensure that products serve intended function.

B. Provide balancing dampers at branch takeoffs from main ducts. Unless otherwise noted on drawings, provide prefabricated 45 degree, high efficiency, rectangular/round branch duct takeoff fittings with manual balancing damper and locking quadrant for branch duct connections and take-offs to individual diffusers, registers and grilles.

C. Coordinate all smoke and fire/smoke damper installation, wiring, and checkout to ensure that the dampers function properly and that they respond to the proper fire alarm system signal.

D. Install ceiling radiation dampers per manufacturer's instructions. Support damper assembly from structure.

E. Smoke Detectors: Provide detectors as shown on drawings.

1. Comply with the "Smoke-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for smoke detector spacing.

2. Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a lighting fixture and not directly above pendant mounted or indirect lighting.

3. Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover.

4. Coordinate with Division 26 for power wiring and interlocks.

F. Duct Smoke Detectors: Comply with NFPA 72, and NFPA 90A where adopted by the local AHJ. Install sampling tubes so they extend the full width of the duct. Tubes more than 36 inches long shall be supported at both ends.

1. Do not install smoke detector in duct smoke detector housing during construction. Install detector only during system testing and prior to system turnover.

2. Air handling units with smoke detection that serve fan-powered terminal units:

a. Provide duct detection and shutdown fan-powered terminal units that are less than 2,000 cfm when the respective air handling unit shuts down.

b. Provide individual duct detection and shutdown for each fan-powered terminal unit exceeding 2,000 cfm.

3. Provide duct detection and shutdown for air distribution systems exceeding 2,000 cfm.

G. Provide turning vanes, of same gauge as ductwork, rigidly fastened with guide strips in ductwork having an offset of 45 degrees or more. Vanes shall be provided in all supply and exhaust ductwork and in return and outside air ductwork that has an air velocity exceeding 1000 fpm. Do not install vanes in grease ductwork.

H. Provide duct access doors to maintain and/or clean components internal to ductwork including, but not limited to, coils, airflow stations, motorized and backdraft dampers, humidifiers, etc, and equipment at the following locations: Install access doors to open against system air pressure, with latches operable from either side, except outside only where duct is too small for person to enter.

I. Provide duct access door(s) as scheduled below, at each fire and smoke damper within 12 inches of the device to allow for testing and maintenance. Label each door (with minimum 1" lettering) indicating which damper type is served. Door should be capable of being fully opened or provide removable door.

DUCT ACCESS DOOR SCHEDULE

Duct Width/Depth	Door Size	Quantity
10" TO 12"	10 X 10	1
14" TO 18"	12 X 12	1
20" TO 36"	14 X 14	1
38" TO 54"	18 X 18	1
56" TO 72"	18 X 18	2 (1 EACH END)
74" TO 96"	20 X 20	2 (1 EACH END)

J. Install flexible duct in accordance with manufacturer's instructions. At a minimum, install two wraps of duct tape around the inner core connection and a metallic or non-metallic clamp over the tape and two wraps of duct tape or a clamp over the outer jacket.

1. Flexible duct runs shall not exceed 5 feet in length. Utilize the minimum length of duct to make the connections.

2. Flexible ductwork shall be installed straight as possible avoiding tight turns with a maximum of one 90 degree bend in any length. Install flexible duct fully extended minimizing compression.

3. Provide continuous length with no intermediate joints.

4. Support flexible duct from structure and not from ceiling tile, light fixtures or air terminals. Support for maximum sag of 1/2-inch per foot.

5. Avoid incidental contact with metal fixtures, water lines, pipes, or conduit.

6. Support straps/saddles shall be minimum 1-1/4" wide. Use of wire hanging systems shall utilize strap and connect wire to strap.

    a. Factory installed suspension systems are acceptable

7. Ductwork shall not be crimped against joist or truss members, pipes, conduits, etc.

8. The bend radius at the center line shall be equal to or greater than one duct diameter.

    a. Support bends approximately one duct diameter on both sides of bends.

9. Connections to ductwork and air devices shall have at least 1" overlap.

K. Provide rigid duct elbow or flexible elbow assembly where a 90 degree elbow is required at connection to air devices.

L. Provide flexible duct connections wherever ductwork connects to vibrating equipment and when transitioning between two different metallic duct materials (e.g., aluminum to galvanized steel). Construct flexible connections of fabric crimped into duct flanges for attachment to duct and equipment. Make airtight joint. Provide adequate joint flexibility to allow for thermal, axial, transverse, and torsional movement, and also capable of absorbing vibration of connected equipment.

M. Install grease exhaust and fire rated duct wrap in accordance with manufacturer's instructions to provide the fire rating of the material as tested per UL requirements. Overlap seams, install stainless steel bands and/or pins to secure wrap to duct and fill annular spaces in floor and wall penetrations with UL rated forming materials and/or putty to maintain the integrity of the system.

N. Install duct silencers at locations indicated on the drawings with straight sections of upstream and downstream ductwork as recommended by the manufacturer.

O. Coordinate with other work, including ductwork, as necessary to interface installation of ductwork accessories properly with other work.

3.3 FIELD QUALITY CONTROL

A. Operate installed ductwork accessories to demonstrate compliance with requirements. Test for air leakage while system is operating. Repair or replace faulty accessories, as required to obtain proper operation and leakproof performance.

3.4 ADJUSTING AND CLEANING

A. Adjusting: Adjust ductwork accessories for proper settings, install fusible links in fire dampers and adjust for proper action.

B. Label access doors in accordance with Division-23 section "Identification for HVAC Piping and Equipment".

C. Final positioning of manual dampers is specified in Division-23 section "Testing, Adjusting, and Balancing for HVAC".

D. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION

SECTION 233416 - CENTRIFUGAL HVAC FANS

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section includes the following types of centrifugal fans:

1. Centrifugal fans for indoor installations
2. Tubular centrifugal fans
3. Inline centrifugal fans
4. Plenum fans
5. Utility set fans

1.2 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections:

1. Product data for selected models, including specialties, accessories, and the following:
    a. Certified fan performance curves with system operating conditions indicated.
    b. Certified fan sound power ratings.
    c. Motor ratings and electrical characteristics plus motor and fan accessories. For fans with factory-furnished starters or variable frequency drives, include short circuit current ratings.
    d. Materials gages and finishes, including color charts.
    e. Dampers, including housings, linkages, and operators.
2. Shop drawings from manufacturer detailing equipment assemblies and indicating dimensions, weights, required clearances, components, and location and size of field connections.
3. Wiring diagrams that detail power, signal, and control wiring. Differentiate between manufacturer-installed wiring and field-installed wiring.
4. Product certificates, signed by manufacturers of centrifugal fans, certifying that their products comply with specified requirements.
5. Maintenance data for air-handling units, for inclusion in Operating and Maintenance Manual specified in Division 1 and Division 23 Section "General Mechanical Requirements."

1.3 QUALITY ASSURANCE

A. AMCA Compliance: Provide products that meet performance requirements and are licensed to use the AMCA Seal.

B. UL Compliance: Fans and components shall be UL listed and labeled.

C. Nationally Recognized Testing Laboratory and NEMA Compliance (NRTL): Fans and components shall be NRTL listed and labeled. The term "NRTL" shall be as defined in OSHA Regulation 1910.7.

D. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

E. Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code."

F. UL 705 – Standard for Power Ventilators, Underwriter's Laboratory, most current edition.

1.4 SEQUENCING AND SCHEDULING

A. Coordinate the size and location of concrete equipment pads. Cast anchor bolt inserts into pad.

B. Coordinate the size and location of structural steel support members.

1.5 SPARE PARTS

A. Furnish one additional complete set of belts for each belt-driven fan.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

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

1. Centrifugal Fans:

a. Acme Engrg. & Mfg. Corp.

b. Barry Blower

c. Bayley Fan Group.

d. Chicago Blower Corp.

e. Cook (Loren) Co.

f. Greenheck Fan Corp.

g. Hartzell Fan, Inc.

h. RuppAir Management Systems

i. Trane Co.

j. Twin City Fan Company

2. Inline Centrifugal Fans:

a. Acme Engrg. & Mfg. Corp.

b. Barry Blower

c. Carnes Company, Inc.

d. Cook (Loren) Co.

e. Greenheck Fan Corp.

f. PennBarry.

g. RuppAir Management Systems.

h. Twin City Fan Company

3. Utility Sets:

a. Accurex.

b. Acme Engrg. & Mfg. Corp.

c. Barry Blower

d. Bayley Fan Group.

e. Carnes Company, Inc.

f. Chicago Blower Corp.

g. Cook (Loren) Co.

h. Greenheck Fan Corp.

i. Hartzell Fan, Inc.

j. RuppAir Management Systems

k. Trane Co.

l. Twin City Fan Company

2.2 SOURCE QUALITY CONTROL

A. Testing Requirements: The following factory tests are required:

1. Sound Power Level Ratings: Comply with AMCA Standard 301 "Method for Calculating Fan Sound Ratings From Laboratory Test Data." Test fans in accordance with AMCA Standard 300 "Test Code for Sound Rating." Fans shall be licensed to bear the AMCA Certified Sound Ratings Seal.

2. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings in accordance with AMCA Standard 210/ASHRAE Standard 51 - Laboratory Methods of Testing Fans for Rating.

2.3 FANS, GENERAL

A. General: Provide fans that are factory fabricated and assembled, factory tested, and factory finished, with indicated capacities and characteristics.

B. Fans and Shafts: Statically and dynamically balanced and designed for continuous operation at the maximum rated fan speed and motor horsepower.

1. Fan Shaft: Turned, ground, and polished steel, designed to operate at no more than 70 percent of the first critical speed at the top of the speed range of the fan's class.

C. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.

1. Service Factor: 1.4.

D. Belts: Oil-resistant, nonsparking, and nonstatic.

1. Fans used for smoke control applications shall have 1.5 times the number of belts required for the design duty with a minimum of two belts.

E. Motors: Refer to Section "Common Motor Requirements for HVAC Equipment" for requirements.

F. Motors and Fan Wheel Pulleys: Adjustable pitch for use with motors through 15 HP; fixed pitch for use with motors larger than 15 HP. Select pulley so that pitch adjustment is at the middle of the adjustment range at fan design conditions.

1. Belt Guards: Provide steel belt guards for motors mounted on the outside of the fan cabinet.

G. Shaft Bearings: Provide type indicated, having a median life "Rating Life" (AFBMA L(50)) of 200,000, calculated in accordance with AFBMA Standard 9 for ball bearings and AFBMA Standard 11 for roller bearings.

H. Hazardous Duty: Provide fans with spark resistant construction and explosion proof motor where specified in the schedule.

I. Factory Finish: The following finishes are required:

1. Sheet Metal Parts: Prime coating prior to final assembly.

2. Exterior Surfaces: Baked-enamel finish coat after assembly.

2.4 CENTRIFUGAL FANS

A. General Description: Belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and support structure.

B. Housings: Fabricated from formed and reinforced galvanized steel panels to form curved scroll housings with continuously welded or deep-locked seams and access doors or panels to allow access to internal parts and components.

1. Inlet Cones: Spun metal.

2. Duct Connections: Flanged.

3. Panel Bracing: Steel angle-or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.

C. Fan Wheels: Single-width, single-inlet, welded to cast-iron or cast-steel hub and spun steel inlet cone, with hub keyed to the shaft.

1. Blade Materials: Steel.

2. Blade Type: Backward-curved, flat-plate type.

3. Blade Type: Backward-curved, airfoil type.

4. Blade Type: Forward-curved, airfoil type.

D. Shaft Bearings: Grease-lubricated, self-aligning, pillow-block type; tapered roller bearings with double-locking collars and two-piece, cast-iron housing.

E. Accessories: Provide the following accessories where indicated:

1. Scroll Bypass Dampers: Aluminum, opposed, airfoil blades with extruded vinyl seals on blades, low-friction bearings, and positive control linkage for manual or automatic operation.

2. Scroll Housing Access Doors: Latch-type handles; flush-mounted for uninsulated housings and raised-mounted for insulated housings.

3. Inlet Vanes: Radial vanes with linkage for manual or automatic operation.

a. Double-Width Fans Inlet Vanes: Connected for single operator.

4. Inlet Screens: Heavy wire mesh screens, mounted inside of shaft bearings.

5. Discharge Dampers: Heavy-gage steel, opposed blade design, with linkage for manual or automatic operation.

6. Drain Connections: Threaded, 3/4-inch NPS, capped nipple installed at lowest point of housing.

7. Shaft Cooler: Metal disc between bearings and fan wheel, designed to dissipate heat from shaft.

8. Spark-Resistant Construction: AMCA construction option A, B, or C as indicated.

9. Shaft Seals: Air-tight seals installed around shaft on drive side of single-width fans.

2.5 INLINE CENTRIFUGAL FANS

A. General Description: Inline, belt-driven, centrifugal fans consisting of housing, wheel, outlet guide vanes, fan shaft, bearings, drive assembly, motor and disconnect switch, mounting brackets, and accessories.

B. Housing: Split, spun-aluminum housing, with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.

C. Direct-Drive Units: Motor encased in housing out of air stream, factory-wired to disconnect located on outside of fan housing.

D. Belt-Drive Units: Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.

E. Wheel: Aluminum, airfoil blades welded to aluminum hub.

F. Accessories: Provide the following accessories as indicated:

1. Volume Control Damper: Manual operated with quadrant lock, located in fan outlet.

2. Companion Flanges: For inlet and outlet duct connections.

3. Fan Guards: Expanded metal in removable frame.

4. Speed Control: Variable speed switch with on-off control and speed control for 100 to 50 percent of fan air delivery.

5. Motor sound attenuator.

2.6 UTILITY SET FANS

A. General Description: Belt-driven, centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and accessories.

B. Housings: Fabricated of heavy-gage steel with side sheets fastened to scroll sheets by means of welding or deep lock seam.

1. Inlet: Round duct collar.

2. Discharge: Slip-joint duct connection.

3. Housings Discharge Arrangement: Adjustable to 8 standard positions.

C. Fan Wheels: Single-width, single-inlet, welded to cast-iron or cast-steel hub and spun steel inlet cone, with hub keyed to the shaft.

1. Blade Materials: Steel

2. Blade Type: Backward-curved, die-formed.

3. Blade Type: Forward-curved, die-formed.

D. Shaft Bearings: Prelubricated and sealed, self-aligning, pillow-block-type ball bearings.

E. Accessories: Provide the following accessories where indicated:

1. Backdraft Dampers: Gravity-actuated with counterweight and interlocking aluminum blades and felt edges in steel frame installed on fan discharge.

2. Access Doors: Gasketed doors with latch-type handles.

3. Scroll Dampers: Single-blade damper installed at fan scroll top with adjustable linkage.

4. Spark-Resistant Construction: AMCA construction option A, B, or C as indicated.

5. Inlet Screens: Removable, heavy wire mesh.

6. Drain Connections: 3/4-inch, threaded coupling drain connection installed at lowest point of housing.

7. Weather Hoods: Weather-resistant with stamped vents over motor and drive compartment.

2.7 MOTORS

A. Torque Characteristics: Sufficient to accelerate the driven loads satisfactorily.

B. Motor Sizes: Minimum sizes and characteristics as indicated. If not indicated, large enough so that the driven load will not require the motor to operate in the service factor range.

C. Temperature Rating: 90 deg C maximum temperature rise at 40 deg C ambient for continuous duty at full load (Class B Insulation).

D. Service Factor: 1.15 for polyphase motors and 1.35 for single-phase motors. Provide permanent-split capacitor classification motors for shaft-mounted fans and capacitor start classification for belted fans.

E. Motor Construction: NEMA Standard MG 1, general purpose, continuous duty, Design B.

1. Bases: Adjustable.

2. Bearings: The following features are required:

a. Ball or roller bearings with inner and outer shaft seals.

b. Grease lubricated.

c. Designed to resist thrust loading where belt drives or other drives produce lateral or axial thrust in motor.

3. Enclosure Type: The following features are required:

a. Open drip-proof motors where satisfactorily housed or remotely located during operation.

b. Guarded drip-proof motors where exposed to contact by employees or building occupants.

4. Overload protection: Built-in, automatic reset, thermal overload protection.

5. Noise rating: Quiet.

6. Efficiency: Energy-efficient motors shall have a minimum efficiency as scheduled in accordance with IEEE Standard 112, Test Method B. If efficiency not specified, motors shall have a higher efficiency than "average standard industry motors" in accordance with IEEE Standard 112, Test Method B.

7. Nameplate: Indicate the full identification of manufacturer, ratings, characteristics, construction, and special features.

F. Starters, Electrical Devices, and Wiring: Starters, electrical devices and connections are specified in Division 26.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install fans level and plumb, in accordance with manufacturer's written instructions. Support units as described below, using the vibration control devices indicated. Vibration control devices are specified in Division 23 Section "Vibration Isolation for HVAC Piping and Equipment."

1. Support floor-mounted units on concrete equipment bases using neoprene pads. Secure units to anchor bolts installed in concrete equipment base.

2. Support floor-mounted units on concrete equipment bases using housed spring isolators. Secure units to anchor bolts installed in concrete equipment base.

3. Suspended Units: Suspend units from structural steel support frame using threaded steel rods and vibration isolation springs.

B. Arrange installation to provide access space around fans for service and maintenance.

3.2 EQUIPMENT BASES

A. Construct concrete equipment pads in accordance with Division 23 Section "Common Work Results for HVAC".

3.3 ADJUSTING, CLEANING, AND PROTECTING

A. Adjust damper linkages for proper damper operation.

B. Clean the entire unit including cabinet interiors just prior to substantial completion to remove foreign material and construction dirt and dust. Vacuum clean fan wheel and cabinet.

3.4 STARTUP

A. Final checks before start-up: Perform the following operations and checks before start-up:

1. Remove shipping, blocking, and bracing.

2. Verify fan assembly is secure on mountings and supporting devices and that connections for ductwork, and electrical are complete. Verify proper thermal overload protection is installed in motors, starters, and disconnects.

3. Perform cleaning and adjusting specified in this Section.

4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearings operations. Reconnect fan drive system, align belts, and install belt guards.

5. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.

6. Verify manual and automatic volume control and that fire and smoke dampers in connected ductwork systems are in the full-open position.

7. Disable automatic temperature control operators.

B. Starting procedures for fans:

1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated RPM.

a. Replace fan and motor pulleys as required to achieve design conditions.

b. Measure and record motor electrical values for voltage and amperage.

c. Shut unit down and reconnect automatic temperature control operators.

d. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for procedures for air-handling-system testing, adjusting, and balancing.

3.5 DEMONSTRATION

A. Demonstration Services: Train Owner's maintenance personnel on the following:

1. Procedures and schedules related to start-up and shutdown, troubleshooting, servicing, preventative maintenance, and how to obtain replacement parts.

2. Familiarization with contents of Operating and Maintenance Manuals specified in Division 1 Section "Closeout Procedures" and Division 23 Section "General Mechanical Requirements."

B. Schedule training with at least 7 days' advance notice.

END OF SECTION

SECTION 233423 - HVAC POWER VENTILATORS

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section includes the following types of power ventilators:

1. Roof-mounted exhausters
2. Ceiling-mounted ventilators

1.2 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections:

1. Product data for selected models, including specialties, accessories, and the following:
    a. Certified fan performance curves with system operating conditions indicated.
    b. Certified fan sound power ratings.
    c. Motor ratings and electrical characteristics plus motor and fan accessories. For fans with factory-furnished starters or variable frequency drives, include short circuit current ratings.
    d. Materials gages and finishes, including color charts.
    e. Dampers, including housings, linkages, and operators.
2. Shop drawings from manufacturer detailing equipment assemblies and indicating dimensions, weights, required clearances, components, and location and size of field connections.
3. Wiring diagrams that detail power, signal, and control wiring. Differentiate between manufacturer-installed wiring and field-installed wiring.
4. Maintenance data for power ventilators, for inclusion in Operating and Maintenance Manual specified in Division 1 and Division 23 Section "General Mechanical Requirements."

1.3 QUALITY ASSURANCE

A. AMCA Compliance: Provide products that meet performance requirements and are licensed to use the AMCA Seal.

B. UL Compliance: Fans and fan motors shall be designed, manufactured, and tested in accordance with UL 705 "Power Ventilators."

C. UL Compliance: Fans and components shall be UL listed and labeled.

D. Nationally Recognized Testing Laboratory and NEMA Compliance (NRTL): Fans and components shall be NRTL listed and labeled. The term "NRTL" shall be as defined in OSHA Regulation 1910.7.

E. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

F. Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code."

1.4 SEQUENCING AND SCHEDULING

A. Coordinate the size and location of structural steel support members.

1.5 SPARE PARTS

A. Furnish one additional complete set of belts for each belt-driven fan.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

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

1. Centrifugal Roof Ventilators:

a. Accurex.

b. Acme Engrg. & Mfg. Corp.

c. Carnes Company, Inc.

d. Cook (Loren) Co.

e. Greenheck Fan Corp.

f. Hartzell Fan, Inc.

g. PennBarry.

h. RuppAir Management Systems

i. Twin City Fan Company

2. Upblast Propeller Roof Exhaust Fans:

a. Acme Engrg. & Mfg. Corp.

b. Carnes Company, Inc.

c. Cook (Loren) Co.

d. Greenheck Fan Corp.

e. Hartzell Fan, Inc.

f. PennBarry.

g. RuppAir Management Systems.

h. Twin City Fan Company

3. Centrifugal Wall Ventilators:

a. Accurex.

b. Acme Engrg. & Mfg. Corp.

c. Carnes Company, Inc.

d. Cook (Loren) Co.

e. Greenheck Fan Corp.

f. Hartzell Fan, Inc.

g. PennBarry.

h. RuppAir Management Systems

i. Twin City Fan Company

4. Ceiling-Mounted Ventilators:

a. Acme Engrg. & Mfg. Corp.

b. Carnes Company, Inc.

c. Cook (Loren) Co.

d. Greenheck Fan Corp.

e. Panasonic

f. PennBarry.

g. RuppAir Management Systems.

h. Twin City Fan Company

2.2 SOURCE QUALITY CONTROL

A. Testing Requirements: The following factory tests are required:

1. Sound Power Level Ratings: Comply with AMCA Standard 301 "Method for Calculating Fan Sound Ratings From Laboratory Test Data." Test fans in accordance with AMCA Standard 300 "Test Code for Sound Rating." Fans shall be licensed to bear the AMCA Certified Sound Ratings Seal.

2. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings in accordance with AMCA Standard 210/ASHRAE Standard 51 - Laboratory Methods of Testing Fans for Rating.

2.3 FANS, GENERAL

A. General: Provide fans that are factory fabricated and assembled, factory tested, and factory finished; with indicated capacities and characteristics.

B. Fans and Shafts: Statically and dynamically balanced and designed for continuous operation at the maximum rated fan speed and motor horsepower.

1. Fan Shaft: Turned, ground, and polished steel designed to operate at no more than 70 percent of the first critical speed at the top of the speed range of the fan's class.

C. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.

1. Service Factor: 1.4.

D. Belts: Oil-resistant, nonsparking, and nonstatic.

1. Fans used for smoke control applications shall have 1.5 times the number of belts required for the design duty with a minimum of two belts.

E. Motors and Fan Wheel Pulleys: Adjustable pitch for use with motors through 15 HP; fixed pitch for use with motors larger than 15 HP. Select pulley so that pitch adjustment is at the middle of the adjustment range at fan design conditions.

1. Belt Guards: Provide steel belt guards for motors mounted on the outside of the fan cabinet.

F. Shaft Bearings: Provide type indicated, having a median life "Rating Life" (AFBMA L(50)) of 200,000, calculated in accordance with AFBMA Standard 9 for ball bearings and AFBMA Standard 11 for roller bearings.

G. Hazardous Duty: Provide fans with spark resistant construction and explosion proof motor where specified in the schedule.

H. Factory Finish: The following finishes are required:

1. Sheet Metal Parts: Prime coating prior to final assembly.

2. Exterior Surfaces: Baked-enamel finish coat after assembly.

2.4 CENTRIFUGAL ROOF VENTILATORS

A. General Description: Belt-driven or direct-drive as indicated, centrifugal consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.

B. Housing: Heavy-gage, removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone.

1. Up-blast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains.

2. Provide quick release latches to facilitate removal of scroll housing for access into the motor compartment.

C. Fan Wheel: Aluminum hub and wheel with backward-inclined blades.

D. Belt-Driven Drive Assembly: Resiliently mounted to the housing, with the following features:

1. Pulleys: Cast-iron, adjustable-pitch.

2. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.

3. Fan Shaft: Turned, ground, and polished steel drive shaft keyed to wheel hub.

4. Fan and motor isolated from exhaust air stream.

E. Accessories: Provide the following items as indicated:

1. Disconnect Switch: Nonfusible type, with thermal overload protection mounted inside fan housing, factory-wired through an internal aluminum conduit.

2. Bird Screens: Maximum 1/2-inch mesh, 16-gage, aluminum or brass wire.

3. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base, factory set to close when fan stops.

4. Dampers: Motor-operated, parallel-blade, volume control dampers mounted in curb base.

a. Blades: Die-formed sheet aluminum.

b. Frame: Extruded aluminum, with waterproof, felt blade seals.

c. Linkage: Nonferrous metals, connecting blades to counter weight or operator.

d. Operators: Manufacturer's standard electric motor.

e. Operators: Manufacturer's standard pneumatic motor.

F. Roof Curbs: Refer to Section "Hangers and Supports for HVAC" for pre-engineered roof equipment supports .

2.5 AXIAL ROOF VENTILATORS

A. General Description: Belt-driven or direct-drive as indicated, axial fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.

B. Housing: Heavy-gage, removable, spun-aluminum, dome top and outlet baffle; and square, one-piece, aluminum base.

C. Fan Wheel: Aluminum hub and blades.

D. Fan Wheel: Steel hub and blades.

E. Belt-Driven Drive Assembly: Resiliently mounted to the housing, with the following features:

1. Pulleys: Cast-iron, adjustable-pitch.

2. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.

3. Fan Shaft: Turned, ground, and polished steel drive shaft keyed to wheel hub.

F. Accessories: Provide the following items as indicated:

1. Disconnect Switch: Nonfusible type, with thermal overload protection mounted inside fan housing, factory-wired through an internal aluminum conduit.

2. Bird Screens: Maximum 1/2-inch mesh, 16-gage aluminum or brass wire.

3. Dampers: Counter-balanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.

4. Dampers: Motor-operated, parallel-blade, volume control dampers mounted in curb base.

a. Blades: Die-formed sheet aluminum.

b. Frame: Extruded aluminum, with waterproof, felt blade bumpers.

c. Linkage: Nonferrous metals.

d. Operators: Manufacturer's standard electric motor.

e. Operators: Manufacturer's standard pneumatic motor.

G. Roof Curbs: Refer to Section "Hangers and Supports for HVAC" for pre-engineered roof equipment supports.

2.6 UPBLAST PROPELLER ROOF EXHAUST FANS

A. General Description: Belt-driven or direct-drive as indicated, propeller fans consisting of housing, wheel, butterfly-type discharge damper, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.

B. Wind Band, Fan Housing, and Base: Reinforced and braced galvanized steel, containing galvanized steel butterfly dampers and rain trough, motor and drive assembly, and fan wheel.

C. Wind Band, Fan Housing, and Base: Reinforced and braced aluminum, containing aluminum butterfly dampers and rain trough, motor and drive assembly, and fan wheel.

1. Dampers Rods: Steel with bronze bearings.

2. Dampers Rods: Steel with nylon bearings.

D. Fan Wheel: Dynamically and statically balanced, replaceable, cast-aluminum blades fastened to cast-aluminum hub. Factory-set pitch angle of blades.

E. Fan Wheel: Replaceable, extruded-aluminum, airfoil blades fastened to cast-aluminum hub. Factory set pitch angle of blades.

F. Shaft Bearings: Prelubricated and sealed, self-aligning, pillow-block-type ball bearings.

G. Motors and Fan Wheel Pulleys: Adjustable pitch. Select pulley so that pitch adjustment is at the middle of the adjustment range at design conditions.

H. Motors Mounts: Outside of the fan cabinet with adjustable base for belt tensioning, drive assembly and belts enclosure, and weatherproof housing of same material as fan housing.

I. Roof Curbs: Refer to Section "Hangers and Supports for HVAC" for pre-engineered roof equipment supports.

2.7 CEILING-MOUNTED VENTILATORS

A. General Description: Centrifugal fan designed for installation in ceiling, wall, or concealed inline applications.

B. Housing: Galvanized steel lined with acoustical insulation.

C. Fan Wheel: Centrifugal wheels directly mounted on motor shaft Fan shrouds, motor, and fan wheel shall be removable for service.

D. Grille: Stainless steel, louvered grille with flange on intake and thumbscrew attachment to fan housing.

E. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.

F. Remote Fan Speed Control: Solid state, capable of controlling fan speed from full speed to approximately half speed.

G. Accessories: Manufacturer's standard roof jack, wall cap, and transition fittings as indicated.

2.8 MOTORS

A. Torque Characteristics: Sufficient to accelerate the driven loads satisfactorily.

B. Motor Sizes: Minimum sizes and electrical characteristics as indicated. If not indicated, large enough so that the driven load will not require the motor to operate in the service factor range.

C. Temperature Rating: 90 deg C maximum temperature rise at 40 deg C ambient for continuous duty at full load (Class B Insulation).

D. Service Factor: 1.15 for polyphase motors and 1.35 for single-phase motors.

E. Motor Construction: NEMA Standard MG 1, general purpose, continuous duty, Design B. Provide permanent-split capacitor classification motors for shaft-mounted fans and capacitor start classification for belted fans.

1. Bases: Adjustable.

2. Bearings: The following features are required:

a. Ball or roller bearings with inner and outer shaft seals.

b. Grease lubricated.

c. Designed to resist thrust loading where belt drives or other drives produce lateral or axial thrust in motor.

3. Enclosure Type: The following features are required:

a. Open drip-proof motors where satisfactorily housed or remotely located during operation.

b. Guarded drip-proof motors where exposed to contact by employees or building occupants.

4. Overload protection: Built-in, automatic reset, thermal overload protection.

5. Noise rating: Quiet.

6. Efficiency: Energy-efficient motors shall have a minimum efficiency as scheduled in accordance with IEEE Standard 112, Test Method B. If efficiency not specified, motors shall have a higher efficiency than "average standard industry motors" in accordance with IEEE Standard 112, Test Method B.

7. Nameplate: Indicate the full identification of manufacturer, ratings, characteristics, construction, and special features.

F. Starters, Electrical Devices, and Wiring: Starters, electrical devices and connections are specified in Division 26.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install fans level and plumb, in accordance with manufacturer's written instructions.

B. Secure roof-mounted fans to pre-engineered roof equipment supports in accordance with the requirements specified in Section "Hangers and Supports for HVAC Piping and Equipment."

C. Ceiling Units: Suspend units from structural steel support frame using steel wire or metal straps.

D. Install vibration isolation for equipment as specified in Division 23 Section "Vibration Isolation for HVAC Piping and Equipment."

E. Arrange installation to provide access space around fans for service and maintenance.

3.2 ADJUSTING, CLEANING, AND PROTECTING

A. Adjust damper linkages for proper damper operation.

B. Clean the entire unit including cabinet interiors just prior to substantial completion to remove foreign material and construction dirt and dust. Vacuum clean fan wheel and cabinet.

3.3 STARTUP

A. Final Checks Before Start-Up: Perform the following operations and checks before start-up:

1. Remove shipping blocking and bracing.

2. Verify fan assembly is secure on mountings and supporting devices and that connections for ductwork, and electrical are complete. Verify proper thermal overload protection is installed in motors, starters, and disconnects.

3. Perform cleaning and adjusting specified in this Section.

4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearings operations. Reconnect fan drive system, align belts, and install belt guards.

5. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.

6. Verify manual and automatic volume control and that fire and smoke dampers in connected ductwork systems are in the full-open position.

7. Disable automatic temperature control operators.

B. Starting procedures for fans:

1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated RPM.

    a. Replace fan and motor pulleys as required to achieve design conditions.

2. Measure and record motor electrical values for voltage and amperage.

3. Shut unit down and reconnect automatic temperature control operators.

4. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for procedures for air-handling-system testing, adjusting, and balancing.

3.4 DEMONSTRATION

A. Demonstration Services: Train Owner's maintenance personnel on the following:

1. Procedures and schedules related to start-up and shutdown, troubleshooting, servicing, preventative maintenance, and how to obtain replacement parts.

2. Familiarization with contents of Operating and Maintenance Manuals specified in Division 1 Section "Closeout Procedures" and Division 23 Section "General Mechanical Requirements."

B. Schedule training with at least 7 days' advance notice.

END OF SECTION

SECTION 233600 - AIR TERMINAL UNITS

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. Extent of air terminals work required by this section is indicated on drawings and schedules, and by requirements of this section.

B. Types of air terminals specified in this section include the following:

1. Variable Air Volume Terminal Units

a. Shutoff Single Duct

b. Reheat

c. By-Pass

d. Fan Powered

1.2 QUALITY ASSURANCE

A. Codes and Standards:

1. ADC Compliance: Provide air terminals which have been tested and rated in accordance with ADC standards, and bear ADC Seal.

2. AHRI Compliance: Provide air terminals which have been tested and rated in accordance with AHRI 880 "Industry Standard for Air Terminals" and bear AHRI certification seal.

3. NFPA Compliance: Construct air terminals using acoustical and thermal insulations complying with NFPA 90A "Air Conditioning and Ventilating Systems".

4. UL/ETL Compliance: Air terminal units shall be UL or ETL listed as a complete assembly. All electrical components shall be UL listed and installed in accordance with the National Electric Code.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data, including performance data for each size and type of air terminal furnished; certified sound power data for each unit; schedule showing drawing designation, room location, number furnished, model number, size, and accessories furnished; and installation and start-up instructions.

B. Nameplate Data: Nameplate data shall be submitted in a timely manner so as to allow proper coordination with the Electrical Contractor. Submittals that do not have nameplate data will be rejected.

C. Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loadings, required clearances, and methods of assembly of components.

D. Wiring Diagrams: Submit ladder-type wiring diagrams for electric power and control components, clearly indicating required field electrical connections.

E. Maintenance Data: Submit maintenance data and parts list for each type of air terminal; including "trouble-shooting" maintenance guide. Include this data, product data, shop drawings, and maintenance data in maintenance manual; in accordance with requirements of Division 1.

1.4 SPARE PARTS

A. If HVAC equipment is used during construction, the contractor is fully responsible for it's cleaning just before substantial completion prior to testing and balancing. The contractor is to provide one set of filters when the unit is started over the return duct opening throughout construction. Filters shall be changed during construction as needed, but not less than once every month. On the day of substantial completion, the contractor shall provide one complete set of filters for the unit and then provide one additional set as spare stock to the Owner. Obtain receipt from Owner that spare filters have been provided.

PART 2 - PRODUCTS AND MATERIALS

2.1 VARIABLE AIR VOLUME TERMINAL UNITS

A. General: Provide factory-fabricated and tested air terminals as indicated, selected with performance characteristics which match or exceed those indicated on schedule.

B. Acceptable Manufacturers: Subject to compliance with requirements, provide air terminals of one of the following:

1. Carnes Co.
2. Carrier Corp.; Sub. of United Technologies Corp.
3. Environmental Technologies, Inc.
4. Johnson Controls, Inc.
5. Krueger Mfg. Co.
6. Metalaire.
7. Nailor Industries, Inc.
8. Price Industries.
9. Tempmaster Corp.
10. Titus Products Div.; Philips Industries, Inc.

11. Trane (The) Co.

C. Casings: Construct of galvanized sheet metal of minimum 22 gauge thickness or die-cast aluminum of minimum 20 gauge thickness.

1. Provide hanger brackets for attachment of supports.

2. Linings: Line inside surfaces of casings with lining material to provide acoustic performance, thermal insulation, and to prevent condensation on outside surfaces of casing. Provide minimum thickness of 1/2". Lining shall be closed cell foam and comply with UL 181 and NFPA 90A. Insulation shall be 1-1/2 lb. density. Insulation shall be equivalent to Titus Fibre-Free Liner.

3. Access: Provide removable panels in casings to permit access to air dampers, fans and other parts requiring service, adjusting, or maintenance.

a. Provide airtight gasket and quarter-turn latches.

4. Leakage: Construct casings such that when subjected to 0.5-in w.g. pressure for low pressure units, and 3.0-in w.g. pressure for high pressure units, total leakage does not exceed 2% of specified air flow capacity with outlets sealed and inlets wide open. Construct air dampers such that when subjected to 6.0-in w.g. inlet pressure with damper closed, total leakage does not exceed 5% of specified air flow capacity.

5. Multiple Duct Connectors: For air terminals serving more than one air outlet, provide lined outlet plenum with duct collar, butterfly-type damper, and locking device in each outlet.

D. Air Dampers: Construct of materials that cannot corrode, do not require lubrication, nor require periodic servicing. Provide maximum volume dampers that are calibrated in cfm, factory-adjusted, and marked for specified air capacities. Provide mechanism to vary air volume thru damper for minimum to maximum, in response from signal from thermostat.

E. Controls: Provide controls accurate to 1.5 degrees F and adjustable from 65 degrees F to 85 degrees F. Provide air flow measurement station at terminal unit inlet. Provide control type as indicated below.

1. Provide direct digital controls, compatible with direct digital control system specified in other Division 23 sections.

2. Fan Powered Terminal Units: Provide 24 V auxiliary contact to interface with the building fire alarm system for automatic shutdown.

F. Identification: Provide label on each unit indicating Plan Number, cfm range, cfm factory-setting, and calibration curve (if required).

G. Heating Coils: Provide the following features as indicated on Drawings and schedule:

1. Hot Water Heating Coils: Provide heating coils constructed of copper tubes and aluminum fins with galvanized steel casing.

2. Electric Heating Coils: Provide heating coils constructed of electric resistance elements in galvanized steel casing with control box with door interlock disconnect switch and factory-wiring. Provide over-temperature protection and UL-listing as duct heater. Provide heater with mercury contactors and with airflow switch.

H. Units shall incorporate a single point electrical connection for the entire unit. All electrical components shall be UL or ETL listed or recognized and installed in accordance with the National Electrical Code. All electrical components shall be mounted in a control box. The entire assembly shall be UL or ETL listed (cETL in Canada) and so labeled.

I. All sound data shall be compiled in an independent ADC certified laboratory and in accordance with the latest version of AHRI 880. All units shall be AHRI certified and bear the AHRI certification label.

J. Fan and Motor Section: Provide galvanized steel plenum, acoustically lined as specified under Paragraph "Casings", housing forward curved centrifugal fan with belt or direct driven, energy efficient, permanent split capacitor motor with integral thermal overload protection and permanently lubricated ball bearings. Provide air filter in an air filter rack and backdraft damper.

K. Fan and Motor Section: Provide galvanized steel plenum, acoustically lined as specified under Paragraph "Casings", housing forward curved centrifugal fan with direct driven, ultra efficient, electronically commutated (ECM), variable speed, dc brushless motor by General Electric or equal designed for 277 volt, single phase service and furnished with permanently lubricated ball bearings. Motor shall be provided with a single phase integrated controller/inverter that operates the stator and senses rotor position to commutate the stator. Rotor shall be permanent magnet type with near zero losses. Motor shall have built-in soft start and soft speed change ramps. Motor shall maintain a minimum of 70 percent efficiency over its entire operating range. Provide air filter and backdraft damper at return air inlet.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

3.2 FIELD QUALITY CONTROL

A. Upon completion of installation and prior to initial operation, test and demonstrate that air terminals, and duct connections to air terminals, are leak-tight.

B. Repair or replace air terminals and duct connections as required to eliminate leaks, and retest to demonstrate compliance.

3.3 ADJUSTING AND CLEANING

A. Adjust damper linkages for proper damper operation.

B. Clean the entire unit including cabinet interiors just prior to substantial completion to remove foreign material and construction dirt and dust. Vacuum clean fan wheel and cabinet.

END OF SECTION

SECTION 233713 - DIFFUSERS, REGISTERS AND GRILLES

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. Extent of air outlets and inlets work is indicated by drawings and schedules, and by requirements of this Section.

B. Types of outlets and inlets required for project include the following:

1. Ceiling air diffusers.

2. Wall registers and grilles.

3. Louvers.

C. Refer to other Division 23 sections for ductwork and duct accessories required in conjunction with air outlets and inlets; not work of this Section.

D. Refer to other Division 23 sections for balancing of air outlets and inlets; not work of this Section.

1.2 RELATED REQUIREMENTS

A. 230548 – Seismic Controls for Mechanical Systems, for seismic controls.

1.3 QUALITY ASSURANCE

A. Codes and Standards:

1. AHRI Compliance: Test and rate air outlets and inlets in accordance with AHRI 650 "Standard for Air Outlets and Inlets".

2. ASHRAE Compliance: Test and rate air outlets and inlets in accordance with ASHRAE 70 "Method of Testing for Rating the Air Flow Performance of Outlets and Inlets".

3. ADC Compliance: Test and rate air outlets and inlets in certified laboratories under requirements of ADC 1062 "Certification, Rating and Test Manual".

4. ADC Seal: Provide air outlets and inlets bearing ADC Certified Rating Seal.

5. AMCA Compliance: Test and rate louvers in accordance with AMCA 500 "Test Method for Louvers, Dampers and Shutters".

6. AMCA Seal: Provide louvers bearing AMCA Certified Rating Seal.

7. NFPA Compliance: Install air outlets and inlets in accordance with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems".

8. AMCA Standard 540: Test Method for Louvers Impacted by Windborne Debris

9. AMCA Standard 550: Test Method for High Velocity Wind Driven Rain Resistant Louvers.

10. ICC 500: ICC/NSSA Standard for the Design and Construction of Storm Shelters.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data for air outlets and inlets including the following:

1. Schedule of air outlets and inlets indicating drawing designation, room location, number furnished, model number, size, and accessories furnished.

2. Data sheet for each type of air outlet and inlet, and accessory furnished; indicating construction, finish, and mounting details.

3. Performance data for each type of air outlet and inlet furnished, including aspiration ability, temperature and velocity traverses; throw and drop; and noise criteria ratings at specified airflows. Indicate selections on data.

4. Shop Drawings: Submit manufacturer's assembly-type shop drawing for each type of air outlet and inlet, indicating materials and methods of assembly of components.

5. Maintenance Data: Submit maintenance data, including cleaning instructions for finishes, and spare parts lists. Include this data, product data, and shop drawings in maintenance manuals; in accordance with requirements of Division 1.

B. Coordination Drawings: Reflected ceiling plans and wall elevations drawn to scale to show locations and coordination of diffusers, registers, and grilles with other items installed in ceilings and walls.

C. Color Samples for Initial Selection: Manufacturer's color charts showing the full range of colors available for diffusers, registers, and grilles with factory-applied color finishes.

D. Samples for Verification: Provide samples of diffusers, registers, and grilles, in manufacturer's standard sizes, showing the full range of colors. Prepare Samples from the same material to be used for the Work.

1.5 SPARE PARTS

A. Furnish to Owner, with receipt, 3 operating keys for each type of air outlet and inlet that require them.

PART 2 - PRODUCTS AND MATERIALS

2.1 CEILING AIR DIFFUSERS

A. General: Except as otherwise indicated, provide manufacturer's standard ceiling air diffusers where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and provided with accessories as required for a complete installation.

B. Performance: Provide ceiling air diffusers that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device as listed in manufacturer's current data.

C. Ceiling Compatibility: Provide diffusers with border styles that are compatible with adjacent ceiling systems, and that are specifically manufactured to fit into ceiling module with accurate fit and adequate support. Refer to general construction drawings and specifications for types of ceiling systems which will contain each type of ceiling air diffuser.

D. Linear Slot Diffusers: Slot diffusers shall be standard one-piece lengths up to 6-feet and shall be furnished in multiple sections greater than 6-feet. Multiple sections shall be joined together end-to-end with alignment pins to form a continuous slot appearance. All alignment components shall be provided by the manufacturer. Plenums shall be manufactured by the slot diffuser manufacturer. Plenums shall be internally insulated, by the manufacturer, with minimum ¼" thick, closed-cell insulation. Insulation shall not be made of fibrous material.

E. Types: Provide ceiling diffusers of type, capacity, and with accessories and finishes as scheduled on the drawings.

F. Manufacturers: Subject to compliance with requirements, provide diffusers of one of the following:

1. Carnes Co.

2. Price Industries, Inc.

3. Krueger Mfg. Co.

4. Metalaire; Metal Industries, Inc.

5. Nailor Industries, Inc.

6. Titus HVAC

7. Tuttle & Bailey; Div. of Air Systems Components, Inc.

2.2 REGISTERS AND GRILLES

A. General: Except as otherwise indicated, provide manufacturer's standard registers and grilles where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and provided with accessories as required for a complete installation.

B. Performance: Provide wall registers and grilles that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device and listed in manufacturer's current data.

C. Wall Compatibility: Provide registers and grilles with border styles that are compatible with adjacent wall systems, and that are specifically manufactured to fit into wall construction with accurate fit and adequate support. Refer to general construction drawings and specifications for types of wall construction which will contain each type of wall register and grille.

D. Types: Provide registers and grilles of type, capacity, and with accessories and finishes as scheduled on the drawings.

E. Manufacturers: Subject to compliance with requirements, provide registers and grilles of one of the following:

1. Carnes Co.

2. Price Industries, Inc.

3. Krueger Mfg. Co.

4. Metalaire; Metal Industries, Inc.

5. Nailor Industries, Inc.

6. Titus HVAC

7. Tuttle & Bailey; Div. of Air Systems Components, Inc.

2.3 LOUVERS

A. General: Except as otherwise indicated, provide manufacturer's standard louvers as scheduled or indicated on the drawings; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and provided with accessories as required for a complete installation.

B. Performance: Provide louvers that have minimum free area, and maximum pressure drop of each type as listed in manufacturer's current data, complying with louver schedule.

1. Structural Performance: Louvers shall withstand the effects of gravity loads and wind and/or seismic loads as defined in the applicable building code for the installed location without permanent deformation of louver components, noise or metal fatigue caused by louver-blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act normal to the face of the building.

2. Windborne-Debris Impact Resistance: Louvers located within 30 feet of grade shall comply with AMCA 540.

3. Storm Shelter Impact Resistance: Louvers specified on plan for protection of storm shelter penetrations shall pass impact and pressure testing with UL in accordance with the requirements of the most current editions of FEMA-361 and ICC 500. Test specimens shall be no smaller in width and length than louvers specified on the drawings.

4. Louvers installed on buildings located in Wind-Borne Debris Regions of Florida must comply with AMCA 540 and have a Florida Approval Number. Additionally, louvers installed on buildings located in the Miami-Dade or Broward counties of Florida must comply with Miami-Dade test protocols (TAS-201, TAS-202, and TAS-203) and must have a Miami-Dade Notice of Acceptance.

5. Wind Driven Rain Performance: Louvers shall comply with ANSI/AMCA 500L for wind driven rain performance. Louvers shall have not less than 99 percent effectiveness when subjected to wind velocities of 29 and 50 mph with rainfall rates of 3 in/hr and 8 in/hr respectively and a core intake velocity not less than what is scheduled on the plans.

C. Substrate Compatibility: Provide louvers with frame and sill styles that are compatible with adjacent substrate, and that are specifically manufactured to fit into construction openings with accurate fit and adequate support, for weatherproof installation. Refer to general construction drawings and specifications for types of substrate which will contain each type of louver.

D. Materials: Construct of aluminum extrusions, ASTM B 221, Alloy 6063-T52. Weld units or use stainless steel fasteners.

E. Louver Screens: On inside face of exterior louvers, provide 1/2" square mesh anodized aluminum wire bird screens mounted in removable extruded aluminum frames.

F. Louver Supports: Louver design shall limit span between visible mullions to 10' and shall incorporate structural supports required to withstand a wind load of 20 lbs. per sq. ft.

G. Intermediate Blade Supports: Where needed blade supports shall be provided by louver manufacturer on the rear of blade only.

H. Louver Blank-Off Panels: Blank off any unused portions of louver with lined galvanized sheet metal panels and seal airtight. Back of panels shall be insulated with 1" thick, 3 lb. density duct liner.

I. Manufacturers: Subject to compliance with requirements, provide louvers of one of the following:

1. American Warming & Ventilating Inc.

2. Arrow United Industries, Inc.

3. Carnes Co.; Div. of Wehr Corp.

4. Cesco

5. Greenheck

6. Industrial Louvers, Inc.

7. Louvers & Dampers, Inc.

8. Nailor Industries, Inc.

9. Pottorff

10. Ruskin Mfg. Co.

11. Tampco.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which air outlets and inlets are to be installed for compliance with installation tolerances and conditions that would affect the performance of the equipment. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install air outlets and inlets in accordance with manufacturer's written instructions, design drawings, referenced standards, and in accordance with recognized industry practices to ensure that products serve intended function.

B. Coordinate with other work, including ductwork and duct accessories, to interface installation of air outlets and inlets with other work.

C. Where a 90-degree elbow is required at the connection to air devices, provide a rigid duct elbow or, at Contractor's option, a flexible elbow assembly as specified in Division 23 section "Metal Ducts".

D. Locate ceiling air diffusers, registers, and grilles, as indicated on general construction "Reflected Ceiling Plans". Unless otherwise indicated, locate units in center of acoustical ceiling module.

E. Linear Slot Diffuser Installation:

1. For installations in a hard ceiling, install diffuser prior to installation of drywall. Use manufacturer's hard ceiling clips for mounting to ceiling framing. Screws through face of diffuser are not acceptable.

3.3 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before beginning air balance.

3.4 CLEANING

A. After installation of diffusers, registers, and grilles, inspect exposed finish. Clean exposed surfaces to remove dirt and smudges. Replace any air device that has damaged finishes.

END OF SECTION

SECTION 233723 - HVAC GRAVITY VENTILATORS

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. Extent of HVAC gravity ventilator work is indicated by drawings and schedules, and by requirements of this Section.

B. Types of HVAC gravity ventilators required for project include the following:

1. Gravity ventilators.

a. Louvered Penthouse

b. Roof Hoods

2. Goosenecks.

C. Refer to other Division 23 sections for ductwork and duct accessories required in conjunction with HVAC gravity ventilators; not work of this Section.

D. Refer to other Division 23 sections for HVAC gravity ventilators; not work of this Section.

1.2 QUALITY ASSURANCE

A. Codes and Standards:

1. AHRI Compliance: Test and rate HVAC gravity ventilators in accordance with AHRI 650 "Standard for Air Outlets and Inlets".

2. ASHRAE Compliance: Test and rate HVAC gravity ventilators in accordance with ASHRAE 70 "Method of Testing for Rating the Air Flow Performance of Outlets and Inlets".

3. ADC Compliance: Test and rate HVAC gravity ventilators in certified laboratories under requirements of ADC 1062 "Certification, Rating and Test Manual".

4. AMCA Compliance:

5. NFPA Compliance: Install HVAC gravity ventilators in accordance with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems".

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data for HVAC gravity ventilators including the following:

1. Schedule of HVAC gravity ventilators indicating drawing designation, number furnished, model number, size, and accessories furnished.

2. Data sheet for each type of HVAC gravity ventilator, and accessory furnished; indicating construction, finish, and mounting details.

3. Performance data for each type of HVAC gravity ventilator furnished, including pressure loss and noise criteria ratings at specified airflows. Indicate selections on data.

4. Shop Drawings: Submit manufacturer's assembly-type shop drawing for each type of HVAC gravity ventilator, indicating materials and methods of assembly of components.

5. Maintenance Data: Submit maintenance data, including cleaning instructions for finishes, and spare parts lists. Include this data, product data, and shop drawings in maintenance manuals; in accordance with requirements of Division 1.

B. Coordination Drawings: Roof plans drawn to scale to show locations and coordination of HVAC gravity ventilators with other items installed on roof.

C. Color Samples for Initial Selection: Manufacturer's color charts showing the full range of colors available for HVAC gravity ventilators with factory-applied color finishes.

PART 2 - PRODUCTS AND MATERIALS

2.1 GRAVITY VENTILATORS

A. Provide gravity ventilators of type, size and capacity as scheduled on the drawings.

B. Construction: Hoods shall be low silhouette, all aluminum with curb cap, birdscreen and balanced backdraft or motorized damper as scheduled on the drawings. Provide prefabricated, heavy-gage, galvanized steel roof curb with mitered and welded corners; 1-1/2-inch-thick, 3 pound density, rigid, fiberglass insulation adhered to inside walls; built-in cant and mounting flange for flat roof decks; and 2-inch treated wood nailer.

1. Overall Roof Curb Height: Minimum 12 inches for roofs with no insulation, 15" for roofs with insulation or as scheduled on the drawings.

C. Construction: Hoods shall be low silhouette louvered penthouse, all aluminum with curb cap, birdscreen and balanced backdraft or motorized damper as scheduled on the drawings. Provide a storm-proof 0.080 inch aluminum louver with mitered corners. Louvers shall be mounted 4 inches from the roof opening for maximum weather protection. Louver design shall result in low pressure drop, low hood height, and maintain maximum weather resistance. Provide prefabricated, heavy-gage, galvanized steel roof curb with mitered and welded corners; 1-1/2-inch-thick, 3 pound density, rigid, fiberglass insulation adhered to inside walls; built-in cant and mounting flange for flat roof decks; and 2-inch treated wood nailer.

1. Overall Roof Curb Height: Minimum 12 inches for roofs with no insulation, 15" for roofs with insulation or as scheduled on the drawings.

D. Manufacturers: Subject to compliance with requirements, provide gravity ventilators of one of the following:

1. Acme
2. Carnes Company, Inc.
3. Cesco
4. Cook (Loren) Co.
5. Greenheck Fan Corp.
6. Nailor Industries, Inc.
7. RuppAir Management Systems.
8. Vent Products.

2.2 GOOSENECKS

A. Provide gooseneck inlet or outlet of size as on the drawings.

B. Construction: Factory- or shop-fabricate according to SMACNA's "HVAC Duct Construction Standards – Metal and Flexible", Figure 5-5 with minimum 0.052-inch thick galvanized steel sheet.

C. Roof Curb: Provide prefabricated, heavy-gage, galvanized steel roof curb with mitered and welded corners; 1-1/2-inch-thick, 3 pound density, rigid, fiberglass insulation adhered to inside walls; built-in cant and mounting flange for flat roof decks; and 2-inch treated wood nailer.

1. Overall Roof Curb Height: Minimum 12 inches for roofs with no insulation, 15" for roofs with insulation or as scheduled on the drawings.

D. Screening: Provide galvanized½-inch square mesh bird screen

E. Paint Finish:

1. Surface Preparation: Clean surfaces of dirt, grease, and other contaminants. Clean welds, mechanical connections, and abraded areas and repair galvanizing according to ASTM A 780. Apply a conversion coating suited to the organic coating to be applied over it.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which HVAC gravity ventilators are to be installed for compliance with installation tolerances and conditions that would affect the performance of the equipment. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General: Install HVAC gravity ventilators in accordance with manufacturer's written instructions, design drawings, referenced standards, and in accordance with recognized industry practices to insure that products serve intended function.

B. Coordinate with other work, including ductwork and duct accessories, to interface installation of HVAC gravity ventilators with other work.

C. Locate HVAC gravity ventilators and goosenecks as indicated on general construction "Roof Plans". Adjust location to suit structural conditions.

3.3 CLEANING

A. After installation of HVAC gravity ventilators, inspect exposed finish. Clean exposed surfaces to remove dirt and smudges. Replace any HVAC gravity ventilator that has damaged finishes.

END OF SECTION

SECTION 233813 - COMMERCIAL KITCHEN HOODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes Type [II] commercial kitchen hood.

B. Related Sections include the following:

1. Division 23 Section 237443 Dedicated Outdoor Air Units for makeup air units.

2. Division 23 Section 233423 HVAC Power Ventilators for exhaust fans.

1.3 DEFINITIONS

A. Listed Hood: A hood tested according to UL 710 by a testing agency acceptable to authorities having jurisdiction.

B. Standard Hood: A hood that complies with design, construction, and performance criteria of applicable national and local codes.

C. Type II Hood: A hood designed for heat and steam removal and other non-grease applications.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Hoods.

2. Grease removal devices.

3. Fire-suppression systems.

4. Lighting fixtures.

B. Shop Drawings:

1. Show plan view, elevation view, sections, roughing-in dimensions, service requirements, duct connection sizes, and attachments to other work.

2. Show cooking equipment plan and elevation to confirm minimum code-required overhang.

3. Indicate performance, exhaust and makeup air airflow and pressure loss, at actual Project-site elevation.

4. Indicate method of attaching hangers to building structure.

5. Show exhaust and makeup air ducts, and fittings connecting to hoods.

6. Show water-supply and drain piping.

7. Show control cabinets.

8. Show fire-protection piping, actuation devices, and manual control devices.

9. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

10. Design Calculations: Calculate requirements for selecting seismic restraints.

11. Wiring Diagrams: Power, signal, and control wiring.

C. Piping Diagrams: Detail fire-suppression piping and components and differentiate between manufacturer-installed and field-installed piping. Include roughing-in requirements for drain connections. Show cooking equipment plan and elevation to illustrate fire-suppression nozzle locations.

D. Coordination Drawings: Reflected ceiling plans drawn to scale and coordinating penetrations and ceiling-mounted items. Show the following:

1. Relative location of ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings to hoods and accessory equipment.

2. Roof framing and support members for duct penetrations.

3. Ceiling suspension assembly members.

4. Size and location of initial access panels for acoustical tile.

E. Welding certificates.

F. Field test reports.

1.5 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel," for hangers and supports; and AWS D9.1, "Sheet Metal Welding Code," for joint and seam welding.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. NSF Compliance: Fabricate hoods according to NSF 2, "Food Equipment."

D. SMACNA Compliance:

1. Fabricate hoods to comply with SMACNA's "HVAC Duct Construction Standards: Metal and Flexible," second edition.

1.6 PROJECT CONDITIONS

A. Field Measurements: Verify dimensions of food service equipment installation areas by field measurements before fabrication and indicate measurements on Shop Drawings.

1.7 COORDINATION

A. Coordinate equipment layout and installation with other Work, including light fixtures, HVAC equipment, and fire-suppression system components.

1.8 EXTRA MATERIALS

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Commercial Kitchen Hoods:

a. Accurex.

b. Captive-Aire Systems.

c. Duo-Aire, Inc.

d. Halton Company.

e. LC Systems.

2. Wet-Chemical Fire-Suppression Systems:

a. Amerex Corporation.

b. Ansul Incorporated; a Tyco International Ltd. Company.

c. Fenwall Safety Systems, Inc.; Div. of Kidde Technologies, Inc.

d. Pyro Chem, Inc.

3. Residential Kitchen Hoods:

   a. Accurex.

   b. Greenheck.

2.2 HOOD MATERIALS

A. Stainless-Steel Sheet: ASTM A 666, Type 430. Provide Type 304 for corrosive environments.

1. Minimum Thickness: 0.036 inch.

2. General: Comply with SSINA's "Finishes for Stainless Steel" for recommendations for applying and designating finishes.

3. Remove tool and die marks and stretch lines or blend into finish. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.

4. Concealed Stainless-Steel Surfaces: ASTM A 480/A 480M, No. 2B finish (bright, cold-rolled, unpolished finish).

5. Exposed Surfaces: ASTMA 480/A480M, No. 4 finish (bright, directional polish).

6. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

B. Carbon-Steel Sheets: ASTM A 366/A 366M, cold-rolled sheets; commercial quality; with oiled, exposed matte finish.

C. Galvanized Steel Sheet: Lock-forming quality; ASTM A 653/A 653M, G90 (Z275) coating designation; mill-phosphatized finish for surfaces of ducts exposed to view.

1. Minimum Thickness: 0.052 inch

D. Zinc-Coated Steel Shapes: ASTM A 36/A 36M, zinc coated according to ASTM A 123/A 123M requirements.

E. Sealant: ASTM C 920; Type S, Grade NS, Class 25, Use NT. Elastomeric sealant shall be NSF certified for commercial kitchen hood application. Sealants, when cured and washed, shall comply with requirements in 21 CFR, Section 177.2600, for use in areas that come in contact with food.

1. Color: As selected by Architect from manufacturer's full range.

2. Backer Rod: Closed-cell polyethylene, in diameter larger than joint width.

F. Sound Dampening: NSF-certified, nonabsorbent, hard-drying, sound-deadening compound for permanent adhesion to metal in minimum 1/8-inch thickness that does not chip, flake, or blister.

G. Gaskets: NSF certified for end-use application indicated; of resilient rubber, neoprene, or PVC that is nontoxic, stable, odorless, nonabsorbent, and unaffected by exposure to foods and cleaning compounds, and passes testing according to UL 710.

2.3 HOOD FABRICATION, GENERAL

A. Welding: Use welding rod of same composition as metal being welded. Use methods that minimize distortion and develop strength and corrosion resistance of base metal. Make ductile welds free of mechanical imperfections such as gas holes, pits, or cracks.

1. Welded Butt Joints: Full-penetration welds for full-joint length. Make joints flat, continuous, and homogenous with hood material without relying on straps under seams, filling in with solder, or spot welding.

2. Grind exposed welded joints flush with adjoining material and polish to match adjoining surfaces.

3. Where fasteners are welded to underside of equipment, finish reverse side of weld smooth and flush.

4. Coat concealed stainless-steel welded joints with metallic-based paint to prevent corrosion.

5. After zinc-coated steel is welded, clean welds and abraded areas and apply SSPC-Paint 20, high-zinc-dust-content, galvanizing repair paint to comply with ASTM A 780/A 780M.

B. For metal butt joints, comply with SMACNA's "Kitchen Equipment Fabrication Guidelines."

C. Where stainless steel is joined to a dissimilar metal, use stainless-steel welding material or fastening devices.

D. Form metal with break bends that are not flaky, scaly, or cracked in appearance; where breaks mar uniform surface appearance of material, remove marks by grinding, polishing, and finishing.

E. Sheared Metal Edges: Finish free of burrs, fins, and irregular projections.

F. In food zones, as defined in NSF, fabricate surfaces free from exposed fasteners.

G. Cap exposed fastener threads, including those inside cabinets, with stainless-steel lock washers and stainless-steel cap (acorn) nuts.

H. Fabricate pipe slots on equipment with turned-up edges sized to accommodate service and utility lines and mechanical connections.

I. Fabricate enclosures, including panels, housings, and skirts, to conceal service lines, operating components, and mechanical and electrical devices including those inside cabinets, unless otherwise indicated.

J. Fabricate equipment edges and backsplashes according to SMACNA's "Kitchen Equipment Fabrication Guidelines."

K. Fabricate enclosure panels to ceiling and wall as follows:

1. Fabricate panels on oneside[s] with same material as hood, and extend from ceiling to top of hood canopy and from canopy to wall.

2. Wall Offset Spacer: Minimum of 3 inches.

3. Wall Shelves and Overshelves: Fabricate according to SMACNA's "Kitchen Equipment Fabrication Guidelines," with minimum 0.0625-inch thick, stainless-steel shelf tops.

2.4 TYPE II EXHAUST HOOD FABRICATION

A. SMACNA Compliance: Fabricate hoods to comply with SMACNA's "HVAC Duct Construction Standards: Metal and Flexible," second edition.

B. Fabricate hoods with galvanized steel or stainless steel.

C. Hood Configuration: Exhaust and makeup air.

1. Makeup air shall be introduced by combination of induction and diffusion inside canopy. If makeup air is not heated, insulate interior of makeup air plenum with high-density insulation having maximum flame-spread and smoke-developed indices of 25 and 50, respectively.

2. Makeup air shall be introduced through laminar-flow-type perforated metal panels on front of hood canopy.

D. Hood Type: Heat and vaporremoval.

E. Hood Style: Wall-mounted canopyCondensate Hood Baffles: Removable stainless-steel baffles to drain into a hood drain trough, and stainless-steel drain piping.

F. Light Fixtures: UL-listed, recessedfixtures and lamps with lenses sealed vaportight. Wiring shall be installed in stainless-steel conduit on hood exterior. Number and location of fixtures shall provide a minimum of 70 fc on cooking surface below hood.

1. Switches shall be mounted on wall adjacent to hood.

2. Fluorescent Lighting Fixtures: Comply with UL 1570.

3. Incandescent Lighting Fixtures: Comply with UL 1571.

2.5 WET-CHEMICAL FIRE-SUPPRESSION SYSTEM

A. Pre-engineered distribution piping designed for automatic detection and release or manual release of fire-suppression agent by hood operator. Fire-suppression system shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

1. Steel Pipe, NPS 2 (DN 50) and Smaller: ASTM A 53/A 53M, Type S, Grade A, Schedule 40, plain ends.

2. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300.

3. Pipe Covers: Chrome-plated aluminum tubing.

4. Piping, fusible links and release mechanism, tank containing the suppression agent, and controls shall be factory installed. Controls shall be in stainless-steel control cabinet mounted on hood or wall. Furnish manual pull station for wall mounting adjacent to hood. Exposed piping shall be covered with stainless-steel sleeves. Exposed fittings shall be chrome plated.

5. Liquid Extinguishing Agent: Noncorrosive, low-pH liquid.

6. Furnish an electric-operated, gas shutoff valve with clearly marked open and closed indicator for field installation.

7. Fire-suppression system controls shall be integrated with controls for fans, lights, and fuel supply and located in a single cabinet for each group of hoods immediately adjacent.

8. Wiring shall have color-coded, numbered terminal blocks and grounding bar. Spare terminals for fire alarm, optional wiring to start fan with fire alarm, red pilot light to indicate fan operation, and control switches shall all be factory wired in control cabinet with relays or starters.

2.6 RESIDENTIAL KITCHEN HOODS

A. Pre-engineered kitchen hood listed according to UL 300A.

B. Include a self-contained fire suppression system intended for use above residential range top cooking surfaces.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting installation.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before equipment installation.

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

3.2 INSTALLATION

A. Install hoods and associated services with clearances and access for maintaining, cleaning, and servicing hoods, grease removal devices, and fire-suppression systems according to manufacturer's written instructions and requirements of authorities having jurisdiction.

B. Install hoods level and plumb.

C. Complete field assembly of hoods where required.

1. Make closed butt and contact joints that do not require filler.

2. Grind field welds on stainless-steel equipment smooth, and polish to match adjacent finish. Comply with welding requirements in Part 2 "General Hood Fabrication" Article.

D. Make cutouts in hoods where required to run service lines and to make final connections.

E. Securely anchor and attach items and accessories to walls, floors, or bases with stainless-steel fasteners, unless otherwise indicated.

F. Install hoods to operate free from vibration.

G. Install trim strips and similar items requiring fasteners in a bed of sealant. Fasten with stainless-steel fasteners at 48 inches o.c. maximum.

H. Install sealant in joints between equipment and abutting surfaces with continuous joint backing, unless otherwise indicated. Provide airtight, watertight, vermin-proof, sanitary joints.

I. Install lamps, with maximum recommended wattage, in equipment with integral lighting.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine with clearance to allow service and maintenance.

C. .

D. Makeup Water Connection: Comply with applicable requirements in Division 22 Section "Water Distribution Piping and Specialties" for valves and accessories on piping connections to water-cooled units.

E. Duct Connections: Comply with applicable requirements in Division 23 Section "Air Duct Accessories" for flexible connectors on makeup air supply duct. Weld exhaust-duct connections.

F. Fire-Suppression Piping: Install piping connections for remote-mounted suppression systems according to NFPA 17, "Wet Chemical Extinguishing Systems."

G. Ground equipment.

H. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

A. Testing: Engage a qualified testing agency to perform the following field quality-control testing:

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.

1. Test each equipment item for proper operation. Repair or replace equipment that is defective, including units that operate below required capacity or that operate with excessive noise or vibration.

2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3. Test motors and rotating equipment for proper rotation and lubricate moving parts according to manufacturer's written instructions.

4. Test liquid-carrying and water, drain, and gas components for leaks. Repair or replace leaking components.

C. Remove malfunctioning units, replace with new units, and retest as specified above.

3.5 ADJUSTING

A. Set initial temperatures, and calibrate sensors.

B. Set field-adjustable switches.

3.6 CLEANING

A. Remove protective coverings and clean and sanitize hoods and associated services, both inside and out, according to manufacturer's written instructions.

B. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hoods. Refer to Division 1 and Division 23 Section "General Mechanical Requirements".

END OF SECTION

SECTION 234100 - PARTICULATE AIR FILTRATION

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. Extent of air cleaning work required by this Section is indicated on drawings and schedules, and by requirements of this Section.

B. Types of air cleaning equipment specified in this Section include the following:

1. Air Filters

a. Replaceable (throwaway) panel and pleated

2. Filter Holding Systems

a. Front and Rear Access Filter Frames

b. Side Servicing Housings

3. Filter Gages

C. Filter sections of packaged air handling units are work of this section.

1.2 QUALITY ASSURANCE

A. Codes and Standards:

1. NFPA Compliance: Comply with applicable portions of NFPA 90A and 90B, and NEC pertaining to installation of air filters and associated electric wiring and equipment.

2. UL Compliance: Comply with UL Standards pertaining to safety performance of air filter units.

3. ASHRAE Compliance: Comply with provisions of ASHRAE Standard 52 for method of testing, and for recording and calculating air flow rates.

4. AHRI Compliance: Comply with provisions of AHRI Standard 850 pertaining to test and performance of air filter units.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data including, dimensions, weights, required clearances and access, flow capacity including initial and final pressure drop at rated air flow, efficiency and test method, fire classification, and installation instructions.

B. Shop Drawings: Submit manufacturer's assembly-type shop drawings for filter rack assemblies indicating dimensions, materials, and methods of assembly of components.

C. Samples: Submit one sample filter cartridge for each type of filter required; in accordance with requirements of Division 1.

D. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to air filter units. Submit manufacturer's ladder-type wiring diagram for control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

E. Maintenance Data: Submit maintenance data and spare parts lists for each type of filter and rack required. Include this data, product data, shop drawings, and wiring diagrams in maintenance manual; in accordance with requirements of Division 1.

1.4 SPARE PARTS

A. Provide one complete spare set of filters of each type required for each air handling system. Obtain receipt from Owner that spare filters have been provided. In addition to the spare set of filters, install new filters at completion of air handling system work, and prior to testing, adjusting, and balancing work.

B. If HVAC equipment is used during the construction period, Contractor shall provide one set of filters (if system is designed to include pre-filters and after-filters, provide only pre-filters) when the unit is started and replace filters when needed, but not less than every month. On the day of substantial completion, the Contractor shall clean the unit and provide a new set of filters at each location in the unit.

PART 2 - PRODUCTS AND MATERIALS

2.1 ACCEPTABLE MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide air cleaning equipment of one of the following:

1. Air Filters

    a. AAF International.

    b. Air Filter Inc.

    c. Bioclimatic Air Systems

    d. Columbus Industries, Inc..

    e. Filtration Group

    f. Koch Filter Corp.

    g. Research Products Corp.

2.2 AIR FILTERS

A. Replaceable (Throwaway) Pleated Filters: Provide factory-fabricated, pleated type, replaceable air filters with holding frames; as indicated, in sizes indicated or sized for maximum velocity indicated, with 2 inch thick UL Class 2 throwaway media material. Construct filter of a synthetic media, framed in throwaway fiberboard casings with diagonal bracing to adequately support the media on the entering and exiting side of the filter. Provide media support grid of welded wire construction coated with rust inhibitor. Construct ductwork-holding frames of 20-ga galvanized steel, capable of holding media and media frame in place, and gasketed to prevent unfiltered air by-passing between media frames and holding members. Provide 2 inch filters with initial resistance of not greater than 0.40 inches w.g. for 2 inch thick and 0.32 inches w.g. for 4 inch thick at 500 fpm. Filters shall have final rated resistance of 0.9 inches w.g. or greater, average efficiency of 85 percent and average arrestance of 98 percent. The minimum MERV when tested under ASHRAE 52.2 shall be no less than MERV 13.

2.3 FILTER HOLDING SYSTEMS

A. Front and Rear Access Filter Frames: Provide filter bank framing system, constructed of aluminum framing members having minimum thickness of 0.09". Design system for either upstream (front) or downstream (rear) filter servicing. Cut to size and pre-punch members for each assembly into modules of size and capacity or maximum velocity as scheduled or noted on drawings. Provide permanently gasketed framing members to prevent bypass of unfiltered air. If vertical support members are required to prevent deflection of horizontal members, install so as not to interfere with either installation or operation of filters. Incorporate separate track for prefilters, removable from front, or removable from back after removal of after-filters. Provide factory-installed positive sealing device for each row of filters, to insure seal between gasketed filter elements. Provide hardware necessary for field assembly.

B. Side Servicing Housings: Provide factory-assembled side servicing housings with flanges for insertion into ductwork system as indicated. Construct of 16-ga galvanized steel. Provide integral pre-filter tracks to accommodate 2" throw-away or cleanable filters. Provide access doors with continuous gasketing on perimeter and positive locking devices. Incorporate positive-sealing gasket material on channels to seal top and bottom of filter cartridge frames to prevent bypass. Arrange so filter cartridge can be loaded from either access door.

C. Leak-test housing by pressurizing to 3" w.g. and soap-bubble test housing joints, door seals, and filter sealing edges. Provide crank-operated spring-loaded filter-sealing mechanism with limit stop, so geared that total pressure of 600 lbs. will be exerted on each filter. Design clamping frame to provide continuous knife-edge seal for all four edges of each individual filter.

2.4 FILTER GAGES

A. Provide diaphram-type filter gage for each filter bank, with dial and pointer, graduated to read from 0 to 2" w.g.

B. Provide manometer-type filter gage for each filter bank, with logarithmic curve tube gage, with integral leveling gage, graduated to read from 0 to 3" w.g.

1. Provide pressure tips, tubing, gage connections, and mounting bracket.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions and comply with installation requirements as specified elsewhere in these specifications pertaining to air filters housing/casings, and associated supporting devices.

B. Install air filters and holding devices of types indicated, and where shown; in accordance with air filter manufacturer's written instructions and with recognized industry practices; to ensure that filters comply with requirements and serve intended purposes.

C. Locate each filter unit accurately in position indicated, in relation to other work. Position unit with sufficient clearance for normal service and maintenance. Anchor filter holding frames securely to substrate.

D. Coordinate with other work including ductwork and air handling unit work, as necessary to interface installation of filters properly with other work.

E. Install filters in proper position to prevent passage of unfiltered air.

F. Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.

1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 16 Sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment Installer.

2. Install air filter gage pressure tips upstream and downstream of filters to indicate air pressure drop through air filter. Mount filter gages on outside of filter housing or filter plenum, in accessible position. Adjust and level inclined gages if any, for proper readings.

END OF SECTION

SECTION 235100 - BREECHINGS, CHIMNEYS AND STACKS

PART 1 - GENERAL REQUIREMENTS

1.1 SECTION INCLUDES

A. Special gas vents.

1.2 RELATED REQUIREMENTS

A. Section 230548 – Seismic Controls for Mechanical Systems, for seismic controls.

1.3 SUBMITTALS

A. Product Data: Submit product data including materials, dimensions, weights, and accessories.

B. Shop Drawings: Show fabrication and installation details for breechings, chimneys, and stacks. Include plans, elevations, sections, details, and attachments to other Work. Detail assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, hangers and seismic restraints, and location and size of each field connection.

C. Quality Control Submittals:

1. Certificates: Submit certificates of materials compliance with specified ASTM, UL, and ASHRAE requirements.

2. Certificates: Submit Welders' Qualification Certificates.

3. Certificates: Submit complete engineering report certifying that stacks meet the design wind and seismic loads.

1.4 QUALITY ASSURANCE

A. Codes and Standards:

1. NFPA: Comply with NFPA 211 "Standard for Chimneys, Fireplaces, Vents and Solid Fuel Burning Appliances."

2. UL: Comply with applicable portions of UL safety standards; provide products which have been UL listed and labeled.

3. SMACNA: Comply with SMACNA's "HVAC Duct Construction Standards" for fabricated breeching and smoke pipe and with SMACNA's "Guide for Steel Stack Design and Construction" for steel stacks.

4. AWS: All welders and procedures shall be certified in accordance with AWS D1.1, "Structural Welding Code-Steel," for hangers and supports and in accordance with AWS Standard D9.1, "Sheet Metal Welding Code" for duct joining and seam welding.

5. ASHRAE: Comply with the ASHRAE Systems and Equipment Handbook, Chapter 30, for Chimney, Gas Vent, and Fireplace Systems material requirements and design criteria.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Handle breeching and stack components carefully to prevent damage, denting and scoring. Do not install damaged components; replace with new.

PART 2 - PRODUCTS AND MATERIALS

2.1 SPECIAL GAS VENT

A. Manufacturers: Subject to compliance with requirements, provide special gas vents of one of the following:

1. AMPCO.

2. DuraVent Commercial.

3. Enervex Inc.

4. Heat-Fab Inc.

5. Metal-Fab, Inc.

6. Nova-Flex Group.

7. ProTech Systems Inc.

8. Schebler Chimney Systems.

9. Security Chimneys.

10. Selkirk Metalbestos.

B. Description: Double-wall metal vents tested according to UL 1738 and rated for 550 deg F continuously, with positive or negative flue pressure complying with NFPA 211 and suitable for condensing-gas appliances.

1. Construction: Inner shell and outer jacket separated by at least a 1/2-inch annular space.

2. Inner Shell: ASTM A 959, Type AL29-4C stainless steel, ASTM A276 Type 316L stainless steel, or ASTM A268 Type 444 stainless steel.

3. Outer Jacket: Aluminized coated or stainless steel, Type 304, 316, or AL29-4C.

C. Accessories: UL labeled tees, adjustable and variable lengths, elbows, increasers, connectors, dampers, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly. All connections to common breechings shall be 45 degree lateral tees.

D. Discharge Assembly: Provide one of the following discharge assemblies to comply with the manufacturer's listed assembly.

1. Provide round chimney top designed to exclude 98 percent of rainfall.

E. Appliance Adapter: Provide appliance adapter to connect double wall special gas vent to flue outlet of appliance and secure with hose clamp.

a. Enervex Inc. SR.

b. Heat-Fab Model 9401RHM.

c. Selkirk Metalbestos 3CV-AA .

2.2 SPECIAL GAS VENT – POLYPROPYLENE PIPE

A. Manufacturers: Subject to compliance with requirements, provide special gas vents of one of the following:

1. Centrotherm Innoflue Single Wall.

2. Selkirk Polyflue.

3. Nova-Flex Group Z-DENS.

4. Approved equal.

B. Description: Single-wall or concentric polypropylene vents with EPDM gasket connections tested according to UL 1738 and rated for 230 F continuously, with positive or negative flue pressure complying with NFPA 211 and suitable for condensing-gas appliances.

C. Accessories: Third party (UL, Intertek, CSA, etc.) labeled tees, adjustable and variable lengths, elbows, increasers, connectors, dampers, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly. All connections to common breechings shall be 45 degree lateral tees.

D. Discharge Assembly: Free discharge to atmosphere or as recommended by the manufacturer.

E. Appliance Adapter: Provide appliance adapter to connect special gas vent to flue outlet of appliance and secure with hose clamp.

2.3 SPECIAL GAS VENT – CONCENTRIC DOUBLE WALL FOR INSTANTANEOUS GAS WATER HEATERS

A. Manufacturers: Subject to compliance with requirements, provide special gas vents of one of the following:

1. Metal-Fab "Corr/Guard Vent / Air Intake System"

2. Noritz "DVC"

3. Rinnai / Ubbink "Rolux Vent System"

4. Selkirk Metalbestos "Saf-T-Vent SC System"

B. Description: Concentric, double-wall metal vents, where outer wall can be used for combustion air intake, tested according to UL 1738 and rated for 550 deg F continuously, with positive or negative flue pressure complying with NFPA 211 and suitable for condensing-gas appliances.

C. Construction: Inner shell and outer jacket separated by at least a 1/2-inch annular space.

D. Inner Shell: ASTM A 959, Type AL29-4C stainless steel.

E. Outer Jacket: Stainless steel.

F. Accessories: UL labeled tees, adjustable and variable lengths, elbows, increasers, draft hood connectors, dampers, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.

1. Provide exit cone with drain section incorporated into riser.

2.4 GUYING AND BRACING MATERIALS

A. Cable: Galvanized, stranded wire of the following thickness:

1. Minimum Size: 1/4 inch in diameter

2. For ID Sizes 4 to 15 inches: 5/16 inch in diameter.

3. For ID Sizes 18 to 24 inches: 3/8 inch in diameter.

4. For ID Sizes 27 to 30 inches: 7/16 inch in diameter.

5. For ID Sizes 33 to 36 inches: 1/2 inch in diameter.

6. For ID Sizes 39 to 48 inches: 9/16 inch in diameter.

7. For ID Sizes 51 to 60 inches: 5/8 inch in diameter.

B. Pipe: 1-1/4 inch diameter, galvanized steel.

C. Angle Iron: Galvanized steel 2 by 2 by 1/4 inch.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of work.

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

3.2 APPLICATION

A. Listed Special Gas Vent: Condensing gas appliances.

B. Listed Special Gas Vent for Instantaneous Gas Water Heaters: double wall or concentric double wall.

3.3 INSTALLATION, GENERAL

A. Install products in accordance with manufacturer's instructions and third party listing. Maintain minimum clearances from combustibles specified in third party listing.

3.4 INSTALLATION OF TYPE B DOUBLE WALL METAL GAS VENTS

A. Support vents at intervals recommended by the manufacturer to support the weight of the vent and all accessories, without exceeding loading of appliances. Install guy wires and/or braces where maximum unsupported lengths of stacks are exceeded.

B. Slope: Minimum 1/4" per foot or manufacturer's recommended installation instructions, whichever is more stringent.

C. Transitions: Provide flat bottom transition where required to maintain continuous slope in the vent.

3.5 INSTALLATION OF SPECIAL GAS VENTS

A. Connect and seal joints between sections of venting system per manufacturer's installation instructions. Use only sealants or gaskets at joints that are approved by manufacturer.

B. Support vents at intervals recommended by the manufacturer to support the weight of the vent and all accessories, without exceeding loading of appliances. Install guy wires and/or braces where maximum unsupported lengths of stacks are exceeded.

C. Connect special gas vents to appliance adapters.

D. Insulate single wall special vents serving instantaneous gas water heaters.

1. Insulate single wall special gas vents for instantaneous gas water heaters. Refer to Division 23 specification section "HVAC Insulation" for insulation thickness, material and installation methods.

E. Slope: Upward from appliance to termination, minimum 1/4" per foot or manufacturer's recommended installation instructions, whichever is more stringent.

F. Install condensate drains at all low points in the venting system, including at appliance connections. Terminate condensate drains at code approved drain receptor.

G. Transitions: Provide flat bottom eccentric transition where required to maintain continuous slope in the vent.

H. Where polypropylene pipe is installed in a return air plenum, wrap the pipe with fire rated plenum insulation.

1. Refer to Division 23 Section "Common Work Results for HVAC" for plenum-rated fire wrap.

3.6 INSTALLATION OF CONDENSING APPLIANCE GAS VENTS

A. Support vents at intervals recommended by the manufacturer to support the weight of the vent and all accessories, without exceeding loading of appliances. Install guy wires and/or braces where maximum unsupported lengths of stacks are exceeded.

B. Slope: Upward from appliance to termination, minimum 1/4" per foot or manufacturer's recommended installation instructions, whichever is more stringent.

C. Install condensate drains at all low points in the venting system, including at appliance connections. Terminate condensate drains at code approved drain receptor.

D. Transitions: Provide flat bottom eccentric transition where required to maintain continuous slope in the vent.

E. Provide special gas vent in lieu of CPVC if plenum-rated CPVC is not available.

F. Coordinate vent material compatibility with the appliance manufacturer's installation instructions prior to installation.

3.7 INSTALLATION OF DAMPERS

A. Locate as close to draft hood collar as possible.

3.8 PROTECTION

A. Temporary Closure: At ends of breechings and chimneys that are not completed or connected to equipment, provide temporary closure that will prevent entrance of dust and debris until installations are completed.

3.9 ADJUSTING AND CLEANING

A. Clean breechings internally during installation, to remove dust and debris. Clean external surfaces to remove welding slag and mill film. Grind welds smooth.

END OF SECTION

SECTION 235216 - CONDENSING BOILERS

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section includes condensing boilers.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 22 Section "Natural Gas Systems" for natural gas equipment connection requirements.

2. Division 23 Sections for concrete equipment bases, piping, specialties, pumps, breechings, temperature controls, and other mechanical equipment not specified in this Section, but required for a complete installation.

3. Division 26 Sections for electrical work including motor starters, disconnects, wires/cables, raceways, and other electrical equipment devices not specified in this Section, but required for a complete installation.

C. Electrical Work: Provide the following wiring as work of this section in accordance with requirements of Division 26:

1. Furnish to Electrical Installer, burner emergency shutoff switch.

2. Provide control wiring between boiler control panel and all electrical components shipped loose from boiler manufacturer.

3. Provide factory-mounted and wired controls and electrical devices as specified in this section.

1.2 SUBMITTALS

A. General: Submit the following in accordance with the Conditions of the Contract and Division 1 Specification Sections.

1. Product data including rated capacities of selected models, weights (shipping, installed, and operating), furnished specialties, and accessories; and installation and startup instructions. For boilers with factory-mounted starters, provide short circuit current rating.

2. Shop drawings detailing fabrication and installation of equipment assemblies. Indicate dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection.

3. Wiring diagrams detailing power and control wiring and differentiating clearly between manufacturer-installed wiring and field-installed wiring.

4. AGA design certificates, for information.

5. Maintenance data for each boiler, control, and accessory to include in the operation and maintenance manual specified in Division 1. Include parts list, maintenance guide, and wiring diagrams.

6. Manufacturer's field reports, indicating work supervised and performed and related observations, for information.

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications: Firm experienced in manufacturing condensing boilers similar to those indicated for this Project and that have a record of successful in-service performance.

B. Comply with NFPA 70 "National Electrical Code" for components and installation.

C. Listing and Labeling: Provide products specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in the "National Electrical Code," Article 100.

2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" (NRTL) as defined in OSHA Regulation 1910.7.

D. AGA Compliance: Design certified by AGA, tests and ratings according to AGA requirements.

E. ASME Compliance: Fabricate and stamp boilers according to ASME Boiler and Pressure Vessel Code, Section IV, "Heating Boilers." Provide control and safety devices in compliance with locally adopted edition of ASME CSD-1.

F. Coordination: Coordinate layout and installation of boilers with related work.

1. Furnish copy of manufacturer's wiring diagram submittal to electrical Installer.

2. Coordinate size and location of concrete housekeeping pads.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

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

B. Constant Primary/Variable Secondary Flow System Condensing Boilers.

1. Fulton as Base Bid

2. Preapproved manufacturer's (refer to substitution request requirements) may be included with alternate (add/deduct) pricing.

2.2 DESCRIPTION

A. Type: Gas-fired, condensing-type hot water boiler with capacities and accessories as scheduled.

B. Factory-assembled and -tested modules include combustion air inlet chamber, pre-purge post-purge blower assembly, air-gas fuel control valve, combustion chamber, cast aluminum or stainless steel heat exchanger, and exhaust; insulated jacket around module and unit-mounted electrical control panel with operation sequence indicator lights.

2.3 CONTROLS

A. Controller: Provide a master firing control processor. Processor will be capable of all boiler operation and efficient staging. The master firing control will also be equipped with open protocol communication according to the drawings and specifications. The processor will be compatible the established or specified control system.

2.4 ACCESSORIES

A. Flow Switch: Furnish field-mounted thermal dispersion flow switch .

2.5 SOURCE QUALITY CONTROL

A. Test and inspect boilers according to ASME Boiler and Pressure Vessel Code, Section IV for low-pressure boilers and Section I for high-pressure boilers.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install boilers level and plumb, according to manufacturer's written instructions, rough-in drawings, and referenced standards.

B. Install according to NFPA 54.

C. Support boilers on concrete pad constructed in accordance with Division 23 section "Common Work Results for HVAC". Cast anchor bolt inserts into pad.

D. Provide spring vibration isolation mounts where recommended by manufacturer for pulse combustion boilers.

E. Assemble units and parts shipped loose or disassembled.

F. Install electrical devices furnished with boiler but not specified to be factory mounted.

3.2 CONNECTIONS

A. Install piping adjacent to boiler to allow service and maintenance.

B. Connect air intake and exhaust piping to boiler, size as recommended by manufacturer. Provide intake and exhaust piping material per manufacturer's recommendations for the boiler operating conditions. Pitch toward boiler minimum of 2 percent or as indicated. Provide termination as indicated.

C. Connect gas piping to boiler according to requirements of Division 22 Section "Natural Gas Systems." Provide union with sufficient clearance for burner removal and service.

1. Install pressure relief lines from the gas train devices to discharge outside of the building. Relief lines shall be black steel pipe with malleable iron fittings one pipe size larger than the relief outlet of the device. Provide turn down with 40 mesh insect screen at discharge. Provide individual relief lines for each gas train device.

D. Connect hot water piping to supply and return boiler tappings, according to requirements of Division 23 section "Hydronic Piping." Provide shutoff valve and union or flange at each connection.

E. Connect condensate piping to boiler according to manufacturer's requirements. Install Schedule 40 CPVC pipe and fittings from boiler to nearest floor drain or as indicated with PH neutralizer. Provide clear plastic tubing between boiler module connection and manifold connection.

3.3 CLEANING AND TOUCH-UP PAINTING

A. Flush and clean boilers upon completion of installation, in accordance with manufacturer's start-up instructions.

B. Just prior to substantial completion clean unit's exposed surfaces.

C. Retouch any marred or scratched surfaces of factory-finished surfaces, using finish materials furnished by manufacturer.

3.4 STARTUP

A. Arrange with National Board of Boiler and Pressure Vessel Inspectors and/or local authority having jurisdiction for inspection of boiler piping and for certification of completed boiler units.

B. Provide services of a factory-authorized service representative to provide startup service.

C. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements of Division 26 Sections. Do not proceed with boiler startup until wiring installation is acceptable to equipment installer.

D. Start boilers according to manufacturer's instructions.

E. Adjust burner for maximum burning efficiency.

F. Operate and adjust controls and safeties.

G. Retouch any marred or scratched surfaces of factory-finished surfaces, using finish materials furnished by manufacturer.

3.5 DEMONSTRATION

A. Provide services of a factory-authorized service representative to demonstrate the operation of the boiler, burner and controls.

B. Operate boiler, including accessories and controls, to demonstrate compliance with requirements.

3.6 TRAINING

A. General: At a time mutually agreed upon between the Owner and Contractor, provide the services of a factory trained and authorized representative to train Owner's designated personnel for a minimum of four hours on the operation and maintenance of the equipment provided under this section. The contractor shall account for all shifts.

B. Content: Training shall include but not be limited to:

1. Overview of the system and/or equipment as it relates to the facility as a whole.

2. Operation and maintenance procedures and schedules related to startup and shutdown, troubleshooting, servicing, preventive maintenance and appropriate operator intervention.

3. Review data included in the operation and maintenance manuals. Refer to Division 1 Section "Operation and Maintenance Data."

C. Certification: Contractor shall submit to the Engineer a certification letter stating that the Owner's designated representative has been trained as specified herein. Letter shall include date, time, attendees and subject of training. The certification letter shall be signed by the Contractor and the Owner's representative indicating agreement that the training has been provided.

D. Schedule: Schedule training with Owner with at least 7 days' advance notice.

END OF SECTION

SECTION 235323 - BOILER ACCESSORIES

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. Extent of boiler accessories work required by this section is indicated on drawings and schedules, and by requirements of this section.

B. Types of boiler accessories specified in this section include the following:

1. Boiler valves. Stop and check valves. Y-type blowdown valves.

2. Safety and relief valves. Steam safety valves. Water relief valves.

3.

C. Refer to other Division-23 sections for boilers, piping, specialties, concrete pads, etc., required for installation of boiler accessories; not work of this section.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of boiler accessories, of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Codes and Standards:

1. ASME Compliance: Construct and install boiler accessories in accordance with ASME "Boiler and Pressure Vessel Code". Install boiler accessories in accordance with ASME B31.1 "Power Piping", or ASME B31.9 "Building Services Piping", as applicable.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data, including rated capacities of selected model clearly indicated, weights (shipping, installed, and operating where applicable), furnished specialties and accessories; and installation and start-up instructions.

B. Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loadings, required clearances, and methods of assembly of components.

C. Wiring Diagrams: Submit ladder-type wiring diagrams for electrically operated boiler accessories. Clearly differentiate between portions of wiring that are factory-installed and portions to be field installed.

D. Maintenance Data: Submit maintenance data and parts lists for each boiler accessory, including "troubleshooting" maintenance guide. Include this data and product data in maintenance manual; in accordance with requirements of Division 1.

PART 2 - PRODUCTS AND MATERIALS

2.1 BOILER VALVES

A. General: Provide factory-fabricated boiler valves recommended by manufacturer for use in service indicated. Provide boiler valves of types and pressure ratings indicated for each service, or if not indicated, provide proper selection as determined by Installer to comply with installation requirements. Provide sizes as indicated, with connections which properly mate with pipe, tube, and equipment connections.

B. Stop and Check Valves: Construct body of cast iron, ASTM A 126, Grade B, pressure rated for 250 PSI at 450 degrees F (232 degrees C) steam. Provide OS&Y construction, straight or angle pattern with flanged ends, and renewable bronze disc and seat ring.

C. Y-Type Blowdown Valves: Construct body of bronze, ASTM B 62, pressure rated for 300 PSI steam. Provide Y-type globe construction, bronze seat ring, renewable composition disc, screw-in bonnet, threaded ends.

D. Manufacturers: Subject to compliance with requirements, provide boiler valves of one of the following:

1. Crane Co., Valve and Fittings Div.

2. Davis Valve.

3. Fairbanks (The) Co.

4. Jenkins Bros.

5. Lunkenheimer (The) Co.; Div. of Conval Corp.

6. Powell (The Wm.) Co.

7. Walworth Co.

2.2 SAFETY AND RELIEF VALVES

A. Water Relief Valves: Provide water relief valves as indicated, of size and capacity as selected by Installer for proper relieving capacity, constructed in accordance with ASME Boiler and Pressure Vessel Code.

1. Pressure Relief Valves: Construct of bronze body, metallic disc, metal seat, with non-mechanically guided stem. Set valve to relieve at 10 PSI above operating pressure.

2. Manufacturers: Subject to compliance with requirements, provide water relief valves of one of the following:

a. Amtrol, Inc.

b. Bell & Gossett ITT.

c. Spirax Sarco Co.

d. Watts Regulator Co.

2.3 BOILER WATER TREATMENT FEEDERS

PART 3 - EXECUTION

3.1 INSTALLATION OF BOILER ACCESSORIES

A. Install boiler accessories as indicated, in accordance with manufacturer's installation instructions, and with recognized industry practices, to ensure that boiler accessories comply with requirements and serve intended purposes. Comply with requirements of state and local boiler codes, applicable portions of ASME Boiler and Pressure Vessel Code, and applicable portions of ANSI B31.1 or ASME B31.9.

B. Coordinate with other work as necessary to interface installation of boiler accessories with other components of heat generation systems.

3.2 BOILER VALVES

A. Stop-and-Check Valves: Install as indicated on top of boiler steam nozzles. Install additional chain operated stop valve between stop-and-check valve and boiler header.

B. Y-Type Blowdown Valves: Install as indicated on blowdown piping. Connect discharge to blowdown separator. Install additional stop valve between blowdown valve and boiler.

3.3 SAFETY AND RELIEF VALVES

A. Water Relief Valves: Install as indicated on top of boilers. Pipe discharge to floor drain.

3.4 BOILER BLOWDOWN SEPARATORS

A. General: Install boiler blowdown separators as indicated, on concrete pad. Connect drain to sewer, and vent to outdoors. Connect boiler blowdown inlet piping, and cold water supply piping with shutoff valve, strainer, and temperature regulator valve. Install temperature regulator valve bulb and thermometer in thermometer wells in blowdown separator discharge.

3.5 BOILER WATER TREATMENT FEEDERS

A. Bypass Feeders: Install as indicated, with supply and return connected to 2 tees in boiler water feed line. Connect feed piping to inlet and outlet connections with shutoff valves. Pipe drain valve discharge to floor drain.

3.6 BOILER ECONOMIZERS

A. Install as indicated, and in accordance with manufacturers installation instructions. Pipe header drains to floor drain.

3.7 FIELD QUALITY CONTROL

A. Flush and clean boiler accessories upon completion of installation, and in accordance with manufacturer's installation instructions.

B. Hydrostatically test, if required, assemble boiler accessories and piping in accordance with applicable sections of ASME Boiler and Pressure Vessel Code.

3.8 TRAINING

A. General: At a time mutually agreed upon between the Owner and Contractor, provide the services of a factory trained and authorized representative to train Owner's designated personnel for a minimum of four hours on the operation and maintenance of the equipment provided under this section.

B. Content: Training shall include but not be limited to:

1. Overview of the system and/or equipment as it relates to the facility as a whole.

2. Operation and maintenance procedures and schedules related to startup and shutdown, troubleshooting, servicing, preventive maintenance and appropriate operator intervention.

3. Review data included in the operation and maintenance manuals. Refer to Division 1 Section "Operation and Maintenance Data."

C. Certification: Contractor shall submit to the Engineer a certification letter stating that the Owner's designated representative has been trained as specified herein. Letter shall include date, time, attendees and subject of training. The certification letter shall be signed by the Contractor and the Owner's representative indicating agreement that the training has been provided.

D. Schedule: Schedule training with Owner with at least 7 days' advance notice.

END OF SECTION

SECTION 236426 - ROTARY-SCREW WATER CHILLERS

PART 1 - GENERAL REQUIREMENTS

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes packaged, rotary-screw water chillers of the following types:

1. Outdoor air cooled

B. Chiller shall be designed for variable flow through the remote evaporator. Refer to the schedules on the drawings and the control system "Sequence of Operation" for additional information.

1.3 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division I Specification Sections.

B. Product data for each chiller, including chiller refrigerant, chiller capacity, minimum and maximum chilled water flows, fluid pressure drops, weights (shipping, installed and operating), furnished accessories and electrical characteristics. Provide short circuit current rating of factory mounted starter or variable frequency drive.

C. Shop Drawings showing fabrication and installation of chillers, including plans, elevations, sections, details of components, attachments, and other construction elements. Include the following:

1. Dimensions.

2. Weight loadings and distribution.

3. Clearances for maintenance and operation.

4. Size and location of field connections.

D. Wiring diagrams detailing wiring for power and control systems and differentiating between manufacturer-installed and field-installed wiring.

E. Operation and maintenance data to be included in Operation and Maintenance manuals.

1.4 QUALITY ASSURANCE

A. AHRI Compliance: Rate chiller according to AHRI 550/590 "Standard for Water Chilling Packages using the Vapor Compression Cycle".

B. ASHRAE Compliance: Conform to ASHRAE 15 "Safety Code for Mechanical Refrigeration" for chiller design, construction, leak testing and installation.

C. ASME Compliance: Fabricate and stamp chillers to comply with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.

D. NEC Compliance: Comply with NFPA Standard 70 – National Electrical Code.

E. Chiller manufacturing plant must be ISO 9001:2000 registered.

1.5 WARRANTY

A. Manufacturer shall warrant all chiller equipment and material for a period of one year from equipment startup, or 18 months from date of shipment, whichever occurs first.

B. Manufacturer's Special Warranty on Compressor and Electric Motor: Written parts and labor warranty, signed by manufacturer agreeing to repair or replace compressor and/or compressor motor, including replacement of refrigerant for a period of 5 years after date of Substantial Completion.

1.6 DELIVERY AND HANDLING

A. Chillers shall be delivered to the job site completely assembled and charged with refrigerant and oil by the manufacturer, except condenserless which shall be charged at site in accordance with manufacturers instructions. If refrigerant is shipped separately from chiller, chiller shall be charged with nitrogen.

B. Comply with manufacturer instructions for rigging and handling equipment.

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

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

1. Daikin Applied.

2. York/JCI

3. Carrier

2.2 OUTDOOR AIR COOLED CHILLER

A. Unit description

1. Factory assembled, run tested, wired water chiller complete with base and frame, evaporator, Multi- Semi-hermetic rotary-screw compressors, air cooled condenser section, remote evaporator, safety controls and operational controls. Unit shall have single or dual refrigerant circuits.

B. Refrigerant

1. Material: HFC-134a; provide full operating factory charge of refrigerant and oil.

   a. Provide refrigerant charging port on each refrigerant circuit.

C. Cabinet

1. Base: Galvanized-steel base extending the perimeter of water chiller. Secure frame, compressors and evaporator to base to provide a single-piece unit.

2. Frame: Rigid galvanized-steel frame secured to base and designed to support cabinet, condenser, control panel, and other chiller components not directly supported from base.

3. Casing: Galvanized-steel.

4. Finish: Coat base, frame and casing with a corrosion-resistant baked enamel or powder coating capable of withstanding a 500-hour salt-spray test according to ASTM B117.

D. Compressor

1. Description: Semi-hermetic, multi- rotary-screw type. Units shall be provided with service valves, check valves, oil separator, oil heater and complete oil lubrication system. Motors shall be weather protected, continuous duty, squirrel cage, induction-type motor provided with thermal protection on all three phases. Mount on vibration isolation pads. Unit shall be provided with full modulating capacity control from 100% to 10% load.

E. Refrigerant circuit

1. Each refrigerant circuit shall include; liquid line shutoff valve, solenoid valve, sight glass with moisture indicator, filter-dryer, pressure relief device, thermal expansion valve, and closed cell foam insulated suction line.

F. Evaporator

1. Evaporator shall be direct expansion, shell and tube heat exchanger with removable head for tube cleaning, replaceable copper tubes and carbon steel shell.

2. Constructed, tested and stamped according to ASME pressure vessel code for minimum 200 psig refrigerant side, 150 psig water side. Provide with grooved mechanical coupling type water connections.

3. Insulation: Evaporator shall be covered with ¾" flexible closed cell foam insulation.

4. Heater: Evaporator shall be heated with a thermostatically controlled electric heater to protect to -20°F ambient.

G. Condenser section

1. Description: Air-cooled condenser coils of seamless copper tubes with aluminum fins. Subcooling coil shall be integral with main condenser coil.

2. Working Pressure: Minimum 375 psi.

3. Fans: Statically and dynamically balanced, direct drive, low sound propeller fans constructed of corrosion resistant material and arranged for vertical discharge. Provide fan guards of heavy gauge PVC coated or galvanized steel. Motors shall be weather protected, TEAO, three phase, permanently lubricated ball bearings.

H. Chiller accessories

1. Chiller shall be provided with the following accessories:

a. Control transformer.

b. Building Automation System interface.

c. Chilled Water Flow Switch: Furnish field-mounted differential pressure sensor (paddle-type flow switch not allowed).

d. Wire mesh coil guards to protect from hail damage.

I. Chiller options

1. Chiller shall be provided with the following options:

a. Low ambient control 0º F.

b. Copper fin condenser coils.

c. Factory mounted non-fused disconnect switch.

d. Integral variable frequency drive.

e. Evaporator flanged water connections.

f. Double-thickness evaporator insulation.

g. Special coating providing 5000+ hour salt spray resistance for coil and coil frame.

h. Premium Low Sound Package

i. Architectural Louvered Panels.

j. Seismically Rated Unit.

J. Operating controls

1. Provide manufacturers standard, microprocessor-based chiller control system in rain and dust tight NEMA 3 cabinet with hinged, latched, lockable and gasket sealed door.

2. Controller shall perform, at a minimum, the following functions:

   a. Compressor start/stop.

   b. Anti-recycle timer.

   c. Automatic pumpdown shutdown.

   d. Condenser fans start/stop.

   e. Evaporator pump start/stop.

   f. Evaporator heater.

   g. Chiller operation 0º F to 125º F ambient.

   h. Automatic reset to normal operation.

3. Controller shall have minimum 40-character liquid crystal display in English and numeric data in English units. Provide sealed keypad with password protection for operator interface.

4. Programmable setpoints shall include, at a minimum, chilled liquid setpoint range, set daily/holiday schedule for start/stop, manual override for servicing, low and high ambient cutouts, low liquid temperature cut out, low suction pressure cutout, high discharge pressure cutout.

5. Display data shall include, at a minimum, return and leaving liquid temperatures, low leaving liquid temp cutout, low ambient temp cutout setting, outdoor air temperature, suction pressure cutout setting.

K. Safety controls

1. Manually reset controls to perform the following functions:

   a. Low evaporator refrigerant temperature and pressure

   b. High condenser refrigerant pressure.

   c. High compressor discharge temperature.

   d. Low oil flow.

   e. Critical sensor or detection circuit fault.

   f. Compressor motor over current.

   g. Compressor motor windings thermal overload

h. Electrical current loss or phase reversal.

i. External and local emergency stop.

2. Automatic reset controls to perform following:

a. Low ambient temperature.

b. Low leaving chilled water temperature.

c. Under/Over voltage.

d. Chilled water flow from proof of flow device switch.

3. Alarm Contact

a. General trouble

b. Low ambient temperature.

c. Low voltage.

d. High discharge pressure.

e. Low suction pressure.

L. Electrical

1. Power panels shall be NEMA 3 rain/dust tight, painted steel cabinets with hinged, latched, lockable and gasketed outer doors. Provide main power connections, control power connections, compressor and fan motor start contactors, current overloads and factory wiring.

2. Power supply shall enter unit at a single location.

3. Evaporator heater shall have a separate power connection from the chiller power connection.

4. Exposed wiring shall be routed through liquid tight conduit.

M. Vibration Isolation

1. Direct isolation and the following vibration isolators are specified in Division 23 Section "Vibration Isolation for HVAC Piping and Equipment":

a. Restrained spring isolators with a minimum deflection of 0.75"

N. Sound

1. Sound pressure and/or power level ratings shall comply with AHRI Standard 370 "Sound Ratings for Large Outdoor Refrigeration and Air-Conditioning Equipment."

2. Do not exceed the maximum permissible dB level in any of the following octave bands:

Sound, dB	63Hz	25Hz	250Hz	.5kHz	1kHz	2kHz	4kHz	8kHz	LwA

Pressure	66	66	66	62	59	54	49	44	64
Power	93	93	93	89	86	79	74	71	91

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive chillers for compliance with installation tolerances and other conditions affecting performance and maintenance of chillers.

B. Examine proposed route of moving chillers into place and verify that it is free of interference's.

C. Verify piping roughing-in locations.

D. Verify branch circuit wiring suitability. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install chillers according to manufacturer's written instructions.

B. Install chillers plumb and level, and anchor. Support units as described below, using the vibration control devices indicated. Vibration control devices are specified in Division 23 Section "Vibration Isolation for HVAC Piping and Equipment."

1. Support floor mounted units on concrete equipment bases using housed spring isolators. Secure units to anchor bolts installed in concrete equipment base.

2. Support ground-mounted air cooled chillers on concrete equipment bases using neoprene pads. Secure units to anchor bolts installed in concrete equipment base.

C. Install vibration isolators according to isolator manufacturer's written instructions.

D. Install chiller accessories which have been shipped loose or unassembled for shipment purposes.

E. Maintain manufacturers recommended clearances for service and maintenance.

F. Install piping connections maintaining clearances for service and maintenance of chillers.

G. Install flange or mechanical coupling connections at chillers.

H. Install flexible pipe connections for chillers mounted on vibration isolators.

I. Install shutoff valves, pressure gauges and temperature gauges at chiller inlet and outlet connections.

3.3 ELECTRICAL CONNECTIONS

A. Refer to Division 26 Sections for wiring devices, wires and cables, and electrical installation requirements.

B. Install and connect proof of flow device switches and remote chiller control panel.

C. Ground equipment.

1. Tighten electrical connectors and terminals, including grounding connections, according to manufacturer'' published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Provide services of a factory-authorized service representative to supervise field assembly of components and installation of chillers, including piping, electrical and control connections, and to report results in writing.

1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.5 CLEANING

A. Clean finishes to remove dust and dirt.

B. Touch up scratches in unfinished surfaces to restore corrosion resistance.

C. Touch up scratches in finished surfaces to restore finish.

D. Comb fins of outdoor condenser coils.

3.6 DEMONSTRATION

A. Provide the services of a factory authorized service representative to provide start-up service and to demonstrate proper operation of equipment, accessories and controls.

B. Start-up Service:

1. Evacuate, dehydrate, vacuum pump and charge with specified refrigerant, and leak test in accordance with manufacturer's instructions, if not factory charged. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.

2. Perform lubrication service, including filling of reservoirs, and confirming that lubricant is of quantity and type recommended by manufacturer.

3. Verify the motor amperage conforms to manufacturer's data.

4. Do not place chillers in sustained operation prior to initial balancing of mechanical systems for interface with chillers.

3.7 TRAINING

A. General: At a time mutually agreed upon between the Owner and Contractor, provide the services of a factory trained and authorized representative to train Owner's designated personnel for a minimum of four hours on the operation and maintenance of the equipment provided under this section.

B. Content: Training shall include but not be limited to:

1. Overview of the system and/or equipment as it relates to the facility as a whole.

2. Operation and maintenance procedures and schedules related to startup and shutdown, troubleshooting, servicing, preventive maintenance and appropriate operator intervention.

3. Review data included in the operation and maintenance manuals. Refer to Division 1 Section "Operating and Maintenance Data."

C. Certification: Contractor shall submit to the Engineer a certification letter stating that the Owner's designated representative has been trained as specified herein. Letter shall include date, time, attendees and subject of training. The certification letter shall be signed by the Contractor and the Owner's representative indicating agreement that the training has been provided.

D. Schedule: Schedule training with Owner with at least 7 days' advance notice.

END OF SECTION

SECTION 237313 - MODULAR INDOOR CENTRAL STATION AIR HANDLING UNITS

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. This Section includes constant and variable volume, central-station air-handling units with coils for indoor installations.

1.2 DEFINITIONS

A. Low Pressure: Greater than 1 inch w.c. and less than or equal to 4 inches w.c. internal positive or negative pressure.

B. Medium Pressure: Greater than 4 inches w.c. and less than 10 inches w.c. internal positive or negative pressure.

C. High Pressure: Greater than or equal to 10 inches w.c. internal positive or negative pressure.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

1. Product data for each central-station air-handling unit indicated, including the following:

a. Certified fan performance curves with system operating conditions indicated.

b. Certified discharge, inlet and case-radiated fan sound power ratings. For variable speed fans, provide sound ratings at 100, 80 and 60 percent of maximum rpm.

c. Certified coil performance ratings with system operating conditions indicated.

d. Motor ratings and electrical characteristics plus motor and fan accessories.

e. Provide short circuit current rating of units with factory mounted starter or variable frequency drive.

f. Materials, gages and finishes.

g. Filters with performance characteristics.

h. Dampers, including housings, linkages, and operators.

i. Total pressure drop for the unit with itemized pressure drop per module. At a minimum, provide line items for the following:

1) External static pressure loss.

2) Unit inlet and outlet opening losses.

3) Internal filter, coil, and casing losses.

4) Pressure drop per module.

2. Shop drawings from manufacturer detailing dimensions, weights, required clearances, components, and location and size of each field connection.

3. Wiring diagrams detailing wiring for power and controls and differentiating between manufacturer-installed wiring and field-installed wiring.

4. Product certificates signed by manufacturers of central-station air-handling units certifying that their products comply with specified requirements.

5. Maintenance data and recommended spare parts list for central-station air-handling units for inclusion in Operating and Maintenance Manual specified in Division 1 and Division 23 Section "General Mechanical Requirements."

1.4 QUALITY ASSURANCE

A. NFPA Compliance: Central-station air-handling units and components shall be designed, fabricated, and installed in compliance with NFPA Standard 90A "Standard for the Installation of Air Conditioning and Ventilating Systems."

B. UL Compliance: Electric coils, along with the complete central-station air-handling unit, shall be listed and labeled by Underwriters' Laboratories.

C. Nationally Recognized Tested Laboratory and NEMA Compliance (NRTL): Electric coils, along with the complete central-station air-handling unit shall be listed and labeled by a NRTL. The term "NRTL" shall be as defined in OSHA Regulation 1910.7.

D. AHRI Certification: Central-station air-handling units and their components shall be factory tested in accordance with the applicable portions of AHRI 430 - Standard for Central-Station Air-Handling Units and shall be listed and bear the label of the Air-Conditioning and Refrigeration Institute.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Shipping Requirements: Each air handling unit and/or air handling unit section, top, bottom and sides, shall be covered with Shrinkfast or equal shrink wrap prior to shipment to protect interior surfaces and components from debris, dirt and moisture damage during shipping and storage.

1. Reference Manufacturer/Model Number: Shrinkfast / R10CCU 10HUV

2. Part Number: Q44R

3. Description: 20' x 100', 10 Mil reinforced poly wrap with scrim.

B. Handle air handling units and components carefully to prevent damage. Follow manufacturer's written instructions for rigging. Replace damaged units or components.

C. Store air handling units and components in clean dry place off the ground. Protect from weather, water, and physical damage. Replace any sections that experience internal water damage due to lack of protection.

1.6 SPARE PARTS

A. General: Furnish to Owner, with receipt, the following spare parts for each air-handling unit.

1. If HVAC equipment is used during the construction period, Contractor shall provide one set of filters when the unit is started and replace filters when needed, but not less than every month. On the day of substantial completion, the Contractor shall clean the unit and provide a new set of filters at each location in the unit.

2. Furnish one additional complete set of belts for each central-station air-handling unit.

3. Furnish one additional gasket for each sectional joint of each central-station air-handling unit.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

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

1. Carrier Air Conditioning

2. Daikin Applied.

3. York International Corporation.

2.2 MANUFACTURED UNITS

A. General Description: Factory assembled, consisting of fans, motor and drive assembly, coils, plenums, filters, and drip pans.

B. Types: Central-station air-handling units included in this project are of the following types:

1. Blow-through.

2. Draw-through.

3. Multizone.

4. Dual-duct.

5. Face-and-bypass.

C. Motor: Refer to Division 23 Section "Common Motor Requirements for HVAC Equipment."

D. Electrical Components: Refer to Division 26 Sections.

2.3 CABINET

A. Materials: Formed and reinforced galvanized steel panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.

1. Medium and high-pressure units shall be constructed with additional bracing and supports. Units rated at 5.5 inches w.g. and higher shall be connected to accessories sections with double-thickness neoprene-coated flexible connection.

B. Insulation: Comply with NFPA Standard 90A "Standard for the Installation of Air Conditioning and Ventilating Systems," for insulation.

1. Type:

a. Coated, glass-fiber insulation having a minimum density of 1-1/2 pcf.

b. Foam injection.

2. Thickness: 1 inch.

3. Minimum R-Value: R-4.

4. Location and Application: Factory applied with adhesive and mechanical fasteners to the internal surface of section panels downstream from and including the cooling coil section.

C. Access Panels and Doors: Same materials and finishes as cabinet and complete with hinges, latches, handles, and gaskets.

1. Fan section shall have inspection and access panels and doors sized and located to allow periodic maintenance and inspections.

D. Single-Wall Drain Pans: Formed sections of stainless steel. Fabricate pans in sizes and shapes to collect condensate from cooling coils (including coil piping connections and return bends) when units are operating at the maximum cataloged face velocity across the cooling coil. Insulate bottom and sides of drain pans.

E. Double-Wall Drain Pans: Formed sections of stainless steel. Fabricate pans in sizes and shapes extensive enough to collect condensate from cooling coils (including coil piping connections and return bends) and humidifiers when units are operating at the maximum cataloged face velocity across the cooling coil. Fill space between double-wall construction with foam insulation and seal moisture tight.

1. Drain connections: Both ends of the pan.

2. Pan top surface coating: Elastomeric compound.

3. Units with stacked coils shall have an intermediate drain pan or a drain through to collect condensate from top coil.

2.4 FANS SECTION

A. Testing Requirements: The following factory tests are required:

1. General: Sound power level ratings shall comply with AMCA Standard 301 "Method for Calculating Fan Sound Ratings from Laboratory Test Data" and shall be the result of tests made in accordance with AMCA Standard 300 "Test Code for Sound Rating." Fans shall be licensed to bear the AMCA Certified Sound Ratings Seal.

2. Unit's fans performance ratings for flow rate, pressure, power, air density, speed of rotation, and efficiency shall be factory tested and ratings established in accordance with AMCA Standard 210/ASHRAE Standard 51 - Laboratory Methods of Testing Fans for Rating.

B. Fan Section Construction: Fan section shall be equipped with a formed steel channel base for integral mounting of fan, motor, and casing panels. The fan scroll, wheel, shaft, bearings, and motor shall be mounted on a structural steel frame with frame mounted on base with vibration isolators.

C. Fans and Shafts: Statically and dynamically balanced and designed for continuous operation at the maximum rated fan speed and motor horsepower. Centrifugal type fans shall be double-width, double-inlet type with forward-curved blades or backward-curved airfoil section blades as best suited for the application. Plenum type fans shall have backward-inclined airfoil blades with heavy gauge spun aluminum inlet cone. Forward-curved blade wheels shall be galvanized steel or bonderized steel painted with baked-enamel finish. Airfoil wheels shall be steel painted with zinc chromate primer and an enamel finish coat. Fan shaft shall be solid steel, turned, ground, and polished. Fan wheels shall be keyed to the shaft.

D. Shaft Bearings: Grease-lubricated ball bearings selected for 200,000 hours' average life, with grease fittings extended to an accessible location outside the fan section.

E. Fan Drives: Designed for a 1.4 service factor and factory mounted with final alignment and belt adjustment made after installation.

1. Belt Drive: Motors and fan wheel pulleys shall be adjustable pitch for use with motors up to and including 15 HP and fixed pitch for use with motors larger than 15 HP.

2. Provide steel belt guards on all belt drive motors.

2.5 MOTORS

A. General: Motors shall conform to the requirements specified in Section "Common Motor Requirements for HVAC Equipment".

B. Motor Sizes: Minimum size as indicated. If not indicated, large enough so that the driven load will not require the motor to operate in the service factor range.

C. Starters, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26.

2.6 COILS

A. Testing Requirements: The following factory tests are required:

1. Coil Performance Tests: Cooling and heating coils, except sprayed surface coils, shall be factory tested for rating in accordance with AHRI 410 - Standard for Forced-Circulation Air-Cooling and Air-Heating Coils.

B. Coil Pressure Ratings:

1. Water Coils: Design for 200 psi working pressure at 325 F, and pressure test at 300 psi under water.

2. Steam Coils: Design for 100 psi working pressure at 400 F, and pressure test at 300 psi.

3. Refrigerant Coils: Design for 300 psi working pressure, and pressure test at 450 psi.

C. Coil Sections: Common or individually insulated, galvanized steel casings for heating and cooling coils. Coil section shall be designed and constructed to facilitate removal of coil for maintenance and replacement and to assure full air flow through coils.

1. Multizone units shall have air deflectors and air baffles for balanced air flow across both heating and cooling coils.

2. Medium and high-pressure units shall have double gaskets between sections and coil connection penetrations through casing sealed to minimize leakage.

D. Coils, General: Drainable, rigidly supported across the full face of the coil, and pitched to allow drainage.

1. Fins: Aluminum or copper, constructed from flat plate with belled collars for tubes. Fins shall be bonded to tubes by mechanically expanding copper tubes.

a. Thickness: Minimum 0.006 inches.

b. Spacing: Maximum 12 fins per inch.

2. Tubes: Seamless copper.

3. Coil Casing: Galvanized steel.

4. Headers for Steam and Water Coils: Steel or cast iron, with connections for drain valve and air vent and threaded piping connections.

5. Water Coil Turbulators: Bronze, spring-type.

E. Steam Coils: Steam-distributing type. Support distributing tube concentrically, inside condensing tube with corrosion-resistant clips.

F. Integral Face and Bypass (IFB) Coils: Where indicated on the drawings, provide an IFB heating coil. Each coil shall be fully drainable, constructed of multiple, alternate heating passages and bypasses, with airflow proportioning to each. IFB coil pressure drop at full airflow shall not exceed that shown on the schedule. Provide unit as manufactured by Wing, Flo-Con or Control Air (Isomix).

G. Direct-Expansion Refrigerant Coils: Designed and fabricated in compliance with ASHRAE Standard 15, "Safety Code for Mechanical Refrigeration." Coils shall have the following features:

1. Suction Headers and Distributor Tubes: Seamless copper.

2. Venturi-type refrigerant distributor, designed for low pressure drop, arranged for down feed with solder connections, and having a maximum of 12 circuits for each distributor.

a. Coils with more than 12 circuits shall have two distributors.

b. Split circuit coils shall have two distributors.

H. Electric Resistance Coils: Open-wire type, 80 percent nickel, 20 percent chromium. Elements shall be uniformly distributed over cross-sectional area of unit with vertical support brackets to prevent coil element sag. Coil elements shall be insulated with ceramic bushings and supported in an aluminized or galvanized steel frame.

I. Electric resistance Coils: Finned-tubular construction with 80 percent nickel, 20 percent chromium. Elements shall be mounted in a copper-plated steel tube and surrounded by compacted magnesium-oxide powder. Tubes shall be spirally wound with copper-plated steel fins that are continuously brazed to tubes. Coils shall be mounted in an aluminized or galvanized steel frame.

1. Control Panel: NEMA 1 enclosure, complete with thermal cutouts, primary and secondary controls, backup contractors, subcircuit fusing, airflow switch, and a fused control transformer.

2. Controls shall include integral primary automatic and secondary manual reset thermal protection devices and static-pressure-type airflow switches to prevent energizing coil when airflow is inadequate.

3. Controls: Refer to the drawings for control sequence.

2.7 DAMPERS

A. General: Dampers and their operators shall comply with performance requirements specified in Division 23 Section "Instrumentation and Control Devices for HVAC."

1. Damper operators shall be electrically operated as specified in Division 23 Section "Direct Digital Control for HVAC."

B. Face and Bypass Dampers: Opposed-blade galvanized steel dampers, with steel operating rods rotating in sintered bronze or nylon bearings mounted in a single galvanized steel frame, and with operating rods

connecting together with a common linkage. Damper blades shall be break-formed at the edge, have gaskets and edge seals, and shall be mechanically fastened to the operating rod.

C. Zone Dampers: Two single-blade galvanized steel dampers offset 90 degrees from each other on the same steel operating rod. Operating rods shall rotate in sintered bronze or nylon bearings mounted in a singled galvanized steel frame. Damper blades shall be break-formed at the edge, have gaskets and edge seals, and shall be mechanically fasted to the operating rod.

D. Mixing Boxes: Parallel-blade dampers in a reinforced, galvanized steel cabinet. Damper blades shall be galvanized steel mechanically fastened to steel operating rod. Connect operating rods for each set of dampers together with a common linkage and interconnect linkages so dampers operated simultaneously and in the opposite direction (one opens when the other closes).

E. Combination Filter/Mixing Box: Parallel-blade dampers in a reinforced, galvanized steel cabinet. Damper blades shall be galvanized steel mechanically fastened to steel operating rod. Connect operating rods for each set of dampers together with a common linkage and interconnect linkages so dampers operate simultaneously and in the opposite direction (one opens when the other closes). Cabinet shall have support members to hold 2-inch-thick, pleated, flat permanent or throwaway filters. Mixing boxes shall have hinged access panels or doors to allow removal of filters for both sides of unit.

2.8 FILTERS SECTION

A. Air Filters: Refer to Division 23 Section "Particulate Air Filtration" for air filters required for air-handling units.

B. General: Filters shall comply with NFPA Standard 90A "Standard for the Installation of Air Conditioning and Ventilating Systems."

C. Filter Section: Cabinet material and finish shall match the air-handling unit cabinet, with filter media holding frames arranged for flat or angular orientation. Section shall have access doors on both sides of the unit.

2.9 AIR BLENDERS

A. Where specified on the drawings, the manufacturer shall provide air blenders manufactured by Air Blenders Products or Kees, Inc. Blender shall be of rotary design with radial blades. Blender shall be of galvanized steel construction. Blender shall be fabricated in one or more bolted sections of size to fit through access to air plenum area. Blender manufacturer shall have catalogued selections with pressure drop ratings and stratification performance ratings. Non-rated and non-tested devices are not acceptable.

2.10 ULTRAVIOLET LIGHTS

A. Provide ultraviolet light emitters as manufactured by UltraViolet Devices, Inc., Sterile Aire, American Ultraviolet Company or Triatomic Environmental Fresh-Aire UV. Emitters shall be provided on the leaving air side of all cooling coils to reduce surface and airborne microbial growth and transfer.

B. Emitters shall be mounted within 18 inches of the coil surface. Lamps shall be shielded, hot filament type, with cathode guards. Lamp connectors shall be water-resistant. Lamps shall be warranted for a minimum of 9000 hours service with output derating not to exceed 20%.

C. Power supplies shall be mounted externally on the air handler casing or they may be internally mounted within the air handler cabinet if the power supply is water resistant and is equipped with a water-resistant on-off switch. Power supplies shall utilize electronic auto-switching multi-voltage ballasts suitable for 120 VAC. Power supplies shall be U. L. listed and warranted for a minimum of 5 years.

D. Provide a safety door interlock to de-energize the emitter power supply when the coil section access door is open. Provide safety warning labels with a visible indicator to show UV emitter is energized.

E. The UV emitter power supply shall be interlocked with the air handler disconnect switch.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions under which air handling units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION, GENERAL

A. Install products in accordance with manufacturer's instructions.

B. Support floor-mounted units on concrete equipment bases using housed spring isolators. Secure units to anchor bolts installed in concrete equipment base.

C. Suspended Units: Suspend units from structural steel support frame using threaded steel rods and vibration isolation springs.

D. Arrange installation of units to provide access space around air-handling units for service and maintenance.

3.3 EQUIPMENT BASES

A. Construct concrete equipment pads in accordance with Section "Common Work Results for HVAC."

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 sections. The Drawings indicate the general arrangement of piping, valves, fittings, and specialties. The following are specific connection requirements:

1. Arrange piping installations adjacent to units to allow unit servicing and maintenance.

2. Connect water supply piping to the air leaving side of water coils.

3. Route unit condensate drain piping to location shown on the plan or, if not shown, to the nearest equipment or floor drain. Construct deep trap, minimum of 1" deeper than fan pressure in inches of water, at connection to drain pan and install cleanouts at changes in direction. Size condensate drain piping in accordance with local code and the following:

Piping Length	Size
Less than 10 feet	Same size as unit connection
More than 10 feet	One pipe size larger than unit connection

B. Duct installations and connections are specified in other Division 23 sections. Make final duct connections with flexible connections.

C. Electrical Connections: The following requirements apply:

1. Electrical power wiring is specified in Division 26.

2. Temperature control wiring and interlock wiring is specified in Division 23 section "Direct-Digital Control for HVAC."

D. Grounding: Connect unit components to ground in accordance with the National Electrical Code.

3.5 ADJUSTING, CLEANING, AND PROTECTING

A. Adjust water coil flow, with control valves to full coil flow, to indicated gpm.

B. Adjust damper linkages for proper damper operation.

C. Clean the entire unit including cabinet interiors just prior to substantial completion to remove foreign material and construction dirt and dust. Vacuum clean fan wheel, fan cabinet, intake plenum cabinet, heat exchange surfaces, cooling/heating coil sections, filter sections, access sections, etc.

3.6 STARTUP

A. Final Checks Before Start-Up: Perform the following operations and checks before start-up:

1. Remove shipping, blocking, and bracing.

2. Verify unit is secure on mountings and supporting devices and that connections for piping, ductwork, and electrical are complete. Verify proper thermal overload protection is installed in motors, starters, and disconnects.

3. Perform cleaning and adjusting specified in this Section.

4. Disconnect fan drive from motor and verify proper motor rotation direction and verify fan wheel free rotation and smooth bearings operations. Reconnect fan drive system, align belts, and install belt guards.

5. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.

6. Set zone dampers to full open for each zone.

7. Set face-and-bypass dampers to full face flow.

8. Set outside-air and return-air mixing dampers to minimum outside-air setting.

9. Comb coil fins for parallel orientation.

10. Install clean filters. Do not operate air handling unit without pre-filters installed.

11. Verify manual and automatic volume control, and fire and smoke dampers in connected ductwork systems are in the full-open position.

12. Disable automatic temperature control operators.

B. Start-Up Procedures: Start-up air-handling units in accordance with manufacturer's written start-up instructions and as specified herein. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

1. Energize motor, verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated RPM.

a. Replace fan and motor pulleys as required to achieve design conditions.

b. Measure and record motor electrical values for voltage and amperage.

c. Shut unit down and reconnect automatic temperature control operators.

d. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for procedures for air-handling-system testing, adjusting, and balancing.

3.7 TRAINING

A. General: At a time mutually agreed upon between the Owner and Contractor, provide the services of a factory trained and authorized representative to train Owner's designated personnel for a minimum of four hours on the operation and maintenance of the equipment provided under this section.

B. Content: Training shall include but not be limited to:

1. Overview of the system and/or equipment as it relates to the facility as a whole.

2. Operation and maintenance procedures and schedules related to startup and shutdown, troubleshooting, servicing, preventive maintenance and appropriate operator intervention.

3. Review data included in the operation and maintenance manuals. Refer to Division 1 Section "Operation and Maintenance Data."

C. Certification: Contractor shall submit to the Engineer a certification letter stating that the Owner's designated representative has been trained as specified herein. Letter shall include date, time, attendees

and subject of training. The certification letter shall be signed by the Contractor and the Owner's representative indicating agreement that the training has been provided.

D. Schedule: Schedule training with Owner with at least 7 days' advance notice.

END OF SECTION

SECTION 238126 - SPLIT SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Section includes split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

1. Indoor evaporator fan coil units.

2. Outdoor condenser units.

1.2 RELATED REQUIREMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division1 Specification Sections apply to this Section.

B. Section 221300 - Plumbing Piping for condensate drains.

C. Section 230500 – Common Work Results for HVAC for concrete, reinforcement, and formwork requirements.

D. Section 230529 – Hangers and Supports for HVAC Piping and Equipment.

E. Section 230550 – Vibration Isolation for HVAC Piping and Equipment.

F. Section 230593 - Testing, Adjusting, and Balancing for HVAC for unit balancing.

G. Section 230913 - Instrumentation and Control Devices for HVAC: Thermostats, humidistats, timeclocks.

H. Section 230923 – Direct Digital Control for HVAC for installing external control components.

I. Section 232300 – Refrigerant Piping for refrigerant piping connecting the system.

J. Section 233113 – Metal Ducts for ductwork connecting to units.

K. Section 262717 – Equipment Wiring: Electrical characteristics and wiring connections.

L. Section 233300 – Air Duct Accessories.

1.3 REFERENCE STANDARDS

A. AHRI 210/240 - Standard for Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment; most current edition.

B. ASHRAE Std 15 - Safety Standard for Refrigeration Systems; most current edition.

C. NFPA 70 – National Electric Code.

1.4 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, type of refrigerant used, refrigerant pipe sizing, and electrical characteristics. Provide short circuit current rating of units with factory mounted starter or variable frequency drive.

B. Shop Drawings: Provide drawings that indicate size, profile, dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection.

C. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.

D. Operation and Maintenance Data: Include start-up instructions, maintenance data, parts lists, controls, accessories, and trouble-shooting guide.

1. Include manufacturer's recommended maintenance schedule of units installed in a seacoast application, within 5 miles of the coast.

E. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Code for Mechanical Refrigeration."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Units shall be designed to operate with HCFC-free refrigerants.

D. Units shall be tested by a Nationally Recognized Testing Laboratory (NRTL), in accordance with ANSI/UL 1995 and bear the Listed Mark.

E. The system components shall be rated in accordance with AHRI Standard 210/240, Performance Rating of Unitary Air-Conditioning & Air-Source Heat Pump Equipment.

1.6 COORDINATION

A. Coordinate layout and installation of units and suspension components with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations with roof construction and actual equipment provided. Roof specialties are specified in Division 7 Sections. Concrete, reinforcement and formwork are specified in Division 3 Sections.

1.7 WARRANTY

A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

B. Special Warranty: A written warranty, executed by the manufacturer and signed by the Contractor, agreeing to replace components that fail in materials or workmanship within the specified warranty period, provided manufacturer's written instructions for installation, operation, and maintenance have been followed.

1. Warranty Period, Compressors: Manufacturers standard, but not less than 5 years after date of Substantial Completion.

1.8 SPARE PARTS

A. General: Furnish to Owner, with receipt, the following spare parts described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.

1. Fan Belts: One set for each belt-drive fan.

2. Gaskets: One set for each access door.

3. One set of spare filters of each type required for each unit.

4. If HVAC equipment is used during the construction period, Contractor shall provide one set of filters (if system is designed to include pre-filters and after-filters, provide only pre-filters) when the unit is started and replace filters when needed, but not less than every month. On the day of substantial completion, the Contractor shall clean the unit and provide a new set of filters at each location in the unit.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

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

1. Carrier.

2. Daikin US Corporation.

3. Fujitsu.

4. Friedrich

5. Lennox Industries, Inc..

6. Mitsubishi Electric & Electronics USA, Inc.

7. Samsung.

8. York.

2.2 INDOOR UNITS

A. General: Self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet, supply fan, heating and cooling element(s), controls, and accessories; wired for single power connection with control transformer.

B. Cabinet: Steel with baked enamel finish, easily removed and secured access doors with safety interlock switches, glass fiber insulation with reflective liner.

C. Supply Fan: Centrifugal type rubber mounted with direct or belt drive with adjustable variable pitch motor pulley.

D. Motor: Comply with NEMA designation temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

E. Air Filters: Washable type for wall-mount units, minimum 1 inch thick throwaway type for all other units, unless scheduled otherwise.

F. Evaporator Coils: Copper tube aluminum fin assembly, galvanized or polymer drain pan sloped in all directions to drain, drain connection, refrigerant piping connections, restricted distributor or thermostatic expansion valve.

G. Controls: Unit-mounted panel with contactors, control transformer with circuit breaker, solid-state temperature- and humidity-control modules, time-delay relay, and thermostat.

H. Where scheduled on the drawings, provide condensate lift pump with a built-in safety cutoff switch and integral check valve on discharge.

2.3 OUTDOOR UNITS

A. General: Self-contained, packaged, pre-wired unit consisting of cabinet, with compressor and condenser.

B. Air-Cooled Condenser:

1. General: Aluminum fin and copper tube coil, AHRI 520 with direct drive axial propeller fan resiliently mounted, galvanized fan guard.

2. Casing: Steel, baked enamel finish, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.

3. Compressor: Hermetic scroll-type with resilient suspension system, oil strainer, crankcase heater, start capacitor, relay, contactor, and internal motor overload protection.

4. Accessories:

   a. Liquid line filter drier.

   b. High pressure switch (manual reset).

   c. Low pressure switch (automatic reset).

   d. Service valve with gauge ports.

   e. Thermometer well in liquid line.

   f. Low-ambient kit where scheduled.

   g. Compressor short-cycling controls.

   h. Reversing valve for heat pump units.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine area for compliance with requirements for installation tolerances and other conditions affecting performance of units. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Verify that flooring or ceiling system is ready to receive work and opening dimensions are as indicated on Shop Drawings.

C. Verify that power supply is available and of the correct characteristics.

3.2 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install unit level and plumb.

C. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

D. Install roof-mounted, compressor-condenser components on roof equipment supports with vibration isolation. Anchor units to supports with removable, cadmium-plated fasteners.

E. Install ground-mounted, compressor-condenser components on cast-in-place concrete equipment base or polyethylene mounting base with vibration isolators.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate the general arrangement of piping. The following are specific connection requirements:

1. Arrange piping installations adjacent to units to allow unit servicing and maintenance.

2. Connect piping to air-handling units with flexible connectors.

3. Connect water supply piping to the air leaving side of water coils.

4. Connect hydronic piping to supply and return coil connections with shutoff-duty valve and union or flange on the supply connection and with throttling-duty valve and union or flange on the return connection.

B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

C. Route unit condensate drain to location shown on the drawings or, if not shown, to nearest indirect waste connection. Provide trap at drain pan, minimum of 1 inch deeper than fan pressure in inches of water, and install cleanouts at changes in direction. Size condensate drain piping in accordance with local code and the following:

Piping Length	Size
Less than 10 feet	Same size as unit connection
More than 10 feet	One pipe size larger than unit connection

D. Duct Connections: Duct installation requirements are specified in Section 233113 "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect ductwork to units with flexible duct connectors. Flexible duct connectors are specified in Section 233300 "Air Duct Accessories." Provide transitions to exactly match unit duct connection size.

3.4 ADJUSTING, CLEANING, AND PROTECTING

A. Adjust fan for required airflow in accordance with Section "Testing, Adjusting and Balancing." Tighten belts as required for proper operation.

B. Adjust water coil flow, with control valves to full coil flow, to indicated gpm.

C. Adjust damper linkages for proper damper operation.

D. Set initial temperature and humidity set points.

E. Clean the entire unit including cabinet interiors just prior to substantial completion to remove foreign material and construction dirt and dust. Vacuum clean fan wheel, fan cabinet, intake plenum cabinet, heat exchange surfaces, cooling/heating coil sections, filter sections, access sections, etc.

3.5 STARTUP

A. Final Checks Before Start-Up: Perform the following operations and checks before start-up:

1. Remove shipping, blocking, and bracing.

2. Verify unit is secure on mountings and supporting devices and that connections for piping, ductwork, and electrical are complete. Verify proper thermal overload protection is installed in motors, starters, and disconnects. Verify vibration isolation and flexible connections are installed correctly.

3. Perform cleaning and adjusting specified in this Section.

4. Disconnect fan drive from motor and verify proper motor rotation direction and verify fan wheel free rotation and smooth bearings operations. Reconnect fan drive system, align belts, and install belt guards.

5. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.

6. Set outside-air and return-air mixing dampers to minimum outside-air setting.

7. Comb coil fins for parallel orientation.

8. Install new filters at completion of installation and prior to testing, adjusting, and balancing. Do not operate air handling unit without pre-filters installed.

9. Verify manual and automatic volume control, and fire and smoke dampers in connected ductwork systems are in the full-open position.

10. Disable automatic temperature control operators.

B. Start-Up Services: Start-up units in accordance with manufacturer's written start-up instructions. Do not operate units without filters installed. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

1. Energize motor, verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated RPM.

a. Replace fan and motor pulleys as required to achieve design conditions.

b. Measure and record motor electrical values for voltage and amperage.

c. Shut unit down and reconnect automatic temperature control operators.

d. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for procedures for system testing, adjusting, and balancing.

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

D. Prepare test and inspection reports.

3.7 DEMONSTRATION

1. General: At a time mutually agreed upon between the Owner and Contractor, provide the services of a factory trained and authorized representative to train Owner's designated personnel for a minimum of two hours on the operation and maintenance of the equipment provided under this section.

2. Content: Training shall include but not be limited to:

a. Overview of the system and/or equipment as it relates to the facility as a whole.

b. Operation and maintenance procedures and schedules related to startup and shutdown, troubleshooting, servicing, preventive maintenance and appropriate operator intervention.

c. Review data included in the operation and maintenance manuals. Refer to Division 1 Section "Operating and Maintenance Data."

3. Certification: Contractor shall submit to the Engineer a certification letter stating that the Owner's designated representative has been trained as specified herein. Letter shall include date, time, attendees and subject of training. The certification letter shall be signed by the Contractor and the Owner's representative indicating agreement that the training has been provided.

4. Schedule: Schedule training with Owner with at least 7 days' advance notice.

END OF SECTION 238126

SECTION 238200 - TERMINAL HEATING AND COOLING UNITS

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

A. Extent of terminal heating and cooling unit work is indicated by drawings and schedules, and by requirements of this Section.

B. Types of terminal heating and cooling units required for project include the following:

1. Unit heaters
2. Cabinet heaters
3. Fan-Coil units

1.2 QUALITY ASSURANCE

A. Reference Standards:

1. AHRI 410 – Forced-Circulation Air-Cooling and Air-Heating Coils; Air-Conditioning, Heating, and Refrigeration Institute, most current edition.
2. AHRI 440 – Performance Rating of Room Fan-Coils; Air-Conditioning, Heating, and Refrigeration Institute, most current edition.
3. AHRI 840 – Performance Rating of Unit Ventilators; Air-Conditioning, Heating, and Refrigeration Institute, most current edition.
4. ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials, most current edition.
5. I=B=R Compliance: Test and rate baseboard and finned tube radiation in accordance with I=B=R, provide published ratings bearing emblem of I=B=R.
6. UL 723 – Standard for Test for Surface Burning Characteristics of Building Materials, Underwriter's Laboratory, most current edition.
7. UL 1995 – Heating and Cooling Equipment; Underwriter's Laboratory, most current edition.
8. UL Compliance: Provide electrical components for terminal heating and cooling units which have been listed and labeled by UL.
9. ISO Compliance: Fan coil units shall be manufactured in accordance with standard ISO 9001, Quality Management Systems, most current edition.
10. CSA C22.2 No. 236: Heating and Cooling Equipment, CSA Group, most current edition.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's specifications for terminal heating and cooling units showing dimensions, capacities, ratings, performance characteristics, gages and finishes of materials, and installation instructions.

B. Shop Drawings: Submit assembly-type shop drawings showing unit dimensions, construction details, and field connection details.

C. Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to terminal heating and cooling units. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

D. Samples: Submit 3 samples of each type of cabinet finish furnished.

E. Maintenance Data: Submit maintenance instructions, including lubrication instructions, filter replacement, motor and drive replacement, and spare parts lists. Include this data, product data, shop drawings in maintenance manuals; in accordance with requirements of Division 1.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Handle terminal heating and cooling units and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged terminal heating and cooling units or components; replace with new.

B. Store terminal heating and cooling units and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.

C. Comply with Manufacturer's rigging and installation instructions for unloading terminal heating and cooling units, and moving them to final location.

1.5 SPARE PARTS

A. General: Furnish to Owner, with receipt, the following spare parts for terminal heating and cooling units.

1. One set of matched fan belts for each belt driven fan.

2. One set of spare filters of each type required for each unit. Obtain receipt from Owner that spare filters have been provided. In addition to the spare set of filters, install new filters at completion of installation work, and prior to testing, adjusting, and balancing work.

3. If HVAC equipment is used during the construction period, Contractor shall provide one set of filters (if system is designed to include pre-filters and after-filters, provide only pre-filters) when the unit is started and replace filters when needed, but not less than every month. On the day of substantial completion, the Contractor shall clean the unit and provide a new set of filters at each location in the unit.

PART 2 - PRODUCTS AND MATERIALS

2.1 UNIT HEATERS

A. General: Provide unit heaters in locations as indicated, and of capacities, style, and having accessories as scheduled.

B. Horizontal Unit Heaters:

1. Casings: Construct of steel, phosphatized inside and out, and finished with baked enamel. Provide motor-mounted panel, minimum of 18-ga steel. Fabricate casing to enclose coil, louvers, and fan blades. Provide louvers for 4-way air diffusion.

2. Fans: Construct of aluminum, and factory-balance. Provide fan inlet orifice, smooth, and drawn into casing back panel.

C. Vertical Unit Heaters:

1. Casings: Construct of steel, phosphatized inside and out, and finished with baked enamel. Design casing to enclose fan, motor, and coil, design fan orifice formed into discharge panel. Provide air diffusers as scheduled.

2. Fans: Construct of aluminum and factory-balance. Design so motor and fan assembly is removable through fan outlet panel.

D. Coils: Construct of plate-type aluminum fins, mechanically bonded to copper tubes. Design coil for use in steam or hot water applications. Coil shall have minimum working pressure of 125 psig.

E. Motors: Provide totally enclosed motors, with built-in overload protection, having electrical characteristics as scheduled.

F. Manufacturer: Subject to compliance with requirements, provide unit heaters of one of the following:

1. Airtherm Mfg. Co.

2. Daikin Applied.

3. Dunham-Bush, Inc.

4. Modine Mfg. Co.

5. Rittling Hydro-Air Components, Inc.

6. Trane (The) Co.

7. Wing (The) Co.; Div. Wing Industries, Inc.

8. Young Radiator Co.

2.2 CABINET HEATERS

A. General: Provide cabinet heaters having cabinet sizes and in locations as indicated, and of capacities, style, and having accessories as scheduled. Include in basic unit chassis, coil, fanboard, fan wheels, housings, motor, and insulation.

B. Chassis: Galvanized steel wrap-around structural frame with edges flanged.

C. Insulation: Faced, heavy density glass fiber.

D. Cabinet: 16-ga removable front panel, 18-ga top and side panels. Insulate front panel over entire coil section. Provide access door on coil connection side. Clean cabinet parts, bonderize, phosphatize, and flow-coat with baked-on primer.

E. Water Coils: Construct of 5/8" seamless copper tubes mechanically bonded to configured aluminum fins. Design for 200 psi and pressure test at 300 psi under water. Provide same end connections for supply and return.

F. Steam Coils: Construct of 1" seamless copper tubes mechanically bonded to configured aluminum fins. Design for 100 psi and pressure test at 300 psi. Provide cast-iron headers, and same end connections for supply and return.

G. Fans: Provide centrifugal, forward curved double width fan wheels constructed of non-corrosive, molded, fiberglass- reinforced thermo-plastic material. Construct fan scrolls of galvanized steel.

H. Motors: Provide shaded pole motors with integral thermal over-load protection, and motor cords for plug-in to junction box in unit.

I. Filters: Provide 1" thick throwaway type filters in fiberboard frames. Filters shall have minimum MERV rating per ASHRAE 52.2 of MERV 4.

J. Accessories: Provide the following accessories as indicated and/ or scheduled.

1. Wall Boxes: Provide aluminum wall boxes with integral eliminators and insect screen.

2. Recessing Flanges: Provide 18-ga steel flanges for recessing cabinet heaters into wall or ceiling.

3. Sub-bases: Provide 18-ga steel sub-base for vertical units, height as indicated.

4. Extended Oilers: Provide plastic motor oiler tubes extending to beneath top discharge grille.

K. Manufacturer: Subject to compliance with requirements, provide cabinet heaters of one of the following:

1. Airtherm Mfg. Co.

2. Daikin Applied.

3. Dunham-Bush, Inc.

4. Modine Mfg. Co.

5. Trane (The) Co.

6. Young Radiator Co.

7. Zehnder Rittling.

2.3 FAN-COIL UNITS

A. General: Provide fan-coil units having cabinet sizes, and in locations indicated, and of capacities, style, and having accessories as scheduled. Include in basic unit chassis, coils. fanboard, drain pan assembly, fans, housing, motor, filter and insulation.

1. Units shall be listed according to UL 1995.

2. Units shall be listed according to CSA C22.2 No. 236.

3. Units shall be certified according to AHRI 440.

4. Units shall be manufactured in accordance with ISO 9001.

B. Chassis: Construct chassis of galvanized steel with flanged edges.

C. Insulation:

1. Faced, heavy density glass fiber.

2. Elastomeric closed cell foam shall conform to UL 181 for erosion and NFPA 90A for fire, smoke and melting, and comply with a 25/50 Flame Spread and Smoke Developed Index per ASTM E-84 or UL 723. Additionally, insulation shall comply with Antimicrobial Performance Rating of 0, no observed growth, per ASTM G-21.

D. Cabinet: Construct of 18-ga steel removable panels, 16-ga front. Provide insulation over entire coil section. Clean cabinet parts, bonderize, phosphatize, and flow-coat with baked-on primer.

E. Refrigerant Coils: Construct direct expansion coils of 2-row copper tubes and aluminum fins, conforming to AHRI 210. Provide factory-installed thermal expansion valve, refrigerant filter/dryer, and R-410A holding charge. Equip with sweat connection special adapters, service valves, and sight glass. Design for 300 psi working pressure, and pressure test at 450 psi.

F. Drain Pans: Construct of galvanized steel. Insulate with polystyrene, elastomeric closed cell foam, or polyurethane insulation. Provide drain connection.

G. Fans: Provide centrifugal forward curved double width wheels of reinforced fiberglass or galvanized steel, in galvanized steel fan scrolls.

H. Motors: Provide motors with integral thermal overload protection. Run test motors at factory in assembled unit prior to shipping. Provide quickly detachable motor cords.

I. Filters: Provide 2" thick throwaway type filters in fiberboard frames. Filters shall have minimum MERV rating per ASHRAE 52.2 of MERV 8.

J. Dampers: Provide 18-ga steel damper blades with polyurethane stop across entire blade length. Provide factory-mounted electric operators for 25% open cycle.

K. Accessories: Provide the following accessories as indicated and/or scheduled:

1. Wall Boxes: Provide aluminum wall boxes with integral eliminators and insect screen.

2. Discharge Grille Panels: Provide 18-ga galvanized or epoxy powder coated steel, stamped integral grilles, with access doors.

3. Sub-Bases: Provide 18-ga steel sub-base, height as indicated.

4. Extended Oilers: Provide plastic motor oiler tubes extending to beneath top discharge grille.

5. Recessing Flanges: Provide 18-ga steel flanges for recessing fan-coil units into wall or ceiling.

6. Provide an integral condensate switch to prevent unit from operating if drain becomes blocked.

7. Provide an integral condensate pump with GFCI to continuously remove condensate.

8. Floor mounted units: Provide adjustable leveling legs.

9. Provide a service disconnect switch to isolate power from the unit during maintenance.

L. Electrical: Unit shall have single point power connection with voltage and phase as scheduled on the drawings.

M. Manufacturer: Subject to compliance with requirements, provide fan-coil units of one of the following:

1. Airtherm Mfg. Co.

2. Carrier Corp.

3. Daikin Applied.

4. Dunham-Bush, Inc.

5. Enviro-Tec by Johnson Controls, Inc.

6. International Environmental Corp.

7. Johnson Controls, Inc.

8. Trane (The) Co.

9. Williams

10. Zehnder Rittling.

PART 3 - EXECUTION

3.1 GENERAL

A. Install terminal heating and cooling units in accordance with manufacturer's written instructions.

B. Examine areas to receive terminal heating and cooling units for compliance with requirements for installation tolerances and other conditions affecting performance.

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

D. Suspended Units: Suspend units from structural steel support frame using threaded steel rods and vibration isolation springs.

E. Arrange installation of units to provide access space around units for service and maintenance.

3.2 INSTALLATION OF BASEBOARD RADIATION

A. Center elements under windows. Where multiple windows occur over units, divide element into equal segments centered under each window.

B. Install end caps where units butt against walls. Install access panels centered in front of each shutoff valve, balancing cock, or temperature control valve.

3.3 INSTALLATION OF UNIT HEATERS

A. Hang units from building substrate, not from piping. Mount as high as possible to maintain greatest headroom possible unless otherwise indicated.

B. Support units with rod-type hangers anchored to building substrate.

C. Protect units with protective covers during balance of construction.

3.4 PIPING CONNECTIONS

A. Piping: Piping installation requirements are specified in other Division 23 sections. The Drawings indicate the general arrangement of piping, valves, fittings, and specialties. The following are specific connection requirements:

1. Arrange piping installations adjacent to units to allow unit servicing and maintenance.

2. Connect water supply piping to the air leaving side of water coils.

3. Route unit condensate drain from cooling coil drain pans to location shown on the drawings or, if not shown, to nearest indirect waste connection. Provide trap at drain pan, minimum of 1" deeper than fan pressure in inches of water, and install cleanouts at changes in direction. Size condensate drain piping in accordance with local code and the following:

Piping Length	Size

Less than 10 feet	Same size as unit connection
More than 10 feet	One pipe size larger than unit connection

3.5 ELECTRICAL WIRING

A. General: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electric Installer.

1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 Sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.

3.6 ADJUSTING AND CLEANING

A. General: Just prior to substantial completion clean unit's exposed surfaces and vacuum clean internal components including fan wheel, fan cabinet, all heat exchange surfaces, cooling/heating coil sections, filter sections, access sections, etc.

B. Retouch any marred or scratched surfaces of factory-finished surfaces, using finish materials furnished by manufacturer.

C. Install new filters in terminal heating and cooling units requiring same. Do not operate units without filters installed.

3.7 STARTUP

A. Final Checks Before Start-Up: Perform the following operations and checks before start-up:

1. Remove shipping, blocking, and bracing.

2. Verify unit is secure on mountings and supporting devices and that connections for piping, ductwork, and electrical are complete. Verify proper thermal overload protection is installed in motors, starters, and disconnects.

3. Perform cleaning and adjusting specified in this Section.

4. Disconnect fan drive from motor and verify proper motor rotation direction and verify fan wheel free rotation and smooth bearings operations. Reconnect fan drive system, align belts, and install belt guards.

5. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.

B. Start-Up Services: Start-up terminal heating and cooling units in accordance with manufacturer's written start-up instructions. Do not operate units without filters installed. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

1. Energize motor, verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated RPM.

a. Replace fan and motor pulleys as required to achieve design conditions.

b. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for procedures for system testing, adjusting, and balancing.

END OF SECTION