

DIVISION 15 - MECHANICAL

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SECTION 15050

COMMON WORK RESULTS FOR PLUMBING

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.
- B. The provisions of This Section, Common Work Results for Plumbing, apply to all sections in Division 15.
- C. All Sections of Division 15 are interrelated. When interpreting any direction, material, and method specified in any section of Division 15 consider it within the entirety of Work in Division 15.

1.2 SUMMARY

- A. The intent of Division 15 Specifications and the accompanying Drawings is to provide a complete and workable facility with complete systems as shown, specified and required by applicable codes. Include all work specified in Division 15 and shown on the accompanying Drawings, including appurtenances, connections, etc., in the finished job.
- B. The Division 15 Specifications and the accompanying Drawings are complimentary and what is called for by one shall be as binding as if called for by both. Items shown on the Drawings are not necessarily included in the Specifications and vice versa. Specifications shall supersede drawings in case of conflict.
- C. Imperative language is frequently used in Division 15 Specifications. Except as otherwise specified, requirements expressed imperatively are to be performed by the Contractor.
- D. The Drawings that accompany the Division 15 Specifications are diagrammatic. They do not show every offset, bend, tee, or elbow which may be required to install work in the space provided and avoid conflicts. Offsets and transitions shall be assumed at a minimum at each duct crossing, structural penetrations through shear walls or beams, structural grids where ceiling heights are restricted, and at piping mains. Follow the Drawing as closely as is practical to do so and install additional bends, offsets and elbows where required by local conditions from measurements taken at the Building, subject to approval, and without additional cost to the Owner. The right is reserved to make any reasonable changes in fixture location prior to roughing-in, without cost impact.

1.3 RELATED WORK

- A. The General and Supplemental Conditions apply to this Division, including but not limited to:
 - 1. Drawings and specifications.
 - 2. Public ordinances, permits.

3. Include payments and fees required by governing authorities for work of this Division.

B. Division 1, General Requirements, applies to this Division.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements:

1. All products and equipments shall comply with Oregon Revised Statute (ORS) 453.005(7)(e) prohibiting pentabrominated, octabrominated and decabrominated diphenyl ethers. Where products or equipments within this specification contain these banned substances, provide complying products and equipments from approved manufacturers with equal performance characteristics.
2. General: All work and materials shall conform to the local and State codes, and all Federal, State and other applicable laws and regulations.
3. Contractor responsible for obtaining and payment for all permits, licenses, and inspection certificates required in accordance with provisions of Contract Documents.

B. Materials and equipment shall be new. Work shall be of good quality, free of faults and defects and in conformance with the Contract Documents.

C. Apparatus shall be built and installed to deliver its full rated capacity at the efficiency for which it was designed.

D. The entire plumbing system and apparatus shall operate at full capacity without objectionable noise or vibration.

E. All equipment shall be installed level and true. Housekeeping pads and curbs shall account for floor or roof slope.

F. Materials and Equipment:

1. Each piece of equipment furnished shall meet all detailed requirements of the Drawings and Specifications and shall be suitable for the installation shown. Equipment not meeting all requirements will not be acceptable, even though specified by name along with other manufacturers.
2. Where two or more units of the same class of equipment are furnished, use products of the same manufacturer. Component parts of the entire system need not be products of same manufacturer.
3. Furnish all materials and equipment of size, make, type, and quality herein specified.
4. Equipment scheduled by performance or model number shall be considered the basis of the design. If other specified manufacturer's equipment is provided in lieu of the basis of design equipment the contractor is responsible for all changes and costs which may be necessary to accommodate this equipment, including different sizes and locations for connections, different electrical characteristics, different dimensions, different access requirements or any other differences which impact the project.

G. Workmanship:

1. General: All materials shall be installed in a neat and professional manner.

2. Manufacturer's Instructions: Follow manufacturer's directions where they cover points not specifically indicated. If they are in conflict with the Drawings and Division 15 Specifications, obtain clarification before starting work.

H. Cutting and Patching:

1. Cutting, patching, and repairing for the proper installation and completion of the work specified in this Division including plastering, masonry work, concrete work, carpentry work, and painting shall be performed by skilled craftsmen of each respective trade in conformance with the appropriate Division of Work.
2. Additional openings required in building construction shall be made by drilling or cutting. Use of jackhammer is specifically prohibited.
3. Fill holes which are cut oversize so that a tight fit is obtained around the sleeves passing through.
4. Beams or columns shall not be pierced without permission of Architect and then only as directed.
5. All new or existing work cut or damaged shall be restored to its original condition. Where alterations disturb lawns, paving, walks, etc., the surfaces shall be repaired, refinished, and left in condition existing prior to commencement of work.

1.5 SUBMITTALS

A. Shop Drawings:

1. The Contract Drawings indicate the general layout of the piping, and various items of equipment. Coordination with other trades and with field conditions will be required. For this purpose, prepare Shop Drawings of all piping, and equipment installations. Shop Drawings shall be new drawings prepared by Contractor and not reproductions or tracings of Architect's Drawings. Overlay drawings with shop drawings of other trades and check for conflicts. All drawings shall be same size as Architect's Drawings with title block similar to Contract Drawings and identifying Architect's Drawing number or any reference drawings. All drawings shall be fully dimensioned including both plan and elevation dimensions. Shop drawings cannot be used to make scope changes.

B. Product Data:

1. In general, submit product data for review on all scheduled pieces of equipment, on all equipment requiring electrical connections or connections by other trades, and as required by each specification section or by Drawing notes. Include manufacturer's detailed shop drawings, specifications and data sheets. Data sheets shall include capacities, RPM, BHP, pressure drop, design and operating pressures, temperatures, and similar data. Manufacturer's abbreviations or codes are not acceptable.
2. List the name of the motor manufacturer and service factor for each piece of equipment.
3. Indicate equipment operating weights including bases and weight distribution at support points.
4. In the case of equipment such as wiring devices, time switches, valves, etc., specified by specific catalog number, a statement of conformance will suffice.

C. Submission Requirements:

1. Shop Drawings and Product Data:
 - a. Refer to Division 1 for additional requirements related to submittals.

- b. Submit copies of shop drawings and product data for Work of Division 15 in a 3-ring loose leaf binder with each item filed under a tab and labeled with its respective specification section number, article and paragraph, and mark if applicable.
- c. Submit electronic copies of shop drawings and product data for Work of Division 15 in PDF format with each item filed under a folder and labeled with its respective specification section number, article, and paragraph and mark, if applicable.
- d. Include a complete index in the original submittal. Indicate both original items submitted and note stragglers that will be submitted at a later date to avoid delay in submitting.
- e. The bulk of the shop drawings and product data, excepting Controls and Instrumentation, shall be included with the original submittal. Controls and Instrumentation submittals may lag but shall be complete when submitted. Partial submittals will not be accepted. Other stragglers submitted after return of the original binder shall include a tab similar to that originally submitted. Upon receipt of the returned late submittal, insert them in the previously submitted binder.

- D. Contractor Responsibilities: It shall be the Contractor's responsibility to:
 - 1. See that all submittals are submitted at one time and are in proper order.
 - 2. Ensure that all equipment will fit in the space provided.
 - 3. Assure that all deviations from Drawings and Specifications are specifically noted in the submittals. Failure to comply will void review automatically.

1.6 OPERATING AND MAINTENANCE MANUAL, PARTS LISTS, AND OWNERS INSTRUCTIONS

- A. Refer to Division 1 for additional requirements.
- B. Submit three bound copies of manufacturer's operation and maintenance instruction manuals and parts lists for each piece of equipment or item requiring servicing. Literature shall be on 8-1/2"x11" sheets or catalogs suitable for side binding. Submit data when the work is substantially complete, packaged separately, and clearly identified in durable 3-ring binder. Include name and contact information for location of source parts and service for each piece of equipment. Clearly mark and label in each submittal, the piece of equipment provided with the proper nameplate and model number identified. Provide wiring diagrams for all electrically powered equipment.
- C. Instruct Owner thoroughly in proper operation of equipment and systems, in accordance with manufacturer's instruction manuals. Operating instructions shall cover all phases of control.

1.7 PROJECT CONDITIONS

- A. Existing Conditions: Prior to bidding, verify and become familiar with all existing conditions by visiting the site, and include all factors which may affect the execution of this Work. Include all related costs in the initial bid proposal.

- B. Coordinate exact requirements governed by actual job conditions. Check all information and report any discrepancies before fabricating work. Report changes in time to avoid unnecessary work.
- C. Coordinate shutdown and start-up of existing, temporary, and new systems and utilities. Notify Owner, City and Utility Company.

1.8 WARRANTY

- A. Provide a written guaranty covering the work of this Division (for a period of one calendar year from the date of acceptance by the Owner) as required by the General Conditions.
- B. Provide manufacturer's written warranties for material and equipment furnished under this Division insuring parts and labor for a period of one year from the date of Owner acceptance of Work of this Division.
- C. Correct warranty items promptly upon notification.

1.9 PROVISIONS FOR LARGE EQUIPMENT

- A. Contractor shall make provisions for the necessary openings in building to allow for admittance of all equipment.

1.10 TEST REPORTS AND CERTIFICATES

- A. Contractor shall submit one copy of all test reports and certificates specified herein to the Architect.

1.11 SUBSTITUTIONS

- A. Contractor shall submit any requests for product substitutions in accordance with the Instructions to Bidders and the General and Supplemental Conditions.

PART 2 - PRODUCTS

2.1 ACCESS PANELS

- A. Furnish under this Division as specified in another Division of work.

2.2 PIPE SLEEVES

- A. Interior Wall and Floor Sleeves: 18 gauge galvanized steel, or another pre-approved system.
- B. Interior Wall and Floor Sleeves (fire rated): Fire rated and water tight system approved by Authority Having Jurisdiction and Owners Insurance underwriter, with rating equal to floor or wall penetration, and designed specifically for the floor or wall construction, piping material, size and service.

- C. Exterior Wall Sleeves: Cast iron.
- D. On Grade Floor Sleeves: Same as exterior wall sleeves.
- E. Water Tight Sleeves: Combination steel pipe sleeves with water stop and anchor plate; Link Seal Model WS, mated with synthetic rubber links interlocked with bolts and nuts; Link Seal Model LS.

2.3 FLOOR, WALL AND CEILING PLATES

- A. Furnish stamped split type plates as follows:
 1. Floor Plates: Cast brass, chromium plated.
 2. Wall and Ceiling Plates: Spun aluminum.

2.4 MACHINERY GUARDS

- A. Furnish guards for protection on all rotating and moving parts of equipment. Provide guards for all metal fan drives and motor pulleys, regardless of being enclosed in a metal cabinet.
- B. Design guards so as not to restrict air flow at fan inlets resulting in reduced capacity.
- C. Provide shaft holes in guards for easy use of tachometers at pulley centers. Guards shall be easily removable for pulley adjustment or removal and changing of belts.
- D. All guards shall meet OSHA requirements including back plates.
- E. Provide inlet and outlet screens on all fans in plenums or where exposed to personnel.

2.5 ELECTRICAL EQUIPMENT

- A. General: All equipment and installed work shall be as specified under Division 26, Electrical.
- B. Coordinate with the electrical Drawings and electrical contractor for minimum electrical equipment bracing requirements based on the available interrupting current (AIC) rating at the bus of the panelboard or switchboard serving the piece of equipment. Provide equipment that meets the bracing requirement.
- C. Motors:
 1. Motors shall be furnished as integral part of driven equipment. They shall be drip-proof induction type with ball bearings unless noted otherwise. Motors 1 HP and above shall be premium energy efficient type, except for emergency equipment motors. Motors shall be built to NEMA Standards for the service intended. The motors shall be rated for the voltage specified, suitable for operation within the range of 10% above to 10% below the specified voltage.
 2. Energy efficient motors shall be Baldor, Westinghouse, General Electric or approved equal.
 3. The motor shall meet the efficiency standards identified in the table below as determined using the IEEE Method B test at full load.

| MINIMUM MOTOR EFFICIENCIES | | | | | |
|-----------------------------------|-----------|-----------------------------|-------------|-------------|-------------|
| | | RPM | | | |
| | | IEEE 112B Efficiency | | | |
| HP | KW | 900 | 1200 | 1800 | 3600 |
| 1 | 0.75 | -- | 82.5 | 85.5 | 80.0 |
| 1.5 | 1.15 | -- | 86.5 | 86.5 | 85.5 |
| 2 | 1.53 | -- | 87.5 | 86.5 | 86.5 |
| 3 | 2.3 | 84.0 | 89.5 | 89.5 | 88.5 |
| 5 | 3.8 | 85.5 | 89.5 | 89.5 | 89.5 |
| 7.5 | 5.6 | 87.5 | 91.7 | 91.7 | 91.0 |
| 10 | 7.5 | 88.5 | 91.7 | 91.7 | 91.7 |
| 15 | 7.5 | 88.5 | 91.7 | 92.4 | 91.7 |
| 20 | 15.9 | 90.2 | 92.4 | 93.0 | 92.4 |
| 25 | 18.8 | 91.0 | 93.0 | 93.6 | 93.0 |
| 30 | 22.5 | 91.0 | 93.6 | 94.1 | 93.0 |
| 40 | 30.0 | 91.7 | 94.1 | 94.5 | 93.6 |
| 50 | 37.5 | 92.4 | 94.1 | 94.5 | 94.1 |
| 60 | 45.0 | 93.0 | 94.5 | 95.0 | 94.1 |
| 75 | 56.3 | 93.0 | 95.0 | 95.4 | 94.5 |
| 100 | 75.0 | 93.0 | 95.4 | 95.4 | 95.0 |
| 125 | 93.8 | 94.5 | 95.4 | 95.4 | 95.4 |
| 150 | 112.5 | 94.5 | 95.8 | 95.8 | 95.4 |
| 200 | 150.0 | 94.5 | 95.8 | 96.2 | 95.8 |
| 250 | 187.5 | 94.5 | 95.1 | 96.2 | 95.1 |
| 300 | 225.0 | 94.5 | 95.3 | 96.2 | 95.3 |
| 350 | 225.0 | 94.5 | 95.3 | 96.2 | 95.3 |
| 400 | 300.0 | 94.5 | 95.4 | 96.2 | 95.4 |
| 450 | 337.5 | 94.5 | 95.5 | 96.2 | 95.5 |
| 500 | 375.0 | 94.5 | 95.6 | 96.2 | 95.6 |

4. Refer to Equipment Schedules on the Drawings for motor horsepower, voltage and phase.
5. Refer to individual product sections for additional motor requirements.
6. Motors shall have built-in thermal overload protection, or be protected externally with separate thermal overload devices with low voltage release or lockout. Hermetically sealed motors shall have quick trip devices.
7. All motors controlled by variable frequency drives shall be inverter duty rated and have Class F insulation or better. They shall also be able to withstand repeated voltage peaks of 1600 volts with rise times of 0.1 microseconds and greater in accordance with NEMA Standard MG1 Part 31.
8. Motors served from variable frequency drives shall be equipped with shaft grounding system which shall provide a path for current to flow between the shaft and motor frame. SGS or equal.
9. Motors located in environment air plenums not tied to air handling functions shall be totally enclosed type motors.

- D. Starters: Provided under Division 26, Electrical, suitable for performing the control functions required, with the exception of self-contained equipment and where the starters are furnished as part of the control package.
- E. Equipment Wiring: Interconnecting wiring within or on a piece of mechanical equipment shall be provided with the equipment unless shown otherwise. This does not include the wiring of motors, starters and controllers provided under Division 26, Electrical.
- F. Control Wiring: All control wiring for plumbing equipment shall be provided herewith.
- G. Codes: All electrical equipment and products shall bear the Underwriters label as required by governing codes and ordinances.

PART 3 - EXECUTION

3.1 ACCESS PANELS

- A. Install in accord with manufacturer's recommendations, coordinated with architectural features.
- B. Provide 2-hour fire rated doors where required bearing the U.L. label.
- C. Furnish 18x18-inch panels for ceilings and for access to equipment in soffits and shafts, and 12x12-inch for walls unless indicated otherwise.
- D. Furnish where indicated and where required to access valves, trap primers, shock arresters, and other appurtenances requiring operation, service or maintenance. Submit proposed locations for review prior to installation.

3.2 SLEEVES

- A. Interior Floor and Wall Sleeves: Provide sleeves large enough to provide 3/4-inch clearances around pipe or ductwork. Where pipe or ductwork is insulated, insulation shall pass continuously through sleeve with 3/4-inch clearance between insulation and sleeve. Penetrations through mechanical room and fan room floors shall be made watertight by packing with safing insulation and sealing with Tremco Dymeric Sealant or approved system.
- B. Sleeves Through Rated Floors and Walls: Similar to interior sleeves except install fire rated system approved by Authority Having Jurisdiction and Owners insurance underwriter, with rating equal to floor or wall penetration, and designed specifically for the floor or wall construction, piping material, size and service.
- C. Exterior Wall Sleeves Below Grade: Provide water tight sleeves. Install at pipes entering building below grade and where shown. Adjust to provide positive hydrostatic seal. Contractor shall be responsible for following manufacturer's procedure for installing and tightening seal. Secure sleeves against displacement.
- D. On Grade Floor Sleeves: Same as below grade exterior wall sleeves, caulked from inside.

- E. Exterior Wall Sleeves Above Grade: Similar to interior wall sleeves except caulk outside with Tremco Dymeric Sealant.
- F. Layout work prior to concrete forming. Do all cutting and patching required. Reinforce sleeves to prevent collapse during forming and pouring.
- G. All floor sleeves shall maintain a water barrier by providing a water tight seal or they shall extend 1-inch above finished floor except through mechanical equipment room floors and shafts where sleeves shall extend 2 inches above finished floor level. Sleeves through roof shall extend 8 inches above roof. Wall sleeves shall be flush with face of wall unless otherwise indicated. Waste stacks using carriers shall have sleeves flush with floor and sealed. Sleeves through planters shall extend 8 inches above planter base.
- H. Do not support pipes by resting pipe clamps on floor sleeves. Supplementary members shall be provided so pipes are floor supported.
- I. Special sleeves detailed on drawings shall take precedence over this section.

3.3 CLEANING

- A. General: Clean plumbing equipment, fixtures and piping of stampings and markings (except those required by codes), iron cuttings, and other refuse.
- B. Painted Surfaces: Clean scratched or marred painted surfaces of rust or other foreign matter and paint with matching color industrial enamel, except as otherwise noted.
- C. Additional requirements are specified under specific Sections of this Division.

3.4 EQUIPMENT PROTECTION

- A. Keep pipe and conduit openings closed by means of plugs or caps to prevent the entrance of foreign matter. Protect piping, conduit, fixtures, equipment and apparatus against dirty water, chemical or mechanical damage both before and after installation. Restore damaged or contaminated fixtures, equipment, or apparatus to original conditions or replace at no cost to the Owner.
- B. Protect bright finished shafts, bearing housings, and similar items until in service. No rust will be permitted.
- C. Cover or otherwise suitably protect equipment and materials stored on the job site.

3.5 ACCESSIBILITY

- A. General: Locate valves, thermometers, cleanout fittings and other indicating equipment or specialties requiring frequent reading, adjustments, inspection, repairs, and removal or replacement conveniently and accessibly with reference to the finished building.
- B. Thermometers and Gauges: Install thermometers and gauges so as to be easily read from the floors, platforms and walkways.

3.6 FLOOR, WALL AND CEILING PLATES

- A. Install on piping and ductwork passing through finished walls, floors, ceilings, partitions, and plaster furrings. Plates shall completely cover opening around pipe.
- B. Secure wall and ceiling plates to pipe, insulation, or structure.
- C. Plates shall not penetrate insulation vapor barriers.
- D. Plates not required in mechanical rooms or unfinished spaces.

3.7 PAINTING

- A. General: Coordinate painting of mechanical equipment and items with products and methods in conformance with the appropriate Division of Work, Painting. All exposed work under this division shall receive either a factory painted finish or a field prime coat finish, except:
 - 1. Exposed copper piping.
 - 2. Aluminum jacketed outdoor insulated piping.
- B. Equipment Rooms and Finished Areas:
 - 1. Insulation: Not painted.
 - 2. Hangers, Uninsulated Piping, Miscellaneous Iron Work, Structural Steel Stands, Uninsulated Tanks, and Equipment Bases: Paint one coat of black enamel.
 - 3. Steel Valve Bodies and Bonnets: One coat of black enamel.
 - 4. Brass Valve Bodies: Not painted.
 - 5. Equipment: One coat of grey machinery enamel. Do not paint nameplates.
- C. Concealed Spaces (above ceilings, not visible):
 - 1. Insulation: Not painted.
 - 2. Hangers, Uninsulated Piping, Miscellaneous Iron Work, Valve Bodies and Bonnets: Not painted.
- D. Exterior Steel: Wire brush and apply two coats of rust-inhibiting primer and one coat of grey exterior machinery enamel.
- E. Exterior Black Steel Pipe: Wire brush and apply two coats of rust-inhibiting primer and one coat of exterior enamel. Painting schemes shall comply with ANSI A13.1.

3.8 ADJUSTING AND CLEANING

- A. Before operating any equipment or systems, make thorough check to determine that systems have been flushed and cleaned as required and equipment has been properly installed, lubricated, and serviced. Check factory instructions to see that installations have been made accordingly and that recommended lubricants have been used.
- B. Use particular care in lubricating bearings to avoid damage by overlubrication and blowing out seals. Check equipment for damage that may have occurred during shipment, after delivery, or during installation. Repair damaged equipment as approved or replace with new equipment.

3.9 ELECTRICAL EQUIPMENT

- A. Piping for plumbing systems not serving electrical space shall not be installed in any switchgear room, transformer vault, telephone room, or electric closet except as indicated.
- B. Piping for plumbing systems shall not pass over switchboards or electrical panelboards. Where conflicts exist, bring to attention of Architect.

3.10 EQUIPMENT CONNECTIONS

- A. Make final connections to equipment specified in sections other than Division 15 of the specifications and Owner furnished equipment in accordance with manufacturer's instructions and shop drawings furnished and as indicated.
- B. Piping:
 - 1. Connections shall include hot and cold water, deionized water, distilled water, natural gas, medical gases, medical air and vacuum, dental air and vacuum, lab air and vacuum, sanitary waste and vent, lab waste and vent and fuel oil.
 - 2. Provide valves and specialties as specified and as detailed on the Drawings. Provide increasers, reducers, and any other fittings required for complete installation.
 - 3. All piping connections shall be independently supported to prevent undue strain on equipment.

END OF SECTION

SECTION 15051

COMMON WORK RESULTS FOR HVAC

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.
- B. The provisions of This Section, Common Work Results for HVAC, apply to all sections in Division 15.
- C. All Sections of Division 15 are interrelated. When interpreting any direction, material, and method specified in any section of Division 15, consider it within the entirety of Work in Division 15.

1.2 SUMMARY

- A. The intent of Division 15 Specifications and the accompanying Drawings is to provide a complete and workable facility with complete systems as shown, specified and required by applicable codes. Include all work specified in Division 15 and shown on the accompanying Drawings, including appurtenances, connections, etc., in the finished job.
- B. The Division 15 Specifications and the accompanying Drawings are complimentary and what is called for by one shall be as binding as if called for by both. Items shown on the Drawings are not necessarily included in the Specifications and vice versa. Specifications shall supersede drawings in case of conflict.
- C. Imperative language is frequently used in Division 15 Specifications. Except as otherwise specified, requirements expressed imperatively are to be performed by the Contractor.
- D. The Drawings that accompany the Division 15 Specifications are diagrammatic. They do not show every offset, bend, tee, or elbow which may be required to install work in the space provided and avoid conflicts. Offsets and transitions shall be assumed at a minimum at each duct crossing, structural penetrations through shear walls or beams, structural grids where ceiling heights are restricted, and at piping mains. Follow the Drawing as closely as is practical to do so and install additional bends, offsets and elbows where required by local conditions from measurements taken at the Building, subject to approval, and without additional cost to the Owner. The right is reserved to make any reasonable changes in outlet location prior to roughing-in, without cost impact.

1.3 RELATED WORK

- A. The General and Supplemental Conditions apply to this Division, including but not limited to:
 - 1. Drawings and specifications.
 - 2. Public ordinances, permits.

3. Include payments and fees required by governing authorities for work of this Division.

B. Division 1, General Requirements, applies to this Division.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements:

1. All products and equipments shall comply with Oregon Revised Statute (ORS) 453.005(7)(e) prohibiting pentabrominated, octabrominated and decabrominated diphenyl ethers. Where products or equipments within this specification contain these banned substances, provide complying products and equipments from approved manufacturers with equal performance characteristics.
2. General: All work and materials shall conform to the local and State codes, and all Federal, State and other applicable laws and regulations.
3. Contractor responsible for obtaining and payment for all permits, licenses, and inspection certificates required in accordance with provisions of Contract Documents.

B. Materials and equipment shall be new. Work shall be of good quality, free of faults and defects and in conformance with the Contract Documents.

C. Apparatus shall be built and installed to deliver its full rated capacity at the efficiency for which it was designed.

D. The entire mechanical system and apparatus shall operate at full capacity without objectionable noise or vibration.

E. All equipment shall be installed level and true. Housekeeping pads and curbs shall account for floor or roof slope.

F. Materials and Equipment:

1. Each piece of equipment furnished shall meet all detailed requirements of the Drawings and Specifications and shall be suitable for the installation shown. Equipment not meeting all requirements will not be acceptable, even though specified by name along with other manufacturers.
2. Where two or more units of the same class of equipment are furnished, use products of the same manufacturer. Component parts of the entire system need not be products of same manufacturer.
3. Furnish all materials and equipment of size, make, type, and quality herein specified.
4. Equipment scheduled by performance or model number shall be considered the basis of the design. If other specified manufacturer's equipment is provided in lieu of the basis of design equipment the contractor is responsible for all changes and costs which may be necessary to accommodate this equipment, including different sizes and locations for connections, different electrical characteristics, different dimensions, different access requirements or any other differences which impact the project.

G. Workmanship:

1. General: All materials shall be installed in a neat and professional manner.

2. Manufacturer's Instructions: Follow manufacturer's directions where they cover points not specifically indicated. If they are in conflict with the Drawings and Division 15 Specifications, obtain clarification before starting work.

H. Cutting and Patching:

1. Cutting, patching, and repairing for the proper installation and completion of the work specified in this Division including plastering, masonry work, concrete work, carpentry work, and painting shall be performed by skilled craftsmen of each respective trade in conformance with the appropriate Division of Work.
2. Additional openings required in building construction shall be made by drilling or cutting. Use of jackhammer is specifically prohibited.
3. Fill holes which are cut oversize so that a tight fit is obtained around the sleeves passing through.
4. Beams or columns shall not be pierced without permission of Architect and then only as directed.
5. All new or existing work cut or damaged shall be restored to its original condition. Where alterations disturb lawns, paving, walks, etc., the surfaces shall be repaired, refinished, and left in condition existing prior to commencement of work.

1.5 SUBMITTALS

A. Shop Drawings:

1. The Contract Drawings indicate the general layout of the piping, ductwork, and various items of equipment. Coordination with other trades and with field conditions will be required. For this purpose, prepare Shop Drawings of all piping, ductwork and equipment installations. Shop Drawings shall be new drawings prepared by Contractor and not reproductions or tracings of Architect's Drawings. Overlay drawings with shop drawings of other trades and check for conflicts. All drawings shall be same size as Architect's Drawings with title block similar to Contract Drawings and identifying Architect's Drawing number or any reference drawings. All drawings shall be fully dimensioned including both plan and elevation dimensions. Shop drawings cannot be used to make scope changes.
2. Submit shop drawings for review prior to beginning fabrication. Additional shop drawings may be requested when it appears that coordination issues are not being resolved in the field or when there is a question as to whether contract documents are being complied with or the design intent is being met.

B. Product Data:

1. In general, submit product data for review on all scheduled pieces of equipment, on all equipment requiring electrical connections or connections by other trades, and as required by each specification section or by Drawing notes. Include manufacturer's detailed shop drawings, specifications and data sheets. Data sheets shall include capacities, RPM, BHP, pressure drop, design and operating pressures, temperatures, and similar data. Manufacturer's abbreviations or codes are not acceptable.
2. List the name of the motor manufacturer and service factor for each piece of equipment.
3. Indicate equipment operating weights including bases and weight distribution at support points.
4. In the case of equipment such as wiring devices, time switches, valves, etc., specified by specific catalog number, a statement of conformance will suffice.

- C. Submission Requirements:
 - 1. Shop Drawings and Product Data:
 - a. Refer to Division 1 for additional requirements related to submittals.
 - b. Submit copies of shop drawings and product data for Work of Division 15 in a 3-ring loose leaf binder with each item filed under a tab and labeled with its respective specification section number, article and paragraph, and mark if applicable.
- D. Contractor Responsibilities: It shall be the Contractor's responsibility to:
 - 1. See that all submittals are submitted at one time and are in proper order.
 - 2. Ensure that all equipment will fit in the space provided.
 - 3. Assure that all deviations from Drawings and Specifications are specifically noted in the submittals. Failure to comply will void review automatically.

1.6 OPERATING AND MAINTENANCE MANUAL, PARTS LISTS, AND OWNERS INSTRUCTIONS

- A. Refer to Division 1 for additional requirements.
- B. Submit three bound copies of manufacturer's operation and maintenance instruction manuals and parts lists for each piece of equipment or item requiring servicing. Literature shall be on 8-1/2"x11" sheets or catalogs suitable for side binding. Submit data when the work is substantially complete, packaged separately, and clearly identified in durable 3-ring binder. Include name and contact information for location of source parts and service for each piece of equipment. Clearly mark and label in each submittal, the piece of equipment provided with the proper nameplate and model number identified. Provide wiring diagrams for all electrically powered equipment.
- C. Instruct Owner thoroughly in proper operation of equipment and systems, in accordance with manufacturer's instruction manuals. Operating instructions shall cover all phases of control.

1.7 PROJECT CONDITIONS

- A. Existing Conditions: Prior to bidding, verify and become familiar with all existing conditions by visiting the site, and include all factors which may affect the execution of this Work. Include all related costs in the initial bid proposal.
- B. Coordinate exact requirements governed by actual job conditions. Check all information and report any discrepancies before fabricating work. Report changes in time to avoid unnecessary work.
- C. Coordinate shutdown and start-up of existing, temporary, and new systems and utilities. Notify Owner, City and Utility Company.

1.8 WARRANTY

- A. Provide a written guaranty covering the work of this Division (for a period of one calendar year from the date of acceptance by the Owner) as required by the General Conditions.

B. Provide manufacturer's written warranties for material and equipment furnished under this Division insuring parts and labor for a period of one year from the date of Owner acceptance of Work of this Division.

C. Correct warranty items promptly upon notification.

1.9 PROVISIONS FOR LARGE EQUIPMENT

A. Contractor shall make provisions for the necessary openings in building to allow for admittance of all equipment.

1.10 TEST REPORTS AND CERTIFICATES

A. Contractor shall submit one copy of all test reports and certificates specified herein to the Architect.

1.11 SUBSTITUTIONS

A. Contractor shall submit any requests for product substitutions in accordance with the Instructions to Bidders and the General and Supplemental Conditions.

PART 2 - PRODUCTS

2.1 ACCESS PANELS

A. Furnish under this Division as specified in another Division of work.

2.2 PIPE AND DUCT SLEEVES

A. Interior Wall and Floor Sleeves: 18 gauge galvanized steel, or another pre-approved system.

B. Interior Wall and Floor Sleeves (fire rated): Fire rated and water tight system approved by Authority Having Jurisdiction and Owners Insurance underwriter, with rating equal to floor or wall penetration, and designed specifically for the floor or wall construction, piping material, size and service.

C. Exterior Wall Sleeves: Cast iron.

D. On Grade Floor Sleeves: Same as exterior wall sleeves.

E. Water Tight Sleeves: Combination steel pipe sleeves with water stop and anchor plate; Link Seal Model WS, mated with synthetic rubber links interlocked with bolts and nuts; Link Seal Model LS.

2.3 FLOOR, WALL AND CEILING PLATES

A. Furnish stamped split type plates as follows:
1. Floor Plates: Cast brass, chromium plated.

2. Wall and Ceiling Plates: Spun aluminum.

2.4 MACHINERY GUARDS

- A. Furnish guards for protection on all rotating and moving parts of equipment. Provide guards for all metal fan drives and motor pulleys, regardless of being enclosed in a metal cabinet.
- B. Design guards so as not to restrict air flow at fan inlets resulting in reduced capacity.
- C. Provide shaft holes in guards for easy use of tachometers at pulley centers. Guards shall be easily removable for pulley adjustment or removal and changing of belts.
- D. All guards shall meet OSHA requirements including back plates.
- E. Provide inlet and outlet screens on all fans in plenums or where exposed to personnel.

2.5 ELECTRICAL EQUIPMENT

- A. General: All equipment and installed work shall be as specified under Division 16, Electrical.
- B. Coordinate with the electrical Drawings and electrical contractor for minimum electrical equipment bracing requirements based on the available interrupting current (AIC) rating at the bus of the panelboard or switchboard serving the piece of equipment. Provide equipment that meets the bracing requirement.
- C. Motors:
 - 1. Motors shall be furnished as integral part of driven equipment. They shall be drip proof induction type with ball bearings unless noted otherwise. Motors 1 HP and above shall be premium energy efficient type, except for emergency equipment motors. Motors shall be built to NEMA Standards for the service intended. The motors shall be rated for the voltage specified, suitable for operation within the range of 10% above to 10% below the specified voltage.
 - 2. Energy efficient motors shall be Baldor, Westinghouse, and General Electric or approved equal.
 - 3. The motor shall meet the efficiency standards identified in the table below as determined using the IEEE Method B test at full load.

| MINIMUM MOTOR EFFICIENCIES | | | | | |
|-----------------------------------|-----------|-----------------------------|-------------|-------------|-------------|
| | | RPM | | | |
| | | IEEE 112B Efficiency | | | |
| HP | KW | 900 | 1200 | 1800 | 3600 |
| 1 | 0.75 | -- | 82.5 | 85.5 | 80.0 |
| 1.5 | 1.15 | -- | 86.5 | 86.5 | 85.5 |
| 2 | 1.53 | -- | 87.5 | 86.5 | 86.5 |
| 3 | 2.3 | 84.0 | 89.5 | 89.5 | 88.5 |
| 5 | 3.8 | 85.5 | 89.5 | 89.5 | 89.5 |
| 7.5 | 5.6 | 87.5 | 91.7 | 91.7 | 91.0 |
| 10 | 7.5 | 88.5 | 91.7 | 91.7 | 91.7 |
| 15 | 7.5 | 88.5 | 91.7 | 92.4 | 91.7 |
| 20 | 15.9 | 90.2 | 92.4 | 93.0 | 92.4 |
| 25 | 18.8 | 91.0 | 93.0 | 93.6 | 93.0 |
| 30 | 22.5 | 91.0 | 93.6 | 94.1 | 93.0 |
| 40 | 30.0 | 91.7 | 94.1 | 94.5 | 93.6 |
| 50 | 37.5 | 92.4 | 94.1 | 94.5 | 94.1 |
| 60 | 45.0 | 93.0 | 94.5 | 95.0 | 94.1 |
| 75 | 56.3 | 93.0 | 95.0 | 95.4 | 94.5 |
| 100 | 75.0 | 93.0 | 95.4 | 95.4 | 95.0 |
| 125 | 93.8 | 94.5 | 95.4 | 95.4 | 95.4 |
| 150 | 112.5 | 94.5 | 95.8 | 95.8 | 95.4 |
| 200 | 150.0 | 94.5 | 95.8 | 96.2 | 95.8 |
| 250 | 187.5 | 94.5 | 95.1 | 96.2 | 95.1 |
| 300 | 225.0 | 94.5 | 95.3 | 96.2 | 95.3 |
| 350 | 225.0 | 94.5 | 95.3 | 96.2 | 95.3 |
| 400 | 300.0 | 94.5 | 95.4 | 96.2 | 95.4 |
| 450 | 337.5 | 94.5 | 95.5 | 96.2 | 95.5 |
| 500 | 375.0 | 94.5 | 95.6 | 96.2 | 95.6 |

4. Refer to Equipment Schedules on the Drawings for motor horsepower, voltage and phase.
5. Refer to individual product sections for additional motor requirements.
6. Furnish motors on belt drive equipment of nominal nameplate horsepower not less than 120% of equipment brake horsepower required for performance specified.
7. Motors shall have built-in thermal overload protection, or be protected externally with separate thermal overload devices with low voltage release or lockout. Hermetically sealed motors shall have quick trip devices.
8. All motors controlled by variable frequency drives shall be inverter duty rated and have Class F insulation or better. They shall also be able to withstand repeated voltage peaks of 1600 volts with rise times of 0.1 microseconds and greater in accordance with NEMA Standard MG1 Part 31.
9. Motors served from variable frequency drives shall be equipped with shaft grounding system which shall provide a path for current to flow between the shaft and motor frame. SGS or equal.

- 10. Motors located in environment air plenums not tied to air handling functions shall be totally enclosed type motors.
- D. Starters: Provided under Division 26, Electrical, suitable for performing the control functions required, with the exception of self-contained equipment and where the starters are furnished as part of the control package.
- E. Equipment Wiring: Interconnecting wiring within or on a piece of mechanical equipment shall be provided with the equipment unless shown otherwise. This does not include the wiring of motors, starters and controllers provided under Division 26, Electrical.
- F. Control Wiring: All control wiring for mechanical equipment shall be provided under Section 15905, Instrumentation and Controls for HVAC.
- G. Codes: All electrical equipment and products shall bear the Underwriters label as required by governing codes and ordinances.

PART 3 - EXECUTION

3.1 ACCESS PANELS

- A. Install in accord with manufacturer's recommendations, coordinated with architectural features.
- B. Provide 2-hour fire rated doors where required bearing the U.L. label.
- C. Furnish 18x18-inch panels for ceilings and for access to equipment in soffits and shafts, and 12"x12" for walls unless indicated otherwise.
- D. Furnish where indicated and where required to access valves, fire/smoke dampers, trap primers, shock arresters, and other appurtenances requiring operation, service or maintenance. Submit proposed locations for review prior to installation.

3.2 SLEEVES

- A. Interior Floor and Wall Sleeves: Provide sleeves large enough to provide 3/4-inch clearances around pipe or ductwork. Where pipe or ductwork is insulated, insulation shall pass continuously through sleeve with 3/4-inch clearance between insulation and sleeve. Penetrations through mechanical room and fan room floors shall be made watertight by packing with safig insulation and sealing with Tremco Dymeric Sealant or approved system.
- B. Sleeves Through Rated Floors and Walls: Similar to interior sleeves except install fire rated system approved by Authority Having Jurisdiction and Owners insurance underwriter, with rating equal to floor or wall penetration, and designed specifically for the floor or wall construction, piping or duct material, size and service.
- C. Sleeves specified or indicated at fire damper penetrations shall take precedence over this article.

- D. Exterior Wall Sleeves Below Grade: Provide water tight sleeves. Install at pipes entering building below grade and where shown. Adjust to provide positive hydrostatic seal. Contractor shall be responsible for following manufacturer's procedure for installing and tightening seal. Secure sleeves against displacement.
- E. On Grade Floor Sleeves: Same as below grade exterior wall sleeves, caulked from inside.
- F. Exterior Wall Sleeves Above Grade: Similar to interior wall sleeves except caulk outside with Tremco Dymeric Sealant.
- G. Layout work prior to concrete forming. Do all cutting and patching required. Reinforce sleeves to prevent collapse during forming and pouring.
- H. All floor sleeves shall maintain a water barrier by providing a water tight seal or they shall extend 1-inch above finished floor except through mechanical equipment room floors and shafts where sleeves shall extend 2 inches above finished floor level. Sleeves through roof shall extend 8 inches above roof. Wall sleeves shall be flush with face of wall unless otherwise indicated.
- I. Do not support pipes by resting pipe clamps on floor sleeves. Supplementary members shall be provided so pipes are floor supported.
- J. Special sleeves detailed on drawings shall take precedence over this section.

3.3 CLEANING

- A. General: Clean mechanical equipment, piping and ductwork of stampings and markings (except those required by codes), iron cuttings, and other refuse.
- B. Painted Surfaces: Clean scratched or marred painted surfaces of rust or other foreign matter and paint with matching color industrial enamel, except as otherwise noted.
- C. Additional requirements are specified under specific Sections of this Division.

3.4 EQUIPMENT PROTECTION

- A. Keep pipe, ductwork and conduit openings closed by means of plugs or caps to prevent the entrance of foreign matter. Protect piping, conduit, ductwork, equipment and apparatus against dirty water, chemical or mechanical damage both before and after installation. Restore damaged or contaminated fixtures, equipment, or apparatus to original conditions or replace at no cost to the Owner.
- B. Protect bright finished shafts, bearing housings, and similar items until in service. No rust will be permitted.
- C. Cover or otherwise suitably protect equipment and materials stored on the job site.

3.5 ACCESSIBILITY

- A. General: Locate valves, thermometers, cleanout fittings and other indicating equipment or specialties requiring frequent reading, adjustments, inspection, repairs, and removal or replacement conveniently and accessibly with reference to the finished building.
- B. Thermometers and Gauges: Install thermometers and gauges so as to be easily read from the floors, platforms and walkways.

3.6 FLOOR, WALL AND CEILING PLATES

- A. Install on piping and ductwork passing through finished walls, floors, ceilings, partitions, and plaster furrings. Plates shall completely cover opening around pipe and duct.
- B. Secure wall and ceiling plates to pipe, insulation, or structure.
- C. Plates shall not penetrate insulation vapor barriers.
- D. Plates not required in mechanical rooms or unfinished spaces.

3.7 PAINTING

- A. General: Coordinate painting of mechanical equipment and items with products and methods in conformance with the appropriate Division of Work, Painting. All exposed work under this division shall receive either a factory painted finish or a field prime coat finish, except:
 - 1. Exposed copper piping.
 - 2. Aluminum jacketed outdoor insulated piping.
- B. Equipment Rooms and Finished Areas:
 - 1. Insulation: Not painted.
 - 2. Hangers, Uninsulated Piping, Miscellaneous Iron Work, Structural Steel Stands, Uninsulated Tanks, and Equipment Bases: Paint one coat of black enamel.
 - 3. Steel Valve Bodies and Bonnets: One coat of black enamel.
 - 4. Brass Valve Bodies: Not painted.
 - 5. Equipment: One coat of grey machinery enamel. Do not paint nameplates.
 - 6. Grilles, Diffusers, Registers: Paint sheet metal and visible ductwork behind grilles, diffusers and registers flat black.
- C. Concealed Spaces (above ceilings, not visible):
 - 1. Insulation: Not painted.
 - 2. Hangers, Uninsulated Piping, Miscellaneous Iron Work, Valve Bodies and Bonnets: Not painted.
- D. Exterior Steel: Wire brush and apply two coats of rust-inhibiting primer and one coat of grey exterior machinery enamel.
- E. Roof Mounted Equipment: Paint two coats of exterior machinery enamel. Color as selected by Architect. Where factory standard finish is indicated in the equipment specification, it is assumed that the standard finish is painted.

- F. Exterior Black Steel Pipe: Wire brush and apply two coats of rust-inhibiting primer and one coat of exterior enamel. Painting schemes shall comply with ANSI A13.1.

3.8 ADJUSTING AND CLEANING

- A. Before operating any equipment or systems, make thorough check to determine that systems have been flushed and cleaned as required and equipment has been properly installed, lubricated, and serviced. Check factory instructions to see that installations have been made accordingly and that recommended lubricants have been used.
- B. Use particular care in lubricating bearings to avoid damage by over-lubrication and blowing out seals. Check equipment for damage that may have occurred during shipment, after delivery, or during installation. Repair damaged equipment as approved or replace with new equipment.

3.9 ELECTRICAL EQUIPMENT

- A. Ductwork or piping for mechanical systems not serving electrical space shall not be installed in any switchgear room, transformer vault, telephone room, or electric closet except as indicated.
- B. Ductwork or piping for mechanical systems shall not pass over switchboards or electrical panelboards. Where conflicts exist, bring to attention of Architect.

3.10 EQUIPMENT CONNECTIONS

- A. Make final connections to equipment specified in sections other than Division 15 of the specifications and Owner furnished equipment in accordance with manufacturer's instructions and shop drawings furnished and as indicated.
- B. Piping:
 - 1. Connections shall include steam supply, steam vent and condensate.
 - 2. Provide valves and specialties as specified and as detailed on the Drawings. Provide increasers, reducers, and any other fittings required for complete installation.
 - 3. All piping connections shall be independently supported to prevent undue strain on equipment.
- C. Ductwork: Make exhaust connections to fume hoods, emergency generator radiators, and any other processing, laboratory, or kitchen equipment in strict accordance with manufacturer's instructions.

END OF SECTION

SECTION 15060

HANGERS, SUPPORTS AND ANCHORS FOR PLUMBING

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.
- B. The provisions of Section 15050, Common Work Results for Plumbing apply to work specified in this Section.

1.2 SUMMARY

- A. This Section includes: Supports and anchors for piping systems and equipment.
- B. Related Sections include:
 - 1. Section 15071 Vibration and Seismic Controls for Plumbing Piping and Equipment.
 - 2. Section 15080 Insulation for Plumbing.
 - 3. Section 15105 Pipe and Pipe Fittings Plumbing.

1.3 SUBMITTALS

- A. Submit the following:
 - 1. Shop Drawings of contractor fabricated piping support structures.
 - 2. No other submittals required under this section.

PART 2 - PRODUCTS

2.1 SUPPORTS, ANCHORAGE AND RESTRAINT

- A. General: Provide pipe and equipment hangers and supports in accordance with the following:
 - 1. When supports, anchorages, and seismic restraints for equipment, and supports and seismic restraints for conduit, piping, and ductwork are not shown on the Drawings, the contractor shall be responsible for their design.
 - 2. Seismic restraints and anchorages shall resist seismic forces as specified in the latest edition of the International Building Code for the seismic zone in which the project is constructed.
 - 3. Seismic restraint shall not introduce excessive stresses in the piping caused by thermal expansion or contraction.
 - 4. Connections to structural framing shall not introduce twisting, torsion, or lateral bending in the framing members. Provide supplementary steel as required.
 - 5. Seismic restraints shall be in accordance with the latest edition of the SMACNA "Seismic Restraint Manual - Guidelines for Mechanical Systems" for the Seismic Hazard Level corresponding to the seismic zone in which the project is constructed.

6. Seismic restraints shall be in accordance with the applicable code.
7. Seismic restraints shall follow the provisions described in Section 15071 Vibration and Seismic Controls for Plumbing Piping and Equipment.

- B. Engineered Support Systems: The following support systems shall be designed, detailed, and bear the seal of a professional engineer registered in the State having jurisdiction.
1. Supports and seismic restraints for suspended piping and equipment.
 2. Support frames such as pipe racks or stanchions for piping and equipment which provide support from below.
 3. Equipment and piping support frame anchorage to supporting slab or structure.

2.2 SUPPORTS, GENERAL

- A. Fabricate support members from welded standard structural shapes, pipe, and plate to carry the necessary rollers, hangers, and accessories as required. Support piping less than 4-inch pipe size from or by prefabricated roll-formed channels with necessary accessories to adequately support piping system.
- B. Acceptable Manufacturers: Unistrut, Superstrut, Powerstrut and Kinline, B-Line Systems, AnvilStrut.
- C. Supports and Accessories: Preformed roll-formed channels and accessories with matching compatible accessories as shown, as specified, and as required.
- D. Dissimilar Metal Protection: Hydra-Zorb cushions or Cush-a-strip.
- E. Clamps: Super Strut Series 700 through 702 or AnvilStrut Series 1000 through 1200.

2.3 PIPE ATTACHMENTS

- A. Acceptable Manufacturers: Anvil as noted or equivalent products by Superstrut, B-Line Systems, Tolco, Michigan Hanger.
- B. Uninsulated Horizontal Copper Piping:
1. 2-inch and Smaller: Anvil CT-65, CT-69, CT-99C.
 2. Larger than 2-inch: Anvil 260 field or factory copper plated, plastic coated or other recognized industry methods. Electricians' tape is unacceptable.
- C. Insulated Horizontal Copper Pipe with Hangers Inside of Insulation: Same as Uninsulated Horizontal Copper Pipe.
- D. Insulated Horizontal Copper Pipe with Hangers Outside of Insulation:
1. 2-inch and Smaller: Anvil 65, 70, 104 or 260.
 2. Larger than 2-inch: Anvil 260.
- E. Other Uninsulated Horizontal Pipe:
1. 2-inch and Smaller: Anvil 65, 70, 104 or 260.
 2. Larger than 2-inch: Anvil 260.

F. Other Insulated Horizontal Pipe With Hangers Inside of Insulation:

1. 2-inch and Smaller: Anvil 65, 70, 104, 260 or 300.
2. Larger than 2-inch: Anvil 260.

G. Other Insulated Horizontal Pipe with Hangers Outside of Insulation:

1. 2-inch and Smaller: Anvil 65, 70, 104 or 260.
2. Larger than 2-inch: Anvil 260.

H. Riser Clamps Copper Pipe:

1. 4-inch and Smaller: Anvil CT-121, CT-121C or 261C.
2. Larger than 4-inch: Anvil 261C.

I. Riser Clamps Other Piping: Anvil 261.

2.4 PIPE ROLLERS, INSULATION PROTECTION SHIELDS AND INSULATION PROTECTION SADDLES

A. Acceptable Manufacturers: Anvil as noted or equivalent Super Strut, B-Line Systems, Tolco, Michigan Hangers.

B. Pipe Rollers: Anvil 174 or 274 as required. Size for pipe plus insulation for insulated pipe.

C. Insulation Protection Shields: Anvil 167.

D. Insulation Protection Saddles: Anvil 160 through 166A as required. Saddles for copper pipe, factory or field copper plated.

2.5 BUILDING ATTACHMENTS

A. Acceptable Manufacturers: Anvil as listed or equivalent products by Elcen, Superstrut, B-Line Systems, Tolco, Michigan Hangers.

B. Beam Hangers:

1. On piping 6-inch and smaller: Anvil 86 with retaining clip Fig. 89.
2. On piping larger than 6-inch: Anvil 228, or 292.

C. Inserts: Anvil 152 malleable iron or 281 steel inserts. Inserts sized for required rod to support load being carried.

D. Expansion Plugs: Similar and equal to Phillips “red-head” self-drilling flush shell selected for safety factor of 4.

E. Powder actuated fasteners with silencers as approved by Architect.

PART 3 - EXECUTION

3.1 HANGERS AND SUPPORTS

A. General:

1. Install all support systems as detailed and in accordance with manufacturer's recommendations. Provide pipe racks, pipe stands, trapeze hangers, etc., as required and as detailed on the Drawings.
2. Provide adjustable hangers for all pipes complete with inserts, adjusters, bolts, nuts, swivels, all-thread rods, etc., except where specified otherwise.
3. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping and do not support piping from other piping.
4. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.
5. Install all cast iron piping in accordance with Cast Iron Soil Pipe Industry (CISPI) Standards.
6. Support all piping within 2 feet of each change of direction on both sides of fitting.

B. Insulated Piping Systems:

1. See Section 15080 for insulation requirements.
2. Insulated Piping Systems with Vapor Barrier Insulation:
 - a. Install hangers outside of insulation.
 - b. On piping 1-1/2-inch and larger, provide insulation protection shields at each support location.
3. Insulated Piping Systems with Non-Vapor Barrier Insulation:
 - a. At the contractor's option, hangers may be installed inside or outside of insulation for piping 2-inch and smaller.
 - b. If hangers are installed outside of insulation, provide insulation protection shields at all support locations on piping 1-1/2-inch and larger.
 - c. On piping larger than 2-inch, provide insulation saddles at each support location.

C. Vertical Piping:

1. Support with U-clamps fastened to wall to hold piping away from wall unless otherwise approved.
2. Riser clamps on steel pipe to be directly welded to pipe. Riser clamps on copper pipe to be installed directly under fitting.
3. Risers that are not subject to thermal change to be supported at each floor of penetration.
4. Risers that are subject to thermal change require engineered supports. Size supports to carry all forces exerted by piping system when in operation. Riser supports shall follow the provisions described in Section 15071, Vibration and Seismic Controls for Plumbing Piping and Equipment.

D. Horizontal Piping:

1. Trapeze Hangers: Multiple pipe runs where indicated shall be supported on channels with rust resistant finish. Provide all necessary rods and supporting steel.

2. Support Spacing: Provide support at minimum spacing per MSS SP-69-1996 Pipe Hangers and Supports - Selection and Application:
 - a. Support piping within 2 feet of each change in direction.
 - b. Steel Pipe, Copper Tubing:

| Minimum Pipe Size | Max. Span Steel | Max. Span Copper | Rod Size |
|----------------------|-----------------|------------------|----------|
| 1-inch and smaller | 7 feet | 5 feet | 1/4-inch |
| 1-1/4-inch to 2-inch | 8 feet | 8 feet | 3/8-inch |
| 2-1/2-inch to 3-inch | 11 feet | 9 feet | 1/2-inch |
| 4-inch to 5-inch | 14 feet | 12 feet | 1/2-inch |
| 6-inch | 17 feet | 14 feet | 1/2-inch |
| 8-inch or larger | 19 feet | 16 feet | 5/8-inch |
| 10-inch | 20 feet | 18 feet | 3/4-inch |
| 12-inch | 23 feet | 19 feet | 7/8-inch |
| 14-inch | 25 feet | | 1-inch |
| 16-inch | 27 feet | | 1-inch |

- c. Fuel Gas Piping: Support in accordance with local code requirements.
- d. Plumbing Piping: Support in accordance with local plumbing code.
- e. Plastic Pipe: Supported a maximum of 3 feet on center for piping 1-inch and smaller and 4 feet on center for piping 1-1/4-inch and larger with rod sizes as recommended by the manufacturer.
- f. Piping provided with acoustical lagging wrap shall be supported a maximum of 5 feet on center. Install hangers outside of acoustical lagging.

E. Building Attachments:

1. Fastening or attaching to steel deck (without concrete fill) is prohibited. It will be necessary to support all piping from structural members, beams, joists, or provide intermediate angle iron supporting members between joists. Supports may be attached to concrete filled steel deck with load limitations shown on the structural drawings or otherwise obtained from the structural engineer.
2. Provide horizontal bracing on all horizontal runs 1-1/2 inch and larger and exceeding 50 feet in length at 75 foot intervals and as required to provide stabilized piping systems.
3. Provide all additional structural steel angles, channels, or other members required to support piping where structures do not occur as required for proper support.
4. Arrange supports to prevent eccentric loading of joists and joist girders. Locate supports at joist panel points.

END OF SECTION

SECTION 15060

HANGERS, SUPPORTS AND ANCHORS FOR HVAC

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.
- B. The provisions of Section 15051, Common Work Results for HVAC apply to work specified in this Section.

1.2 SUMMARY

- A. This Section includes: Supports and anchors for piping systems and equipment.
- B. Related Sections include:
 - 1. Section 15072 Vibration and Seismic Controls for HVAC Piping and Equipment.
 - 2. Section 15080 Insulation for HVAC.
 - 3. Section 15106 Pipe and Pipe Fittings HVAC.

1.3 QUALITY ASSURANCE

- A. Provide pipe and equipment hangers and supports in accordance with the following:
 - 1. When supports, anchorages, and seismic restraints for equipment, and supports and seismic restraints for conduit, piping, and ductwork are not shown on the Drawings, the contractor shall be responsible for their design.
 - 2. Seismic restraints and anchorages shall resist seismic forces as specified in the latest edition of the International Building Code for the seismic zone in which the project is constructed.
 - 3. Seismic restraint shall not introduce excessive stresses in the piping caused by thermal expansion or contraction.
 - 4. Connections to structural framing shall not introduce twisting, torsion, or lateral bending in the framing members. Provide supplementary steel as required.
 - 5. Seismic restraints shall be in accordance with the latest edition of the SMACNA "Seismic Restraint Manual - Guidelines for Mechanical Systems" for the Seismic Hazard Level corresponding to the seismic zone in which the project is constructed.
 - 6. Seismic restraints shall be in accordance with the applicable code.
 - 7. Seismic restraints shall follow the provisions described in Section 15072, Vibration and Seismic Controls for HVAC Piping and Equipment.
- B. Engineered Support Systems: The following support systems shall be designed, detailed, and bear the seal of a professional engineer registered in the State having jurisdiction.
 - 1. Supports and seismic restraints for suspended piping and equipment.
 - 2. Support frames such as pipe racks or stanchions for piping and equipment which provide support from below.

3. Equipment and piping support frame anchorage to supporting slab or structure.

1.4 SUBMITTALS

- A. Submit the following:
 1. Shop Drawings of contractor fabricated support structures.
 2. Structural Details and Calculations: Submit structural details and calculations substantiating that building structure, anchorages, and fabricated steel braces can safely withstand maximum calculated loads.
 3. No other submittals required under this section.

PART 2 - PRODUCTS

2.1 SUPPORTS, GENERAL

- A. Fabricate support members from welded standard structural shapes, pipe, and plate to carry the necessary rollers, hangers, and accessories as required. Support piping less than 4-inch pipe size from or by prefabricated roll-formed channels with necessary accessories to adequately support piping system.
- B. Acceptable Manufacturers: Unistrut, Superstrut, Powerstrut and Kinline, B-Line Systems, AnvilStrut.
- C. Supports and Accessories: Preformed roll-formed channels and accessories with matching compatible accessories as shown, as specified, and as required.
- D. Dissimilar Metal Protection: Hydra-Zorb cushions or Cush-a-strip.
- E. Clamps: Super Strut Series 700 through 702 or AnvilStrut Series 1000 through 1200.

2.2 PIPE ATTACHMENTS

- A. Acceptable Manufacturers: Anvil as noted or equivalent products by Superstrut, B-Line Systems, Tolco, Michigan Hanger.
- B. Uninsulated Horizontal Copper Piping:
 1. 2-inch and Smaller: Anvil CT-65, CT-69, CT-99C.
 2. Larger than 2-inch: Anvil 260 field or factory copper plated, plastic coated or other recognized industry methods. Electricians' tape is unacceptable.
- C. Insulated Horizontal Copper Pipe with Hangers Inside of Insulation: Same as Uninsulated Horizontal Copper Pipe.
- D. Insulated Horizontal Copper Pipe with Hangers Outside of Insulation:
 1. 2-inch and Smaller: Anvil 65, 70, 104 or 260.
 2. Larger than 2-inch: Anvil 260.
- E. Other Uninsulated Horizontal Pipe:
 1. 2-inch and Smaller: Anvil 65, 70, 104 or 260.

- 2. Larger than 2-inch: Anvil 260.
- F. Other Insulated Horizontal Pipe With Hangers Inside of Insulation:
 - 1. 2-inch and Smaller: Anvil 65, 70, 104, 260 or 300.
 - 2. Larger than 2-inch: Anvil 260.
- G. Other Insulated Horizontal Pipe with Hangers Outside of Insulation:
 - 1. 2-inch and Smaller: Anvil 65, 70, 104 or 260.
 - 2. Larger than 2-inch: Anvil 260.
- H. Riser Clamps Copper Pipe:
 - 1. 4-inch and Smaller: Anvil CT-121, CT-121C or 261C.
 - 2. Larger than 4-inch: Anvil 261C.
- I. Riser Clamps Other Piping: Anvil 261.

2.3 PIPE ROLLERS, INSULATION PROTECTION SHIELDS AND INSULATION PROTECTION SADDLES

- A. Acceptable Manufacturers: Anvil as noted or equivalent Super Strut, B-Line Systems, Tolco, Michigan Hangers.
- B. Pipe Rollers: Anvil 174 or 274 as required. Size for pipe plus insulation for insulated pipe.
- C. Insulation Protection Shields: Anvil 167.
- D. Insulation Protection Saddles: Anvil 160 through 166A as required. Saddles for copper pipe, factory or field copper plated.

2.4 BUILDING ATTACHMENTS

- A. Acceptable Manufacturers: Anvil as listed or equivalent products by Elcen, Superstrut, B-Line Systems, Tolco, Michigan Hangers.
- B. Beam Hangers:
 - 1. On piping 6-inch and smaller: Anvil 86 with retaining clip Fig. 89.
- C. Inserts: Anvil 152 malleable iron or 281 steel inserts. Inserts sized for required rod to support load being carried.
- D. Expansion Plugs: Similar and equal to Phillips “red-head” self-drilling flush shell selected for safety factor of 4.
- E. Powder actuated fasteners with silencers as approved by Architect.

2.5 ROOF MOUNTED EQUIPMENT SUPPORT

- A. Acceptable Manufacturers: Greenheck - GES.

- B. Equipment Supports: Welded aluminum or galvanized steel construction suitable for use on insulated (GESR) or non-insulated (GESS) flat roof decks, wood nailer, engineered to support gravity and seismic loads of supported equipment. Account for roof slope to provide level mounting surface for equipment.

PART 3 - EXECUTION

3.1 HANGERS AND SUPPORTS

A. General:

1. Install all support systems as detailed and in accordance with manufacturer's recommendations. Provide pipe racks, pipe stands, trapeze hangers, etc., as required and as detailed on the Drawings.
2. Provide adjustable hangers for all pipes complete with inserts, adjusters, bolts, nuts, swivels, all-thread rods, etc., except where specified otherwise.
3. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping and do not support piping from other piping.
4. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.
5. Support all piping within 2 feet of each change of direction on both sides of fitting.

B. Insulated Piping Systems:

1. See Section 15081 for insulation requirements.
2. Insulated Piping Systems with Vapor Barrier Insulation:
 - a. Install hangers outside of insulation.
 - b. On piping 1-1/2-inch and larger, provide insulation protection shields at each support location.
3. Insulation Protection:
 - a. Band insulation protection shields firmly to insulation to prevent slippage.
 - b. Tack weld insulation protection saddles to steel pipe. Braze saddles to copper pipe.
4. Other insulated Piping Systems with Non-Vapor Barrier Insulation:
 - a. At the contractor's option, hangers may be installed inside or outside of insulation for piping 2-inch and smaller.
 - b. If hangers are installed outside of insulation, provide insulation protection shields at all support locations on piping 1-1/2-inch and larger.
 - c. On piping larger than 2-inch, provide insulation saddles at each support location.

C. Vertical Piping:

1. Support with U-clamps fastened to wall to hold piping away from wall unless otherwise approved.
2. Riser clamps on steel pipe to be directly welded to pipe. Riser clamps on copper pipe to be installed directly under fitting.
3. Risers that are not subject to thermal change to be supported at each floor of penetration.

4. Risers that are subject to thermal change require engineered supports. Size supports to carry all forces exerted by piping system when in operation. Riser supports shall follow the provisions described in Section 15072 Vibration and Seismic Controls for HVAC Piping and Equipment.

D. Horizontal Piping:

1. Trapeze Hangers: Multiple pipe runs where indicated shall be supported on channels with rust resistant finish. Provide all necessary rods and supporting steel.
2. Support Spacing: Provide support at minimum spacing per MSS SP-69-1996 Pipe Hangers and Supports - Selection and Application:
 - a. Support piping within 2 feet of each change in direction.
 - b. Steel Pipe, Copper Tubing:

| Minimum Pipe Size | Max. Span Steel | Max. Span Copper | Rod Size |
|----------------------|-----------------|------------------|----------|
| 1-inch and smaller | 7 feet | 5 feet | 1/4-inch |
| 1-1/4-inch to 2-inch | 8 feet | 8 feet | 3/8-inch |
| 2-1/2-inch to 3-inch | 11 feet | 9 feet | 1/2-inch |
| 4-inch to 5-inch | 14 feet | 12 feet | 1/2-inch |
| 6-inch | 17 feet | 14 feet | 1/2-inch |
| 8-inch or larger | 19 feet | 16 feet | 5/8-inch |
| 10-inch | 20 feet | 18 feet | 3/4-inch |
| 12-inch | 23 feet | 19 feet | 7/8-inch |
| 14-inch | 25 feet | | 1-inch |
| 16-inch | 27 feet | | 1-inch |

- c. Plastic Pipe: Supported a maximum of 3 feet on center for piping 1-inch and smaller and 4 feet on center for piping 1-1/4-inch and larger with rod sizes as recommended by the manufacturer.
- d. Piping provided with acoustical lagging wrap shall be supported a maximum of 5 feet on center. Install hangers outside of acoustical lagging.

E. Building Attachments:

1. Fastening or attaching to steel deck (without concrete fill) is prohibited. It will be necessary to support all piping from structural members, beams, joists, or provide intermediate angle iron supporting members between joists. Supports may be attached to concrete filled steel deck with load limitations shown on the structural drawings or otherwise obtained from the structural engineer.
2. Provide horizontal bracing on all horizontal runs 1-1/2 inch and larger and exceeding 50 feet in length at 75 foot intervals and as required to provide stabilized piping systems.
3. Provide all additional structural steel angles, channels, or other members required to support piping where structures do not occur as required for proper support.
4. Arrange supports to prevent eccentric loading of joists and joist girders. Locate supports at joist panel points.

END OF SECTION

SECTION 15071

VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. The provisions of Section 15050, Common Work Results for Plumbing apply to work specified in this Section.

1.2 SUMMARY

- A. This Section includes:
 - 1. Isolation of mechanical equipment as indicated on the Drawings and specified herein.
 - 2. Seismic restraint of equipment and piping.
- B. Related Sections include:
 - 1. Section 15060 Hangers, Supports and Anchors for Plumbing.

1.3 QUALITY ASSURANCE

- A. A single manufacturer shall select and furnish all isolation required, except packaged equipment with integral isolators meeting all the isolation and seismic requirements of this specification.
- B. Isolation performance requirements are indicated on the Drawings. All deflections indicated are nominal static deflections for specific equipment supported.
- C. Seismic snubbers, restrained isolator housings and cable system components shall have anchorage preapproval "OPA" number from OSHPD in the State of California verifying the maximum certified load ratings.
- D. Isolator Stability and Rated Capacity:
 - 1. Spring diameters not less than 0.8 of the compressed height of the spring at rated load.
 - 2. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection.
- E. Seismic Restraints:
 - 1. Restraint of equipment and piping to be in accordance with the current state and local Building Code.
 - 2. All calculations shall be in accordance with current state and local Building Code.

1.4 SUBMITTALS

- A. Submit the following:
 - 1. Submit Shop Drawings showing complete details of construction for steel and concrete bases including:
 - a. Equipment mounting holes.
 - b. Dimensions.
 - c. Isolation selected for each support point.
 - d. Details of mounting brackets for isolator.
 - e. Weight distribution for each isolator.
 - f. Code number assigned to each isolator.
 - 2. Submit product data and calculation sheets for isolators, showing:
 - a. Size, type, load rating and rated deflection of each required isolator.
 - b. Percent of vibration transmitted based on the lowest disturbing frequency of the equipment.
- B. Installation report as specified in Part 3 of this section.
- C. Operation and maintenance data.

1.5 EQUIPMENT VIBRATION ISOLATION

- A. Provide a balanced set of vibration isolators for each piece of equipment listed in the Equipment Schedules.
- B. Isolation work to include, but not necessarily be limited to, the following:
 - 1. Isolation support of motor-driven equipment.
 - 2. Inertia base frames in conjunction with isolation.
 - 3. Isolation support of piping and piping risers.
 - 4. Penetration isolation of pipework and conduits through walls, floors or ceilings.
 - 5. Flexible connections of piping to equipment.
- C. Each piece of rotating equipment must meet a reasonable criterion for maximum vibration levels at each bearing, while in operation. The criteria for varying operating speeds are given as follows:
 - 1. Rotating equipment operating peak vibration velocities must not exceed 0.08 in./sec.
 - 2. If it is discovered that the operating vibration velocities exceed this criteria, the equipment shall be repaired or replaced at no expense to the owner until approval of the equipment is given by the engineer.
- D. Any components or materials not specially mentioned herein, but necessary to the proper vibration isolation of the equipment, shall be provided.

1.6 ACCEPTABLE MANUFACTURERS

- A. Amber Booth.
- B. Mason Industries, Inc.

- C. Kinetics Corporation.
- D. Vibrex.
- E. Approved equal, meeting all of the conditions and requirements specified herein.

1.7 CONTRACTOR RESPONSIBILITY

- A. All vibration isolation devices, including auxiliary steel bases and pouring forms, shall be designed and furnished by a single manufacturer or suppliers.
- B. Adequately restrain all equipment and piping to resist seismic forces. Design and select restraint devices to meet seismic requirements as defined in the latest issue of the International Building Code under Earthquake Design and applicable state and local codes.
- C. In addition, the contractor shall have the following responsibilities:
 1. Selection, installation, adjustment and performance of vibration isolators which will meet the requirements given on the plans or in the specifications.
 2. Provide Engineering drawings, details, supervision, and instruction to assure proper installation and performance.
 3. Provide whatever assistance necessary to ensure correct installation and adjustment of the isolators.

PART 2 - PRODUCTS

2.1 TYPE 1 - NEOPRENE WAFFLE PAD

- A. 3/4-inch thick neoprene waffle pads with pattern repeating on 1/2-inch centers.
- B. Select Duro rating for maximum deflection at average load rating.
- C. Include load distribution steel plate as required.
- D. Include anchor bolt grommet as required.
- E. Acceptable Manufacturer: Mason Type “Super W” or “Super WM” and “HG Grommet”; Similar Amber-Booth, Kinetics Corporation.

2.2 TYPE 2 - RESTRAINED NEOPRENE MOUNT

- A. Bridge-bearing neoprene mountings shall have a minimum static deflection of 0.2-inches and all directional seismic capability.
- B. The mount shall consist of a ductile iron casting containing two separated and opposing molded neoprene elements.
- C. The elements shall prevent the central threaded sleeve and attachment bolt from contacting the casting during normal operation.

- D. The shock absorbing neoprene materials shall be compounded to bridge-bearing specifications.
- E. Manufacturer: Mason type BR.

2.3 TYPE 3 - SPRINGS

- A. Free standing springs without housings.
- B. 1/4-inch thick molded neoprene cup with steel reinforcement washer or neoprene acoustical friction pads between base plate and support.
- C. All mounting shall have leveling bolts with height saving brackets.
- D. Springs mounted outboard of channels.
- E. Attach baseplate screws using neoprene bushings and washers.
- F. Spring diameters not less than 0.8 of the compressed height of the spring at rated load.
- G. Manufacturer: Mason type SLF, Amber-Booth type SW, Kinetics Corporation, Vibrex.

2.4 TYPE 4 - SPRINGS WITH RESTRAINTS

- A. Same as springs except housing with seismic restraints to be added.
- B. Seismic restraint with molded all directional neoprene bushings an integral part of isolator.
- C. Seismic restraint selected for minimum safety factor of 2 from ultimate seismic capacity.
- D. Spring mount must have neoprene cup or pad inside the seismic housing to allow anchoring of the housing baseplate without short circuiting pad.
- E. Manufacturer: Mason type SSLR or SLRS with seismic restraints; similar Amber-Booth, Kinetics Corporation Model FYS, Vibrex.

2.5 TYPE 5 - BASE WITH SPRINGS

- A. Steel Isolating Frame: Mason WFSL with WF steel beams with a minimum depth of 10% of the span between supports. Provide external height saving brackets.
- B. Manufacturer: Mason as indicated, similar Amber-Booth, Kinetics Corporation, Vibrex.

2.6 TYPE 6 – INERTIA BASE WITH SPRINGS

- A. Inertia Bases: Mason BMK or KSL with 1/2-inch square bar reinforcing, integral height saving brackets and steel templates with anchor bolts sleeves. Bases must be sized to fit stanchions for pump elbows or suction diffusers. Depth of base equal to 8% of the span between supports, 6-inch minimum.

- B. Manufacturer: Mason as indicated, similar Amber-Booth, Kinetics Corporation, Vibrex.

2.7 TYPE 7 - ISOLATING SPRING HANGERS

- A. Combination rubber-in shear and steel spring isolators installed on the hanger rods.
- B. Isolators shall have the proper deflection to allow the piping to deflect as a unit with the pump isolators.
- C. Hangers designed for 30 degree angular movement.
- D. Minimum deflection shall be one inch.
- E. Manufacturer: Mason 30N, similar Amber-Booth, Consolidated Kinetics, Vibrex.

2.8 TYPE 8 – ISOLATING NEOPRENE HANGERS

- A. Double deflection neoprene hangers shall have a minimum static deflection of 0.35-inches.
- B. Provide projecting bushing to prevent steel to steel contact.
- C. Manufacturer: Mason HD, similar Amber-Booth, Consolidated Kinetics, Vibrex.

2.9 ISOLATING SLEEVES

- A. Provided for all piping through walls and floors of penthouses and chiller room. Size for piping as required.
- B. Manufacturers: Potter-Roemer PR isolators or Grinnell Semco Trisolators.

2.10 SEISMIC RESTRAINTS

- A. General Requirements:
 1. Seismic restraints shall be provided for all equipment and piping, both supported and suspended.
 2. Bracing of piping shall be in accordance with the code and with the provisions set forth in the SMACNA seismic restraint manual.
 3. The structural requirements for the restraints, including their attachment to the building structure, shall be reviewed and approved by the structural engineer.
 4. Attachments to supported or suspended equipment must be coordinated with the equipment manufacturer.
- B. Supported Equipment:
 1. All-directional seismic snubbers shall consist of interlocking steel members restrained by a one-piece molded neoprene bushing of bridge bearing neoprene.
 2. Bushing shall be replaceable and a minimum of 1/4-inch thick. Rated loadings shall not exceed 1000 psi.
 3. An air gap of 1/4-inch shall be incorporated in the snubber design in all directions before contact is made between the rigid and resilient surfaces.

4. Snubber end caps shall be removable to allow inspection of internal clearances. Neoprene bushings shall be rotated to ensure no short circuits exist before systems are activated.
5. Snubber shall be type Z-1225 as manufactured by Mason Industries, Inc.

C. Bracing of Pipes:

1. Provide seismic bracing of all piping as detailed below to meet the building code requirements:
 - a. Exception: Piping suspended by individual hanger's 12-inches or less in length, as measured from the top of the pipe to the bottom of the support where the hanger is attached, need not be braced where the following criteria are met.
 - 1) Seismic braces are not required on high deformability piping when the $I_p=1.0$ and provisions are made to avoid impact with larger pipe or mechanical components or to protect the pipe in the event of such impact and the nominal pipe size is 3-inches diameter or less.
 - 2) Seismic braces are not required on high deformability piping when the $I_p=1.5$ and provisions are made to avoid impact with larger pipe or mechanical components or to protect the pipe in the event of such impact and the nominal pipe size is 1-inch diameter or less.
2. Seismic braces for pipes on trapeze hangers may be used.
3. Provide flexibility in joints where pipes pass through building seismic joints or expansion joints, or where pipes connect to equipment.
4. Cast iron pipe of all types, glass pipe, and any other pipe jointed with a shield and clamp assembly, where the top of the pipe is 12-inches or more from the supporting structure, shall be braced on each side of a change in direction of 90 degrees or more. Riser joints on unsupported sections of piping shall be braced or stabilized between floors.
5. Vertical risers shall be laterally supported with a riser clamp at each floor. For buildings greater than six stories high or for piping subject to thermal change all risers shall be engineered individually.

D. Suspended Equipment and Piping:

1. Seismic cable restraints shall consist of galvanized steel aircraft cables sized to resist seismic loads with a minimum safety factor of two and arranged to provide all-directional restraint.
2. Cable must be pre-stretched to achieve a certified minimum modulus of elasticity. Cable end connections shall be steel assemblies that swivel to final installation angle and utilize two clamping bolts to provide proper cable engagement.
3. Cable assemblies shall be type SCB at the ceiling and at the clevis bolt, SCBH between the hanger rod and the clevis or SCBV if clamped to a beam, all as manufactured by Mason Industries, Inc.
4. Steel angles, sized to prevent buckling, shall be clamped to pipe or equipment rods utilizing a minimum of three ductile iron clamps at each restraint location when required. Welding of a minimum of three ductile iron clamps at each restraint location when required. Welding of support rods is not acceptable. Rod clamp assemblies shall be type SRC or UC as manufactured by Mason Industries, Inc.
5. Pipe clevis cross-bolt braces are required in all restraint locations. They shall be special purpose preformed channels deep enough to be held in place by bolts passing over the cross bolt. Clevis cross brace shall be type CCB as manufactured by Mason Industries, Inc.

2.11 FLEXIBLE SPHERE CONNECTOR

- A. Flexible EPDM pipe connectors shall be manufactured of multiple plies of Kevlar tire cord fabric and EPDM; both molded and cured in hydraulic rubber presses. No steel wire or rings shall be used as pressure reinforcement.
- B. Connectors up to and including 2-inch diameter may have a single sphere and threaded ends. Connectors 2-1/2-inch and larger shall be manufactured with twin spheres up to 12-inches and a single sphere on larger sizes and floating steel flanges recessed to lock the connectors raised face EPDM flanges.
- C. All connectors shall be rated a minimum of 150 psi at 220°F. All connections shall be pre-extended as recommended by the manufacturer to prevent additional elongation under pressure.
- D. Mason type SFU, SFDEJ or SFEJ.

2.12 FLEXIBLE HOSE CONNECTOR

- A. Flexible stainless steel hoses shall be manufactured using type 304 stainless steel hose and braid with one fixed and one floating raised face carbon steel plate flange.
- B. Sizes 2-1/2-inch (65mm) and smaller may have threaded male nipples or copper sweat ends. Grooved ends are acceptable in all sizes in grooved piping systems. Weld ends are not acceptable. Copper sweat end hoses for water service shall be all copper or bronze construction.
- C. Hose shall have close pitch annular corrugations for maximum flexibility and low stiffness. Tested hose stiffness at various pressures must be included in the submittals.
- D. Hose shall be capable of continuous operation at 150 psi and system test pressure when installed in piping systems.
- E. Hose shall be the same size as the pipe it connects and have pipe thread connectors on both ends with male or female end adapters as required.
- F. Mason type BSS, FFL, MN, CPS or CPSB, similar HCi, Metraflex.

2.13 EXPANSION JOINT/SEISMIC CONNECTOR

- A. T304 stainless steel hose and braid, Schedule 40 radius elbows and 180 degree bend, flange or weld end Schedule 40 fittings. ASA certified when used for natural gas service. Metraflex Metaloop only.
- B. Connector shall accept differential support displacement without damaging pipe, equipment connections, or support connections.

PART 3 - EXECUTION

3.1 GENERAL

- A. Do not install any equipment or pipe which makes rigid contact with the building. "Building" includes slabs, beams, studs, walls, etc.
- B. The installation or use of vibration isolators must not cause any change of position of equipment or piping which would result in stresses in piping connections or misalignment of shafts or bearings. In order to meet this objective, equipment and piping shall be maintained in a rigid position during installation. The load shall not be transferred to the isolator until the installation is complete and under full operational load.
- C. Correct, at no additional cost, all installations which are defective in workmanship or materials.

3.2 PREPARATION

- A. Treat all isolators, including springs, hardware and housing, with a corrosion protective coating of epoxy powder or electro galvanizing.
- B. Coat steel frames exposed to weather with a rustproof metal primer.
- C. Provide hot dipped galvanizing on steel frames as indicated on the plans for corrosion protection in severe conditions.

3.3 INSTALLATION

- A. General:
 - 1. Install isolation where indicated on the Drawings by type and location and where indicated below.
 - 2. The assigned code number shall be marked on the isolators and bases to assure placement in the proper location.
 - 3. Anchor isolator seismic housing baseplate to floor.
 - 4. Rubber grommets and washers shall be provided to isolate the bolt from the building structure. Under no circumstances shall the isolation efficiency be destroyed when bolting the isolators to the building structure.
- B. Type 1 – Neoprene Waffle Pad
 - 1. Service:
 - a. Water Booster Systems
- C. Type 2 – Restrained Neoprene Mount
 - 1. Service:
 - a.
- D. Type 3 – Springs
 - 1. Service:
 - a.

- E. Type 4 – Springs with Restraints
 - 1. Service:
 - a.

- F. Type 5 – Base with Springs
 - 1. Service:
 - a. Water Booster Systems
 - b. Fuel Oil Transfer Pumps
 - c. Air Compressors
 - d. Vacuum Pumps

- G. Type 6 – Inertia Base with Springs
 - 1. Service:
 - a. Water Booster Systems
 - b. Fuel Oil Transfer Pumps
 - c. Air Compressors
 - d. Vacuum Pumps

- H. Type 7 – Isolating Spring Hangers
 - 1. Service:
 - a. In-Line Circulating Pumps
 - b. Piping rigidly connected to rotating equipment

- I. Type 8 – Isolating Neoprene Hangers
 - 1. Service:
 - a. In-Line Circulating Pumps

- J. Flexible Connectors:
 - 1. Flexible Hose Connectors: Provide as indicated on the drawings and for the following services: Dental Air
 - 2. Expansion Joint/Seismic Connector: Provide for all piping services where they cross expansion or seismic joints.

3.4 SEISMIC RESTRAINTS

- A. General:
 - 1. Install and adjust seismic restraints so that the equipment and piping support is not degraded by the restraints.
 - 2. Restraints must not short circuit vibration isolation systems or transmit objectionable vibration or noise.

- B. Supported Equipment:
 - 1. Each vibration isolation frame for supported equipment shall have a minimum of four seismic snubbers mounted as close as possible to the vibration isolators and/or the frame extremities.
 - 2. Care must be taken so that the 1/4-inch air gap in the seismic restraint snubber is preserved on all sides in order that the vibration isolation potential of the isolator is not compromised. This requires that the final snubber adjustment be completed after the vibration isolators are properly installed and the installation approved.

- C. Bracing of Pipes:
1. Branch lines may not be used to brace main lines.
 2. Transverse bracing shall be at 40 feet maximum, except where a lesser spacing is indicated in the SMACNA tables for bracing of pipes
 3. Longitudinal bracing shall be at 80 feet maximum except where a lesser spacing is indicated in the tables. In pipes where thermal expansion is a consideration, an anchor point may be used as the specified longitudinal brace provided that it has a capacity to resist both the seismic load and the additional force induced by expansion and contraction.
 4. A rigid piping system shall not be braced to dissimilar parts of the building or to two dissimilar building systems that may respond differently during an earthquake.
 5. Transverse bracing for one pipe section may also act as longitudinal bracing for a pipe section of the same size connected perpendicular to it if the bracing is installed within 24 inches of the elbow or tee.
 6. Subject to confirmation by field inspection, seismic bracing is not required on piping when the piping is supported by rod hangers and the hangers in the entire run are 12-inches or less in length from the top of the pipe to the supporting structure, hangers are detailed to avoid bending of the hangers and their attachments and provisions are made for piping to accommodate expected deflections.
- D. Suspended Equipment, Piping, Cable Method:
1. The cables shall be adjusted to a degree of slackness approved by the Structural Engineer.
 2. The uplift and downward restraint nuts and Mason type RW neoprene covered steel rebound washers for the Type 6 hangers shall be adjusted so that there is a maximum 1/4-inch clearance.

3.5 FIELD QUALITY CONTROL

- A. Installation Report: Isolation manufacturer's representative shall confirm that all isolation is installed correctly and submit report stating that isolators are installed as shown on Shop Drawings, isolators are free to work properly, and that installed deflections are as scheduled and as specified.

END OF SECTION

SECTION 15072

VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. The provisions of Section 15051, Common Work Results for HVAC apply to work specified in this Section.

1.2 SUMMARY

- A. This Section includes:
 - 1. Isolation of mechanical equipment as indicated on the Drawings and specified herein.
 - 2. Seismic restraint of equipment, piping and ductwork.
- B. Related Sections include:
 - 1. Section 15127 HVAC Expansion Compensation.
 - 2. Section 15060 Hangers, Supports and Anchors for HVAC.
 - 3. Section 15810 HVAC Ducts and Casing-Low Pressure.

1.3 QUALITY ASSURANCE

- A. A single manufacturer shall select and furnish all isolation required, except packaged equipment with integral isolators meeting all the isolation and seismic requirements of this specification.
- B. The system of vibration isolators and seismic controls shall be designed, detailed, and bear the seal of a professional engineer registered in the State having jurisdiction.
- C. Isolation performance requirements are indicated on the Drawings. All deflections indicated are nominal static deflections for specific equipment supported.
- D. Isolator Stability and Rated Capacity:
 - 1. Spring diameters not less than 0.8 of the compressed height of the spring at rated load.
 - 2. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection.
- E. Seismic Restraints:
 - 1. Restraint of equipment, piping and ductwork to be in accordance with the current state and local Building Code.
 - 2. All calculations shall be in accordance with current state and local Building Code.

1.4 SUBMITTALS

- A. Submit the following:
 - 1. Submit Shop Drawings showing complete details of construction for steel and concrete bases including:
 - a. Equipment mounting holes.
 - b. Dimensions.
 - c. Isolation selected for each support point.
 - d. Details of mounting brackets for isolator.
 - e. Weight distribution for each isolator.
 - f. Code number assigned to each isolator.
 - 2. Submit product data and calculation sheets for isolators, showing:
 - a. Size, type, load rating and rated deflection of each required isolator.
 - b. Percent of vibration transmitted based on the lowest disturbing frequency of the equipment.
 - 3. Structural Details and Calculations: Submit structural details and calculations substantiating that building structure, anchorages, and fabricated steel braces can safely withstand maximum calculated loads.
- B. Installation report as specified in Part 3 of this section.
- C. Operation and maintenance data.

1.5 EQUIPMENT VIBRATION ISOLATION

- A. Provide a balanced set of vibration isolators for each piece of equipment listed in the Equipment Schedules.
- B. Isolation work to include, but not necessarily be limited to, the following:
 - 1. Isolation support of motor-driven equipment.
 - 2. Isolation support of piping, piping risers, and ductwork.
 - 3. Penetration isolation of pipework, ductwork, and conduits through walls, floors or ceilings.
 - 4. Flexible connections of ductwork and piping to equipment.
- C. Each piece of rotating equipment must meet a reasonable criterion for maximum vibration levels at each bearing, while in operation. The criteria for varying operating speeds are given as follows:
 - 1. Rotating equipment operating peak vibration velocities must not exceed 0.08 in./sec.
 - 2. If it is discovered that the operating vibration velocities exceed this criteria, the equipment shall be repaired or replaced at no expense to the owner until approval of the equipment is given by the engineer.
- D. Any components or materials not specially mentioned herein, but necessary to the proper vibration isolation of the equipment, shall be provided.

1.6 ACCEPTABLE MANUFACTURERS

- A. Amber Booth.
- B. Mason Industries, Inc.

- C. Kinetics Corporation.
- D. Vibrex.
- E. Approved equal, meeting all of the conditions and requirements specified herein.

1.7 CONTRACTOR RESPONSIBILITY

- A. All vibration isolation devices, including auxiliary steel bases and pouring forms, shall be designed and furnished by a single manufacturer or suppliers.
- B. Adequately restrain all equipment, piping, and ductwork to resist seismic forces. Design and select restraint devices to meet seismic requirements as defined in the latest issue of the International Building Code under Earthquake Design and applicable state and local codes.
- C. In addition, the contractor shall have the following responsibilities:
 - 1. Selection, installation, adjustment and performance of vibration isolators which will meet the requirements given on the plans or in the specifications.
 - 2. Provide Engineering drawings, details, supervision, and instruction to assure proper installation and performance.
 - 3. Provide whatever assistance necessary to ensure correct installation and adjustment of the isolators.

PART 2 - PRODUCTS

2.1 TYPE 1 - NEOPRENE WAFFLE PAD

- A. 3/4-inch thick neoprene waffle pads with pattern repeating on 1/2-inch centers.
- B. Select Duro rating for maximum deflection at average load rating.
- C. Include load distribution steel plate as required.
- D. Include anchor bolt grommet as required.
- E. Acceptable Manufacturer: Mason Type “Super W” or “Super WM” and “HG Grommet”; Similar Amber-Booth, Kinetics Corporation.

2.2 TYPE 2 - RESTRAINED NEOPRENE MOUNT

- A. Bridge-bearing neoprene mountings shall have all directional seismic capability.
- B. Provide minimum deflection of 0.2-inch.
- C. The mount shall consist of a ductile iron casting containing two separated and opposing molded neoprene elements.

- D. The elements shall prevent the central threaded sleeve and attachment bolt from contacting the casting during normal operation.
- E. The shock absorbing neoprene materials shall be compounded to bridge-bearing specifications.
- F. Manufacturer: Mason type BR.

2.3 TYPE 3 - ISOLATING SPRING HANGERS

- A. Combination rubber-in shear and steel spring isolators installed on the hanger rods.
- B. Provide minimum deflection of 1-inch.
- C. Isolators shall have the proper deflection to allow the piping to deflect as a unit with the pump isolators.
- D. Hangers designed for 30 degree angular movement.
- E. Minimum deflection shall be one inch.
- F. Manufacturer: Mason 30N, similar Amber-Booth, Consolidated Kinetics, Vibrex.

2.4 TYPE 4 – ISOLATING NEOPRENE HANGERS

- A. Double deflection neoprene hangers.
- B. Provide minimum static deflection of 0.35-inches.
- C. Provide projecting bushing to prevent steel to steel contact.
- D. Manufacturer: Mason HD, similar Amber-Booth, Consolidated Kinetics, Vibrex.

2.5 SEISMIC RESTRAINTS

- A. General Requirements:
 - 1. Seismic restraints shall be provided for all equipment, piping and ductwork, both supported and suspended.
 - 2. Bracing of piping and ductwork shall be in accordance with the code and with the provisions set forth in the SMACNA seismic restraint manual.
 - 3. The structural requirements for the restraints, including their attachment to the building structure, shall be reviewed and approved by the structural engineer.
 - 4. Attachments to supported or suspended equipment must be coordinated with the equipment manufacturer.
- B. Supported Equipment:
 - 1. All-directional seismic snubbers shall consist of interlocking steel members restrained by a one-piece molded neoprene bushing of bridge bearing neoprene.
 - 2. Bushing shall be replaceable and a minimum of 1/4-inch thick. Rated loadings shall not exceed 1000 psi.

3. An air gap of 1/4-inch shall be incorporated in the snubber design in all directions before contact is made between the rigid and resilient surfaces.
4. Snubber end caps shall be removable to allow inspection of internal clearances. Neoprene bushings shall be rotated to ensure no short circuits exist before systems are activated.
5. Snubber shall be type Z-1225 as manufactured by Mason Industries, Inc.

C. Bracing of Pipes:

1. Provide seismic bracing of all piping as detailed below to meet the building code requirements:
 - a. Exception: Piping suspended by individual hanger's 12-inches or less in length, as measured from the top of the pipe to the bottom of the support where the hanger is attached, need not be braced where the following criteria are met.
 - 1) Seismic braces are not required on high deformability piping when the $I_p=1.0$ and provisions are made to avoid impact with larger pipe or mechanical components or to protect the pipe in the event of such impact and the nominal pipe size is 3-inches diameter or less.
 - 2) Seismic braces are not required on high deformability piping when the $I_p=1.5$ and provisions are made to avoid impact with larger pipe or mechanical components or to protect the pipe in the event of such impact and the nominal pipe size is 1-inch diameter or less.
2. Seismic braces for pipes on trapeze hangers may be used.
3. Provide flexibility in joints where pipes pass through building seismic joints or expansion joints, or where pipes connect to equipment.

D. Bracing of Ductwork:

1. Transverse bracing shall occur at the interval specified in the SMACNA tables or at both ends if the duct run is less than the specified interval. Transverse bracing shall be installed at each duct turn and at each end of a duct run, with a minimum of one brace at each end.
2. Longitudinal bracing shall occur at the interval specified in the SMACNA tables with at least one brace per duct run. Transverse bracing for one duct section may also act as longitudinal bracing for a duct section connected perpendicular to it if the bracing is installed within four feet of the intersection of the ducts and if the bracing is sized for the larger duct. Duct joints shall conform to SMACNA duct construction standards.
3. Install duct flex connections at equipment connections to accept expected differential displacement and protect the equipment connection from damage.

E. Suspended Equipment and Piping and Ductwork:

1. Seismic cable restraints shall consist of galvanized steel aircraft cables sized to resist seismic loads with a minimum safety factor of two and arranged to provide all-directional restraint.
2. Cable must be pre-stretched to achieve a certified minimum modulus of elasticity. Cable end connections shall be steel assemblies that swivel to final installation angle and utilize two clamping bolts to provide proper cable engagement.
3. Cable assemblies shall be type SCB at the ceiling and at the clevis bolt, SCBH between the hanger rod and the clevis or SCBV if clamped to a beam, all as manufactured by Mason Industries, Inc.

4. Steel angles, sized to prevent buckling, shall be clamped to pipe or equipment rods utilizing a minimum of three ductile iron clamps at each restraint location when required. Welding of a minimum of three ductile iron clamps at each restraint location when required. Welding of support rods is not acceptable. Rod clamp assemblies shall be type SRC or UC as manufactured by Mason Industries, Inc.
5. Pipe clevis cross-bolt braces are required in all restraint locations. They shall be special purpose preformed channels deep enough to be held in place by bolts passing over the cross bolt. Clevis cross brace shall be type CCB as manufactured by Mason Industries, Inc.

PART 3 - EXECUTION

3.1 GENERAL

- A. Do not install any equipment or pipe which makes rigid contact with the building. "Building" includes slabs, beams, studs, walls, etc.
- B. The installation or use of vibration isolators must not cause any change of position of equipment or piping which would result in stresses in piping connections or misalignment of shafts or bearings. In order to meet this objective, equipment and piping shall be maintained in a rigid position during installation. The load shall not be transferred to the isolator until the installation is complete and under full operational load.
- C. Correct, at no additional cost, all installations which are defective in workmanship or materials.

3.2 PREPARATION

- A. Treat all isolators, including springs, hardware and housing, with a corrosion protective coating of epoxy powder or electro galvanizing.
- B. Coat steel frames exposed to weather with a rustproof metal primer.
- C. Provide hot dipped galvanizing on steel frames as indicated on the plans for corrosion protection in severe conditions.

3.3 INSTALLATION

- A. General:
 1. Install isolation where indicated on the Drawings by type and location and where indicated below.
 2. The assigned code number shall be marked on the isolators and bases to assure placement in the proper location.
 3. Anchor isolator seismic housing baseplate to floor.
 4. Rubber grommets and washers shall be provided to isolate the bolt from the building structure. Under no circumstances shall the isolation efficiency be destroyed when bolting the isolators to the building structure.

- B. Type 1 – Neoprene Waffle Pad
 - 1. Service:
 - a. Floor Mounted Indoor Air Handling Units
 - b. Floor Mounted Heat Pumps

- C. Type 2 – Restrained Neoprene Mount
 - 1. Service:
 - a. Ceiling Exhaust Fans
 - b. Inline Centrifugal Fans
 - c. Floor Mounted Air Conditioners
 - d. Floor Mounted Heat Pumps
 - e. Fan Coil Units

- D. Type 3 – Isolating Spring Hangers
 - 1. Service:
 - a. Piping rigidly connected to rotating equipment
 - b. Propeller Fans
 - c. Fan Coil Units
 - d. Split-System Air Conditioning Unit
 - e. Split-System Heat Pump

- E. Type 4 – Isolating Neoprene Hanger
 - 1. Service:
 - a. Split-System Air Conditioning Unit
 - b. Split-System Heat Pump

SEISMIC RESTRAINTS

- F. General:
 - 1. Install and adjust seismic restraints so that the equipment, piping, and ductwork support is not degraded by the restraints.
 - 2. Restraints must not short circuit vibration isolation systems or transmit objectionable vibration or noise.

- G. Supported Equipment:
 - 1. Each vibration isolation frame for supported equipment shall have a minimum of four seismic snubbers mounted as close as possible to the vibration isolators and/or the frame extremities.
 - 2. Care must be taken so that the 1/4-inch air gap in the seismic restraint snubber is preserved on all sides in order that the vibration isolation potential of the isolator is not compromised. This requires that the final snubber adjustment be completed after the vibration isolators are properly installed and the installation approved.

- H. Bracing of Pipes:
 - 1. Branch lines may not be used to brace main lines.
 - 2. Transverse bracing shall be at 40 feet maximum, except where a lesser spacing is indicated in the SMACNA tables for bracing of pipes

3. Longitudinal bracing shall be at 80 feet maximum except where a lesser spacing is indicated in the tables. In pipes where thermal expansion is a consideration, an anchor point may be used as the specified longitudinal brace provided that it has a capacity to resist both the seismic load and the additional force induced by expansion and contraction.
4. A rigid piping system shall not be braced to dissimilar parts of the building or to two dissimilar building systems that may respond differently during an earthquake.
5. Transverse bracing for one pipe section may also act as longitudinal bracing for a pipe section of the same size connected perpendicular to it if the bracing is installed within 24 inches of the elbow or tee.
6. Subject to confirmation by field inspection, seismic bracing is not required on piping when the piping is supported by rod hangers and the hangers in the entire run are 12-inches or less in length from the top of the pipe to the supporting structure, hangers are detailed to avoid bending of the hangers and their attachments and provisions are made for piping to accommodate expected deflections.

I. Bracing of Ductwork:

1. Hanger straps must be positively attached to the duct within 2 inches of the top of the duct with a minimum of two #10 sheetmetal screws.
2. A group of ducts may be combined in a larger frame so that the combined weights and dimensions of the ducts are less than or equal to the maximum weight and dimensions of the duct for which bracing details are selected.
3. Walls, including gypsum board nonbearing partitions, which have ducts running through them, may replace a typical transverse brace. Provide solid blocking around duct penetrations at stud wall construction.
4. Unbraced ducts shall be installed with a 6-inch minimum clearance to vertical ceiling hanger wires.

J. Suspended Equipment, Piping, and Ductwork Cable Method:

1. The cables shall be adjusted to a degree of slackness approved by the Structural Engineer.
2. The uplift and downward restraint nuts and Mason type RW neoprene covered steel rebound washers for the Type 6 hangers shall be adjusted so that there is a maximum 1/4-inch clearance.

3.4 FIELD QUALITY CONTROL

- A. Installation Report: Isolation manufacturer's representative shall confirm that all isolation is installed correctly and submit report stating that isolators are installed as shown on Shop Drawings, isolators are free to work properly, and that installed deflections are as scheduled and as specified.

END OF SECTION

SECTION 15075

IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. The provisions of Section 15050, Common Work Results for Plumbing apply to work specified in this Section.

1.2 SUMMARY

- A. This Section includes: Identify valves, piping and equipment components of the mechanical systems to indicate their function and system served.

1.3 SUBMITTALS

- A. Submit the following:
 - 1. Valve Tag Directory: Submit for approval prior to fabrication of valve tags.
 - 2. Equipment Nameplate Directory: Submit for approval prior to fabrication.
 - 3. Operating and Maintenance Data: Include a copy of valve tag and equipment nameplate directories in each set of Operating and Maintenance manuals.

PART 2 - PRODUCTS

2.1 VALVE IDENTIFICATION

- A. Valve Tags:
 - 1. General: Identify valves with metal tags, legends to be stamped or embossed. It shall indicate the function of the valve and its normal operating position; i.e.,
56 HW (NUMBER AND CONTENT OF PIPE)
ISOLATION (VALVE FUNCTION)
NO (NORMAL OPERATION POSITION)
 - 2. Size: Valve tags 2-inch diameter with 1/4-inch high letters.
 - 3. Material: Use 0.050 or 0.064-inch brass tags.
 - 4. Automatic Valves and Regulating Valves: Use 1/16-inch thick laminated 3-ply plastic, center ply white, outer ply red, "lamicoid" or equal. Form letters by exposing center ply.
 - 5. Buildings Systems: Contact the Owner for coordination with existing building tagging system and supplementary information required for any specific system before valve tagging begins.
- B. Valve Tag Directory: Include tag number, location, exposed or concealed, service, valve size, valve manufacturer, valve model number, and normal operating position of valve.

2.2 PIPING MARKERS

- A. Acceptable Manufacturers:
1. W.H. Brady, Seton, Marking Systems, Inc. (MSI).
 2. Other Manufacturers: Submit Substitution Request.
- B. Pipes shall be labeled with all-vinyl, self-sticking labels or letters. For pipe covering sizes up to and including 3/4-inch outside diameter, select labels with 1/2-inch letters. For sizes from 3/4 to 2-inch outside diameter, 3/4-inch letters; above 2-inches outside diameter, 2-inch letters. The pipe markers shall be identified and color coded as follows with black directional arrows.

| PLUMBING SERVICE | BACKGROUND PIPE MARKER * | COLOR |
|----------------------------|---------------------------------|------------------|
| COLD WATER | “DOMESTIC COLD WATER” | GREEN |
| HOT WATER | “DOMESTIC HOT WATER SUPPLY” | YELLOW |
| | “DOM. HOT WATER RECIRC” | YELLOW OR GREEN |
| AIR, COMPRESSED | “COMPRESSED AIR” | BLUE |
| AIR, INSTRUMENT | “INSTRUMENT AIR” | BLUE |
| SANITARY WASTE | “SANITARY WASTE” | GREEN |
| STORM DRAIN | “STORM DRAIN” | GREEN |
| OVERFLOW DRAIN | “OVERFLOW DRAIN” | GREEN |
| VENT | “VENT” | GREEN |
| NATURAL GAS | “NATURAL GAS” | YELLOW |
| COLD PROCESS WATER | “PROCESS COLD WATER” | GREEN |
| PROCESS GREY WATER | “PROCESS GREY WATER” | GREEN |
| EMERGENCY EYEWASH & SHOWER | “EMERGENCY SHOWER” | YELLOW |
| DEIONIZED WATER | “DI SUPPLY” | GREEN |
| | “DI RETURN” | GREEN |
| | “DI RECLAIM” | GREEN |
| ACID WASTE | “ACID WASTE” | ORANGE |
| FLUORIDE WASTE | “FLUORIDE WASTE” | YELLOW OR ORANGE |
| SOLVENT WASTE | “SOLVENT WASTE” | ORANGE |
| PROCESS VACUUM | “PROCESS VACUUM” | GREEN |
| CLEAN-UP VACUUM | “HOUSE CLEAN VACUUM” | GREEN |
| COMPRESSED AIR | “HIGH PURITY COMPRESSED AIR” | BLUE OR YELLOW |
| LIQUID NITROGEN | “LIQUID NITROGEN” | BLACK |

| | | |
|-----------------------|---|--------|
| GASEOUS HYDROGEN | “HYDROGEN” | BROWN |
| GASEOUS OXYGEN | “OXYGEN” | GREEN |
| GASEOUS NITROGEN | “NITROGEN” | BLACK |
| SPECIALTY GASES | ** “AS IDENTIFIED BY OWNER FOR VARIOUS TOXIC GASES” | BLUE |
| INDUSTRIAL COLD WATER | “INDUSTRIAL COLD WATER” | GREEN |
| FUEL OIL | “FUEL OIL SUPPLY” | YELLOW |
| | “FUEL OIL RETURN” | |
| FUEL OIL VENT | “FUEL OIL VENT” | YELLOW |
| NATURAL GAS VENT | “NATURAL GAS VENT” | YELLOW |
| RECLAIMED WATER | “CAUTION: RECLAIMED WATER, DO NOT DRINK” | PURPLE |
| SOLAR HOT WATER | “SOLAR HOT WATER SUPPLY” | YELLOW |
| | “SOLAR HOT WATER RETURN” | YELLOW |

* Directional arrow applied adjacent to pipe marker indicating direction of flow.

** Provide custom marker labels for all piping for which no standard manufactured marker is available. Submit sample for approval.

| MEDICAL GAS SERVICE | BACKGROUND PIPE MARKER * | BACKGROUND/TEXT COLOR |
|---|---------------------------------|--|
| MEDICAL AIR | “MED AIR” | YELLOW/BLACK |
| CARBON DIOXIDE | “CARBON DIOXIDE” | GRAY/BLACK |
| HELIUM | “HELIUM” | BROWN/WHITE |
| NITROGEN | ”NITROGEN” | BLACK/WHITE |
| NITROUS OXIDE | “NITROUS OXIDE” | BLUE/WHITE |
| OXYGEN | “OXYGEN” | GREEN/WHITE |
| MEDICAL-SURGICAL VACUUM | “MED VAC” | WHITE/BLACK |
| WASTE ANESTHETIC GAS DISPOSAL | “WAGD” | VIOLET/WHITE |
| NONMEDICAL AIR (LEVEL 3 GAS-POWERED DEVICE) | “NON-MED AIR” | YELLOW-AND-WHITE DIAGONAL STRIPE/ BLACK |
| NONMEDICAL AND LEVEL 3 VACUUM | “NON-MED VAC” | WHITE-AND-BLACK DIAGONAL STRIPE/ BLACK BOXED |
| LABORATORY AIR | “LAB AIR” | YELLOW-AND-WHITE CHECKERBOARD/BLACK |

| | | |
|---|------------------|--|
| LABORATORY VACUUM | “LAB VAC” | WHITE-AND-BLACK CHECKERBOARD/BLACK BOXED |
| INSTRUMENT AIR | “INSTRUMENT AIR” | RED/WHITE |
| * Directional arrow applied adjacent to pipe marker indicating direction of flow. | | |

C. Reclaimed Water:

1. All reclaimed water pipe and fittings shall be continuously wrapped with purple-colored Mylar tape over insulation, with the words "CAUTION: RECLAIMED WATER, DO NOT DRINK". The lettering shall be imprinted in two (2) parallel lines, such that after wrapping the pipe with a one-half (1/2) width overlap, one (1) full line of text shall be visible.
2. Wrapping tape is not required for buried PVC pipe manufactured with purple color integral to the plastic and marked on opposite sides to read "CAUTION: RECLAIMED WATER, DO NOT DRINK" in intervals not to exceed three (3) feet (914 mm).
3. Outlets and fixtures served with harvester rainwater shall be easily recognizable by color or symbol for non-potable water.
4. Reference local ruling for additional requirements.

D. Specialty Gases: Piping shall be identified with Brady B-60 fiber tags with chemical symbol on tag.

2.3 EQUIPMENT IDENTIFICATION

A. Nameplates:

1. Tag all pumps, converters, and miscellaneous items of mechanical equipment with engraved nameplates. Nameplates shall be 1/16-inch thick, 3 x 5 laminated 3-ply plastic, center ply white, outer ply black. Form letters by exposing center ply.
2. Identify unit with code number as shown on Drawings and area served.

B. Equipment Nameplate Directory: List pumps, and other equipment nameplates. Include Owner and Contractor furnished equipment. List nameplate designation, manufacturer's model number, location of equipment, area served or function, disconnect location, and normal position of HOA switch.

PART 3 - EXECUTION

3.1 VALVE IDENTIFICATION

A. Valve Tags:

1. Attach to valve with a brass chain.

B. Valve Tag Directory: Post final copy in Operation and Maintenance Manual.

3.2 PIPING MARKERS

- A. Unless recommendations of ANSI A13.1, 1981 are more stringent, apply labels or letters after completion of pipe cleaning, insulation, painting, or other similar work, as follows:
 - 1. Every 20 feet along continuous exposed lines.
 - 2. Every 10 feet along continuous concealed lines.
 - 3. Adjacent to each valve and stubout for future.
 - 4. Where pipe passes through a wall, into and out of concealed spaces.
 - 5. On each riser.
 - 6. On each leg of a “T”.
 - 7. Locate conspicuously where visible.
 - 8. Provide pipe identification (over insulation) for all reclaimed water systems in accordance with current local codes and rulings.

- B. Further, apply labels or letters to lower quarters of the pipe on horizontal runs where view is not obstructed or on the upper quarters when pipe is normally viewed from above. Apply arrow labels indicating direction of flow. Arrows to be the same color and sizes as identification labels.

- C. Install tags on specialty gas piping valves with brass chain.

3.3 EQUIPMENT IDENTIFICATION

- A. Nameplates: Attach to prominent area of equipment, either with sheet metal screws, brass chain, or contact cement as applicable.

- B. Nameplate Directory: Post final copy in Operation and Maintenance Manual.

END OF SECTION

SECTION 15076

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. The provisions of Section 15051, Common Work Results for HVAC apply to work specified in this Section.

1.2 SUMMARY

- A. This Section includes: Identify valves, piping and equipment components of the mechanical systems to indicate their function and system served.

1.3 SUBMITTALS

- A. Submit the following:
 - 1. Valve Tag Directory: Submit for approval prior to fabrication of valve tags.
 - 2. Equipment Nameplate Directory: Submit for approval prior to fabrication.
 - 3. Operating and Maintenance Data: Include a copy of valve tag and equipment nameplate directories in each set of Operating and Maintenance manuals.

PART 2 - PRODUCTS

2.1 VALVE IDENTIFICATION

- A. Valve Tags:
 - 1. General: Identify valves with metal tags, legends to be stamped or embossed. It shall indicate the function of the valve and its normal operating position; i.e.,
56 HW (NUMBER AND CONTENT OF PIPE)
ISOLATION (VALVE FUNCTION)
NO (NORMAL OPERATION POSITION)
 - 2. Size: Valve tags 2-inch diameter with 1/4-inch high letters.
 - 3. Material: Use 0.050 or 0.064-inch brass tags.
 - 4. Automatic Valves and Regulating Valves: Use 1/16-inch thick laminated 3-ply plastic, center ply white, outer ply red, "lamicoid" or equal. Form letters by exposing center ply.
 - 5. Buildings Systems: Contact the Owner for coordination with existing building tagging system and supplementary information required for any specific system before valve tagging begins.
- B. Valve Tag Directory: Include tag number, location, exposed or concealed, service, valve size, valve manufacturer, valve model number, and normal operating position of valve.

2.2 PIPING MARKERS

- A. Acceptable Manufacturers:
1. W.H. Brady, Seton, Marking Systems, Inc. (MSI).
 2. Other Manufacturers: Submit Substitution Request.
- B. Pipes shall be labeled with all-vinyl, self-sticking labels or letters. For pipe covering sizes up to and including 3/4-inch outside diameter, select labels with 1/2-inch letters. For sizes from 3/4 to 2-inch outside diameter, 3/4-inch letters; above 2-inches outside diameter, 2-inch letters. The pipe markers shall be identified and color coded as follows with black directional arrows.

| HVAC SERVICE | BACKGROUND PIPE MARKER * | COLOR |
|-------------------------|---------------------------|--------|
| REFRIGERANT SUCTION | “REFRIGERANT SUCTION” | YELLOW |
| REFRIGERANT LIQUID | “REFRIGERANT LIQUID” | GREEN |
| REFRIGERANT HOT GAS | “REFRIGERANT HOT GAS” | YELLOW |
| REFRIGERANT RELIEF VENT | “REFRIGERANT RELIEF VENT” | GREEN |

* Directional arrow applied adjacent to pipe marker indicating direction of flow.

2.3 EQUIPMENT IDENTIFICATION

- A. Nameplates:
1. Tag all pumps, air handling supply units, fans, terminal units, converters, and miscellaneous items of mechanical equipment with engraved nameplates. Nameplates shall be 1/16-inch thick, 3 x 5 laminated 3-ply plastic, center ply white, outer ply black. Form letters by exposing center ply.
 2. Identify unit with equipment tag as shown on Drawings and area served.
 3. Access points to fire dampers, smoke dampers, and combination fire and smoke dampers shall be permanently identified on the exterior of the duct by a label with letters 1/2-inch in height reading: Fire Damper, Smoke Damper, or Fire/Smoke Damper, as appropriate. Label constructed from same material as equipment nameplates.
- B. Equipment Nameplate Directory: List pumps, air handlers, terminal units, and other equipment nameplates. Include Owner and Contractor furnished equipment. List nameplate designation, manufacturer’s model number, location of equipment, area served or function, disconnect location, and normal position of HOA switch.

PART 3 - EXECUTION

3.1 VALVE IDENTIFICATION

- A. Valve Tags:
1. Attach to valve with a brass chain.

2. Valve tag numbers shall be continuous throughout the building for each system. Contractor shall obtain a list for each system involved from the Owner.

B. Valve Tag Directory: Post final copy in Operation and Maintenance Manual.

3.2 PIPING MARKERS

A. Unless recommendations of ANSI A13.1, 1981 are more stringent, apply labels or letters after completion of pipe cleaning, insulation, painting, or other similar work, as follows:

1. Every 20 feet along continuous exposed lines.
2. Every 10 feet along continuous concealed lines.
3. Adjacent to each valve and stubout for future.
4. Where pipe passes through a wall, into and out of concealed spaces.
5. On each riser.
6. On each leg of a "T".
7. Locate conspicuously where visible.

B. Further, apply labels or letters to lower quarters of the pipe on horizontal runs where view is not obstructed or on the upper quarters when pipe is normally viewed from above. Apply arrow labels indicating direction of flow. Arrows to be the same color and sizes as identification labels.

3.3 EQUIPMENT IDENTIFICATION

A. Nameplates: Attach to prominent area of equipment, either with sheet metal screws, brass chain, or contact cement as applicable.

B. Nameplate Directory: Post final copy in Operation and Maintenance Manual.

END OF SECTION

SECTION 15080

INSULATION FOR PLUMBING

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.
- B. The provisions of Section 15050, Common Work Results for Plumbing apply to work specified in this Section.

1.2 SUMMARY

- A. This Section includes: Insulation for piping, and equipment.
- B. Related Sections include:
 - 1. Section 15060 Hangers, Supports and Anchors for Plumbing.

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. All insulating products shall comply with the Oregon Revised Statute (ORS) 453.005(7)(e) prohibiting pentabrominated, octabrominated and decabrominated diphenyl ethers. Where products within this specification contain these banned substances, provide complying products from approved manufacturers with equal performance characteristics.
 - 2. Flame and Smoke Ratings: Installed composite flame spread not to exceed 25 and smoke developed not to exceed 50 as tested by UL 723.
 - 3. Energy Codes: Local Building and Energy Codes shall govern where insulation performance requirements for thickness exceeds thickness specified.
- B. Protection: Protect against dirt, water, chemical, or mechanical damage before, during, and after installation. Repair or replace damaged insulation at no additional cost.
- C. Source Quality Control:
 - 1. Service: Use insulation specifically manufactured for service specified.
 - 2. Labeling: Insulation labeled or stamped with brand name and number.
 - 3. Insulation and accessories shall not provide any nutritional or bodily use to fungi, bacteria, insects, rats, mice, or other vermin, shall not react corrosively with equipment, piping, or ductwork, and shall be asbestos free.

1.4 SUBMITTALS

- A. Submit the following.
 - 1. Product Data: For each type including density, conductivity, thickness, jacket, vapor barrier, and flame spread and smoke developed indices.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Equivalent products by Johns Manville, Knauf, Owens Corning, and CertainTeed are acceptable.
- B. All such insulation shall be of one manufacturer.
- C. Other Manufacturers: Submit Substitution Request.

2.2 PIPE INSULATION

- A. Fiberglass: Split sectional or snap-on type with 0.23 per inch maximum thermal conductivity (K-factor) at 75°F mean temperature, 850°F maximum service rating and white, vapor barrier jacket with pressure sensitive closure system. Johns Manville Microlok HP.
- B. Calcium Silicate: Sectional with 14 pcf nominal density, 0.40 maximum K-factor at 300°F mean temperature and 1200°F maximum service rating. Johns Manville Thermo-12 Gold.
- C. Elastomeric: Expanded closed cell, 0.27 per inch maximum K-factor at 75°F mean temperature, 220°F maximum service rating with fitting covers and paintable surface. Armacell AP Armaflex, Rubatex.
- D. Polyolefin: Semi-rigid polyolefin form snap-on or slip over type with 0.24 per inch maximum thermal conductivity (K-factor) at 75°F mean temperature -165°F to 210°F service factor and paintable surface. End joints in insulation on piping with fluid temperatures normally below 65°F fuse sealed in accordance with the manufacturer's instructions. Joints longitudinal joints and other end joints made with manufacturer's approval contact adhesive in accordance with the manufacturer's instructions. Joints may be pre-glued or pre-coated with adhesive where applicable.

2.3 PIPE ACOUSTICAL WRAP

- A. Barrier shall be constructed of a 0.10-inch thick mass loaded, limp vinyl sheet bonded to a layer of reinforced aluminum foil on one side. The barrier shall have a nominal density of 1 lb per square foot and minimum STC rating of 28. The barrier shall have a minimum thermal conductivity value of 0.29 and a rated service temperature range of -40°F to 220°F. Barrier shall have a flame spread index of no more than 10 and a smoke development index of less than 40.

- B. The decoupling layer shall be a combination of 1-inch fiberglass batting, non woven porous scrim-coated glass cloth, quilted together in a matrix of 4-inch diamond stitch pattern which encapsulates the glass fibers. The composite material shall be fabricated to include a nominal 6-inch wide barrier overlap tab extending beyond the quilted fiber glass to facilitate a leak-tight seal around field joints.
- C. Kinectics Noise Control model KNM-100ALQ.

2.4 BLOCK INSULATION

- A. Fiberglass: 1-1/2-inch thick unless specified or shown otherwise with 3 pcf nominal density, 0.23 per inch maximum K-factor at 75°F mean temperature and 450°F minimum operating temperature limit. Johns Manville 1000 Series.

2.5 ACCESSORIES PIPING

- A. Adhesives:
 - 1. Fiberglass: Zeston Z-Glu.
 - 2. Calcium Silicate: Benjamin Foster 30-36.
 - 3. Elastomeric: Armacell 520.
 - 4. Polyolefin: As approved by the insulation manufacturer.
- B. Cements:
 - 1. Insulating: Ryder.
 - 2. Heat Transfer: Zeston Z-20.
- C. Wire Mesh: 1-inch mesh with 20 gauge annealed steel wire.
- D. Pipe Fitting Covers: One piece PVC insulated pipe fitting covers. Zeston, Ceel-Co.
- E. Grooved Coupling Insulation: One piece PVC insulated fitting cover, Zeston, Ceel-Co.
- F. Metal Pipe Jacket: 0.016-inch thick aluminum jacket with formed fitting covers, aluminum snap straps and sealant.
- G. Cloth Facing: Presized fiberglass cloth.
- H. Tapes: Pressure sensitive, weather resistant, and for temperatures up to 150°F. Zeston Z-tape.
- I. Paint: Ultraviolet resistant latex paint with special adherence capabilities to the PVC fitting covers, elastomeric, aluminum facing, Kraft paper, tapes and adhesives.

PART 3 - EXECUTION

3.1 GENERAL

- A. Workmanship:
 - 1. Installation: Insulation installed in first class, neat professional manner.

2. Applicators: Applicators shall be employed by firm that specializes in insulation work.

B. Preparation: Surfaces of piping and equipment clean, free of oil or dirt, and dry before insulation is applied.

C. Stamps: ASME stamps, UL labels, and similar stamps and labels shall not be covered.

3.2 PLUMBING PIPE AND EQUIPMENT INSULATION APPLIED LOCATIONS

A. Insulation Applied Locations – Plumbing Piping:

| System | Pipe Size | Insulation Type | Insulation Thickness | Notes |
|--|------------------------|---|----------------------|-------------------------|
| Domestic Cold Water, Above Grade | 1 1/4-inch and smaller | Fiberglass, all purpose jacket or Elastomeric or Polyolefin | 1-inch | Note 1 Note 2 |
| | Above 1 1/4-inch | Fiberglass, all purpose jacket | 1 1/2-inch | Note 1 |
| Industrial Cold Water, Above Grade | 1 1/4-inch and smaller | Fiberglass, all purpose jacket or Elastomeric or Polyolefin | 1-inch | Note 1 Note 2 |
| | Above 1 1/4-inch | Fiberglass, all purpose jacket | 1 1/2-inch | Note 1 |
| Non-Potable Cold Water, Above Grade | 1 1/4-inch and smaller | Fiberglass, all purpose jacket or Elastomeric or Polyolefin | 1-inch | Note 1 Note 2 |
| | Above 1 1/4-inch | Fiberglass, all purpose jacket | 1 1/2-inch | Note 1 |
| Reclaimed Water, Above Grade | 1 1/4-inch and smaller | Fiberglass, all purpose jacket or Elastomeric or Polyolefin | 1-inch | Note 1 Note 2 |
| | Above 1 1/4-inch | Fiberglass, all purpose jacket | 1 1/2-inch | Note 1 |
| Domestic Hot Water Supply/Return, Above Grade | 1 1/2-inch and smaller | Fiberglass, all purpose jacket or Elastomeric or Polyolefin | 1 1/2-inch | Note 1 Note 2 |
| | Above 1 1/2-inch | Fiberglass, all purpose jacket | 2-inch | Note 1 |
| Traps and trap priming lines (In unheated Spaces) | All | Fiberglass, all purpose jacket | 1-inch | Insulate over heat tape |

| System | Pipe Size | Insulation Type | Insulation Thickness | Notes |
|--|-----------|--------------------------------|----------------------|--------|
| Central Compressed Air | All | Elastomeric or Polyolefin | 1/2-inch | Note 2 |
| Condensate or other cold water drains | All | Elastomeric or Polyolefin | 1/2-inch | Note 2 |
| Storage Tanks | All | Fiberglass, all purpose jacket | 3 1/2-inch | |
| | | Elastomeric or Polyolefin | 3 1/2-inch | |
| <p>Note 1: Cover with metal pipe jacket where exposed to weather, and over heat trace cable. Note 2: Elastomeric or polyolefin insulation not allowed over heat trace cable. Note 3: Drain bodies, insulate the first 10 feet connected to the drain body, and all horizontal piping. Do not insulate main vertical stack.</p> | | | | |

- B. The following piping is not insulated:
1. Waste and vent, except where heat traced.
 2. Natural gas.
 3. Fuel oil.
 4. Specialty gases.
 5. Medical gases.
 6. Domestic cold water runouts to single fixture less than 12-inch long and exposed supplies.
 7. Priming lines except where heat traced.
- C. Insulation shall include all fittings, unions, flanges, mechanical couplings, valve bodies, valve bonnets, piping through sleeves, except valve bonnets, unions and flanges need not be insulated on the following systems: Domestic and solar hot water, inside building.
- D. Valves and irregular fittings shall be insulated with section of pipe insulation and insulating cement, securely fastened, and finished with 6 oz. canvas and Foster 30-36 lagging adhesive. The contractor shall have the option on all flanges, valves, strainers, not requiring a vapor barrier to insulate with removable replaceable pads fabricated of 1-inch layer of Pittsburgh Corning Temp Mat sandwiched between inner and outer layer of 8 oz. glass cloth held together with stainless staples with sufficient stainless lacing hooks to hold pad firmly to flange or valve with minimum 3-inch overlap onto adjacent pipe insulation using 18 gauge S.S. lacing wire.
- E. Expansion Joints and Flexible Connectors: Pipe insulation or block of same material and thickness as adjacent piping.

3.3 PIPING INSTALLATION

A. General:

1. Joints: Coat both sides of complete joining area with applicable adhesive.
 - a. Longitudinal Joints: Make joints on top or back of pipe to minimize visibility. Except foam plastic, seal with closure system or 3-inch wide tape.
 - b. Butt Joints: Butt lightly together and, except for foam plastic, seal with 3-inch wide tape or butt straps.
 - c. Multiple Layered Insulation: Joints staggered.
2. Access: Strainer and other items requiring service or maintenance with easily removable and replaceable section of insulation to provide access.
3. Voids: Fill all voids, chipped corners and other openings with insulating cement or material compatible with insulating material. In insulation with Heat Tracing: Where piping is shown or specified to be heat traced, bed heat tape into heat transfer cement with insulation over heat tape and cement.
4. Seal joints, seams and fittings of metal watertight jackets at exterior locations.

B. Fiberglass Insulation: Exterior insulation encased in metal jacket.

C. Calcium Silicate Insulation:

1. Secure with 18-gauge wire embedded into insulation.
2. Cover with continuous vapor barrier jacket.

D. Elastomeric and Polyolefin Insulation:

1. Slit full length and snap around pipe.
2. Make cuts perpendicular to insulating surface leaving no cut section exposed.
3. Do not stretch insulation to cover joints or fittings.
4. Seal joints in elastomeric insulation with adhesive.
5. Seal joints in polyolefin as specified hereinbefore.
6. Exterior insulation painted with two coats of specified paint in accordance with the manufacturer's instructions and encase in metal jacket.
7. Sealing joints with tape will not be allowed.

E. Fittings: Insulation specified with continuous vapor barrier, the vapor barrier must not be violated.

1. On Elastomeric and Polyolefin Insulation: Fittings covered with covers made up of mitered sections of insulation or with formed pipe fitting covers.
2. In Other Insulation: Fittings covered with insulation to the same level of the adjoining insulation or fill with insulating cement. Finish with pipe fitting covers or cloth facing and tape.

F. Unions, Mechanical Joints, Valves, Etc.:

1. General:
 - a. As specified for fittings.
 - b. Minimum thickness same as specified for piping.
2. Unions: Build up insulation at least 1/2-inch beyond adjoining insulation.
3. Flanges: With square corners. Where flanges are not insulated, terminate adjacent insulation so flange bolts can be removed.
4. Flanged Valves: Insulation with square corners.

- G. Vapor Barrier Insulation:
1. Refer to Section 15060 for support requirements.
 2. Piping which requires vapor barrier protection shall have a continuous vapor barrier, which may not be pierced or broken. The following piping systems require vapor barrier protection:
 - a. Domestic cold water.
 - b. Industrial cold water.
 - c. Non-potable cold water.
 - d. All other piping systems with a nominal operating temperature below 65°F.
 3. Vapor Barrier Insulation:
 - a. Insulation for pipe requiring vapor barrier protection 1-1/4-inch or smaller, insulation continuous through pipe hangers and rollers.
 - b. For pipe 1-1/2-inch and larger, 18-inch section of calcium silicate, same thickness as pipe insulation with continuous vapor barrier jacket at each hanger or roller. Provide pipe shield specified in Section 15060.
- H. Non-Vapor Barrier Insulation:
1. Refer to Section 15060 for support requirements.
 2. At contractor's option, insulation may be interrupted at supports. Butt insulation tight to support.
 3. If contractor elects to continue insulation at supports, installation as specified for piping systems with vapor barrier installation.
 4. Void between saddle and pipe filled with insulation.
- I. Non-Vapor Barrier Insulation:
1. Refer to Section 15060 for support requirements.
 2. For pipe 1-1/4-inch or smaller, insulation continuous through pipe hangers and rollers.
 3. For pipe 1-1/2-inch and larger, 18-inch section of calcium silicate, same thickness as pipe insulation. Provide pipe shield specified in Section 15060.
- J. Acoustical Wrap:
1. Install in accordance with the manufacturer's instructions.
 2. Applied locations for piping systems:
 - a. Where specified or indicated on drawings.

3.4 EQUIPMENT INSTALLATION

- A. General: Install true and smooth. Insulation over curved surfaces shall conform to curves of surface.
1. Access: Insulated removable heads, water boxes, pump casings, access, etc., that require service, inspection or maintenance shall be provided with covers or section that are easily removable and replaceable. Reinforce openings in adjacent insulation with metal beading. In vapor barriered insulation, coat joints with vapor barrier mastic.
 2. Voids, Depressions and Cavities: All voids, chipped corners and other openings shall be filled with insulating cement or material compatible with insulating material.
 3. Vapor Barriered Insulation: Where insulation is specified to have a vapor barrier, the barrier shall not be pierced or broken.
 - a. Tears, etc., shall be coated with vapor barrier mastic and patched with insulation facing or tape.

- b. Staples brush coated with vapor barrier coating.
 - c. All raw edges coated with vapor barrier mastic shall be covered and cover shall be sealed to equipment surface.
 - 4. Non-Vapor Barriered Insulation:
 - a. Tears, etc., shall be patched with insulation facing or tape.
 - b. All raw edges shall be covered and neatly beveled to the equipment surface.
 - 5. Multilayered Insulation: With staggered joints.
- B. Fiberglass Block:
 - 1. Anchors: Lug nuts 10 gauge black annealed iron wire welded to metal surfaces.
 - 2. Banding: Block secured to surface with 1/2-inch wide stainless steel bands maximum 18-inches on center and secured to anchors.
 - 3. Insulating Cement: Block covered with insulating cement minimum thickness of 1/2-inch with smooth finish.
 - 4. Vapor Barriered System: On vapor barriered system, apply continuous coat of vapor barrier mastic.
 - 5. Finish: Finish with cloth facing secured with adhesive and lapped a minimum of 2 inches. Defects touched up with finishing cement.
- C. Elastomeric Blanket: Cut insulation to size, make corners with mitering cuts to preclude raw edges, continuously cement insulation to equipment with adhesive. Cement both surfaces of joints and butt tightly together and cover raw edges with two coats of adhesive.
- D. Expansion Joints: Covered with larger size pipe insulation to allow full movement and be removable, ends turned back to pipe, coat with vapor barrier mastic on joints in vapor barriered system and finished with cloth facing cemented to insulation with adhesive.
- E. Heat Exchangers: Insulation thickness and material as specified for piping and applicable service.

3.5 FIELD QUALITY CONTROL

- A. Field Test: All systems shall be tested and approved prior to installation of insulation.
- B. Existing Insulation:
 - 1. Repair existing insulation damaged during construction.
 - 2. Make neat connections where new and existing insulation meet.
 - 3. Where existing piping, or equipment is removed, cover existing surfaces neatly to match existing.

END OF SECTION

SECTION 15081

INSULATION FOR HVAC

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.
- B. The provisions of Section 15051, Common Work Results for HVAC apply to work specified in this Section.

1.2 SUMMARY

- A. This Section includes: Insulation for piping, ductwork (external), ductwork (internal), and equipment.
- B. Related Sections include:
 - 1. Section 15061 Hangers, Supports and Anchors for HVAC.
 - 2. Section 15810 HVAC Ducts and Casing – Low Pressure.

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. All insulating products shall comply with the Oregon Revised Statute (ORS) 453.005(7)(e) prohibiting pentabrominated, octabrominated and decabrominated diphenyl ethers. Where products within this specification contain these banned substances, provide complying products from approved manufacturers with equal performance characteristics.
 - 2. Flame and Smoke Ratings: Installed composite flame spread not to exceed 25 and smoke developed not to exceed 50 as tested by UL 723.
 - 3. Energy Codes: Local Building and Energy Codes shall govern where insulation performance requirements for thickness exceeds thickness specified.
- B. Protection: Protect against dirt, water, chemical, or mechanical damage before, during, and after installation. Repair or replace damaged insulation at no additional cost.
- C. Source Quality Control:
 - 1. Service: Use insulation specifically manufactured for service specified.
 - 2. Labeling: Insulation labeled or stamped with brand name and number.
 - 3. Insulation and accessories shall not provide any nutritional or bodily use to fungi, bacteria, insects, rats, mice, or other vermin, shall not react corrosively with equipment, piping, or ductwork, and shall be asbestos free.

1.4 SUBMITTALS

- A. Submit the following.
 - 1. Product Data: For each type including density, conductivity, thickness, jacket, vapor barrier, and flame spread and smoke developed indices.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Equivalent products by Johns Manville, Knauf, Owens Corning, and CertainTeed are acceptable.
- B. All such insulation shall be of one manufacturer.
- C. Other Manufacturers: Submit Substitution Request.

2.2 PIPE INSULATION

- A. Fiberglass: Split sectional or snap-on type with 0.23 per inch maximum thermal conductivity (K-factor) at 75°F mean temperature, 850°F maximum service rating and white, vapor barrier jacket with pressure sensitive closure system. Johns Manville Microlok HP.
- B. Elastomeric: Expanded closed cell, 0.27 per inch maximum K-factor at 75°F mean temperature, 220°F maximum service rating with fitting covers and paintable surface. ArmacellAP Armaflex, Rubatex.

2.3 DUCTWORK BLANKET INSULATION

- A. Fiberglass: 1.0 pcf nominal density, 0.25 per inch maximum K-factor at 75°F mean temperature, 250°F minimum operating temperature limit. Johns Manville Microlite Type 100 with facing as follows:
 - 1. Exposed: FSK facing (foil scrim Kraft) or vinyl - white appearance.
 - 2. Concealed with Vapor Barrier: FSK reinforced foil and paper.
 - 3. Concealed without Vapor Barrier: Facing not required.
- B. Semi-Rigid Fiberglass: 2.5 pcf nominal density, 0.24 per inch maximum K-factor, at 75°F mean temperature, 250°F minimum operating temperature limit. Johns Manville Micro-Flex with facing as follows:
 - 1. Exposed: FSK facing (foil scrim kraft) or vinyl-white appearance.
 - 2. Concealed with Vapor Barrier: FSK reinforced foil and paper.
 - 3. Concealed without Vapor Barrier: Facing not required.
- C. Elastomeric: Expanded closed cell sheets, 0.27 per inch maximum K-factor at 75°F mean temperature and 220°F minimum operating temperature limit. ArmacellArmaflex.

2.4 DUCTWORK BOARD INSULATION

- A. Semi-Rigid Fiberglass: 0.23 per inch maximum K-factor at 75°F mean temperature, 250°F minimum operating temperature limit and all purpose vapor barrier facing with white Kraft paper finish. Micro-Aire Duct Board Type LP.
- B. Rigid Fiberglass: Same as semi-rigid except with 4.0 pcf density and 0.23 per inch maximum K-factor. Johns Manville Diffuser Board.

2.5 DUCT, PIPE AND TERMINAL UNIT ACOUSTICAL WRAP

- A. Barrier shall be constructed of a 0.10-inch thick mass loaded, limp vinyl sheet bonded to a layer of reinforced aluminum foil on one side. The barrier shall have a nominal density of 1 lb per square foot and minimum STC rating of 28. The barrier shall have a minimum thermal conductivity value of 0.29 and a rated service temperature range of -40 degrees F. to 220 degree F. Barrier shall have a flame spread index of no more than 10 and a smoke development index of less than 40.
- B. The decoupling layer shall be a combination of 1-inch fiberglass batting, non woven porous scrim-coated glass cloth, quilted together in a matrix of 4-inch diamond stitch pattern which encapsulates the glass fibers. The composite material shall be fabricated to include a nominal 6-inch wide barrier overlap tab extending beyond the quilted fiber glass to facilitate a leak-tight seal around field joints.
- C. Kinectics Noise Control model KNM-100ALQ.

2.6 ACCESSORIES PIPING

- A. Adhesives:
 - 1. Fiberglass: Zeston Z-Glu.
 - 2. Calcium Silicate: Benjamin Foster 30-36.
 - 3. Elastomeric: Armacell 520.
 - 4. Polyolefin: As approved by the insulation manufacturer.
- B. Cements:
 - 1. Insulating: Ryder.
 - 2. Heat Transfer: Zeston Z-20.
- C. Wire Mesh: 1-inch mesh with 20 gauge annealed steel wire.
- D. Pipe Fitting Covers: One piece PVC insulated pipe fitting covers. Zeston, Ceel-Co.
- E. Grooved Coupling Insulation: One piece PVC insulated fitting cover. Zeston, Ceel-Co.
- F. Metal Pipe Jacket: 0.016-inch thick aluminum jacket with formed fitting covers, aluminum snap straps and sealant.
- G. Cloth Facing: Presized fiberglass cloth.

- H. Tapes: Pressure sensitive, weather resistant, and for temperatures up to 150°F. Zeston Z-tape.
- I. Paint: Ultraviolet resistant latex paint with special adherence capabilities to the PVC fitting covers, elastomeric, aluminum facing, Kraft paper, tapes and adhesives.

2.7 ACCESSORIES DUCTWORK

- A. Adhesives:
 - 1. Fiberglass: Zeston Z-Glu.
 - 2. Elastomeric: Armacell 520.
 - 3. Polyolefin: As approved by the insulation manufacturer.
 - 4. Duct Insulation, Internal: Benjamin Foster 85-20.
- B. Weld Pins: Duro-Dyne with NC-1 nylon stop clips.
- C. Cements:
 - 1. Insulating: Ryder.
 - 2. Heat Transfer: Zeston Z-20.
- D. Wire Mesh: 1-inch mesh with 20 gauge annealed steel wire.
- E. Mastic: Chicago Mastic:
 - 1. Vapor Barrier: 17-475.
 - 2. Outdoor Mastic: 16-110 white.
- F. Cloth Facing: Presized fiberglass cloth.
- G. Tapes: Pressure sensitive, weather resistant, and for temperatures up to 150°F. Zeston Z-tape.
- H. Paint: Ultraviolet resistant latex paint with special adherence capabilities to the PVC fitting covers, elastomeric, aluminum facing, Kraft paper, tapes and adhesives.

PART 3 - EXECUTION

3.1 GENERAL

- A. Workmanship:
 - 1. Installation: Insulation installed in first class, neat professional manner.
 - 2. Applicators: Applicators shall be employed by firm that specializes in insulation work.
- B. Preparation: Surfaces of piping, ductwork and equipment clean, free of oil or dirt, and dry before insulation is applied.
- C. Stamps: ASME stamps, UL labels, and similar stamps and labels shall not be covered.

3.2 HVAC PIPE AND EQUIPMENT INSULATION APPLIED LOCATIONS

A. Insulation Applied Locations – HVAC Piping:

| System | Pipe Size | Insulation Type | Insulation Thickness | Notes |
|--|-----------|---------------------------|----------------------|--------|
| Pumped Condensate | all | Elastomeric or Polyolefin | 1 inch | Note 1 |
| Refrigerant Suction, Hot Gas | All | Elastomeric or Polyolefin | 1 1/2-inch | Note 1 |
| Note 1: Elastomeric or Polyolefin insulation not allowed over heat trace cable. | | | | |

B. Insulation shall include all fittings, unions, flanges, mechanical couplings, valve bodies, valve bonnets, piping through sleeves, except valve bonnets, unions and flanges need not be insulated on the following systems:

1. Condensate, pumped condensate, inside building.

3.3 PIPING INSTALLATION

A. General:

1. Joints: Coat both sides of complete joining area with applicable adhesive.
 - a. Longitudinal Joints: Make joints on top or back of pipe to minimize visibility. Except foam plastic, seal with closure system or 3-inch wide tape.
 - b. Butt Joints: Butt lightly together and, except for foam plastic, seal with 3-inch wide tape or butt straps.
 - c. Multiple Layered Insulation: Joints staggered.
2. Access: Strainer and other items requiring service or maintenance with easily removable and replaceable section of insulation to provide access.
3. Voids: Fill all voids, chipped corners and other openings with insulating cement or material compatible with insulating material. In insulation with Heat Tracing: Where piping is shown or specified to be heat traced, bed heat tape into heat transfer cement with insulation over heat tape and cement.
4. Seal joints, seams and fittings of metal watertight jackets at exterior locations.

B. Fiberglass Insulation: Exterior insulation encased in metal jacket.

C. Cellular Glass Insulation (pre-insulated piping):

1. Install per manufacturer's instructions.
2. All insulation and jacket shall be factory applied to the carrier piping and fittings.
3. Apply bituminous wrap jacket.
4. Installation to be liquid and vapor tight.

- D. Elastomeric and Polyolefin Insulation:
1. Slit full length and snap around pipe.
 2. Make cuts perpendicular to insulating surface leaving no cut section exposed.
 3. Do not stretch insulation to cover joints or fittings.
 4. Seal joints in elastomeric insulation with adhesive.
 5. Seal joints in polyolefin as specified hereinbefore.
 6. Exterior insulation painted with two coats of specified paint in accordance with the manufacturer's instructions and encase in metal jacket.
 7. Sealing joints with tape will not be allowed.
- E. Fittings: Insulation specified with continuous vapor barrier, the vapor barrier must not be violated.
1. On Elastomeric and Polyolefin Insulation: Fittings covered with covers made up of mitered sections of insulation or with formed pipe fitting covers.
 2. In Other Insulation: Fittings covered with insulation to the same level of the adjoining insulation or fill with insulating cement. Finish with pipe fitting covers or cloth facing and tape.
- F. Unions, Mechanical Joints, Valves, Etc.:
1. General:
 - a. As specified for fittings.
 - b. Minimum thickness same as specified for piping.
 2. Unions: Build up insulation at least 1/2-inch beyond adjoining insulation.
 3. Flanges: With square corners. Where flanges are not insulated, terminate adjacent insulation so flange bolts can be removed.
 4. Flanged Valves: Insulation with square corners.
- G. Vapor Barrier Insulation:
1. Refer to Section 15061 for support requirements.
 2. Piping which requires vapor barrier protection shall have a continuous vapor barrier, which may not be pierced or broken. The following piping systems require vapor barrier protection:
 - a. Chilled water including radiant cooling water.
 - b. Brine water.
 - c. Refrigerant suction.
 - d. All other piping systems with a nominal operating temperature below 65°F.
 3. Vapor Barrier Insulation.
 - a. Insulation for pipe requiring vapor barrier protection 1-1/4-inch or smaller, insulation continuous through pipe hangers and rollers.
 - b. For pipe 1-1/2-inch and larger, 18-inch section of calcium silicate, same thickness as pipe insulation with continuous vapor barrier jacket at each hanger or roller. Provide pipe shield specified in Section 15061.
- H. Non-Vapor Barrier Insulation:
1. Refer to Section 15061 for support requirements.
 2. At contractor's option, insulation may be interrupted at supports. Butt insulation tight to support.
 3. If contractor elects to continue insulation at supports, installation as specified for piping systems with vapor barrier installation.

4. Void between saddle and pipe filled with insulation.

3.4 EQUIPMENT INSTALLATION

- A. General: Install true and smooth. Insulation over curved surfaces shall conform to curves of surface.
 1. Access: Insulated removable heads, water boxes, pump casings, access, etc., that require service, inspection or maintenance shall be provided with covers or section that are easily removable and replaceable. Reinforce openings in adjacent insulation with metal beading. In vapor barriered insulation, coat joints with vapor barrier mastic.
 2. Voids, Depressions and Cavities: All voids, chipped corners and other openings shall be filled with insulating cement or material compatible with insulating material.
 3. Vapor Barriered Insulation: Where insulation is specified to have a vapor barrier, the barrier shall not be pierced or broken.
 - a. Tears, etc., shall be coated with vapor barrier mastic and patched with insulation facing or tape.
 - b. Staples brush coated with vapor barrier coating.
 - c. All raw edges coated with vapor barrier mastic shall be covered and cover shall be sealed to equipment surface.
 4. Non-Vapor Barriered Insulation:
 - a. Tears, etc., shall be patched with insulation facing or tape.
 - b. All raw edges shall be covered and neatly beveled to the equipment surface.
 5. Multilayered Insulation: With staggered joints.
- B. Elastomeric Blanket: Cut insulation to size, make corners with mitering cuts to preclude raw edges, continuously cement insulation to equipment with adhesive. Cement both surfaces of joints and butt tightly together and cover raw edges with two coats of adhesive.
- C. Expansion Joints: Covered with larger size pipe insulation to allow full movement and be removable, ends turned back to pipe, coat with vapor barrier mastic on joints in vapor barriered system and finished with cloth facing cemented to insulation with adhesive.

3.5 DUCT INSULATION APPLIED LOCATIONS

- A. General:
 1. All external insulation with continuous vapor barriers unless specifically noted otherwise.
 2. Internally lined shall be lined completely to grille or diffuser or to indicated terminal points. Dimension shown are net inside of liner.
 3. Internally lined ductwork need not be externally insulated.
 4. In addition to locations described in specification, internally line medium, low, return and exhaust air ductwork where shown on drawings.

B. Insulation Applied Location – HVAC Ductwork:

| System | Location | Duct Type | Insulation Type | Thickness | Notes |
|---|---|-------------|--|-----------------------------------|------------------|
| Low Pressure Supply* | Exposed or Visible (Including above a cloud ceiling) | Rectangular | Internally Lined | 1 1/2-inch | |
| | | Round | Internally Lined | 1 1/2-inch | Note 5 |
| | Concealed or in mechanical rooms | All | Fiberglass Blanket | 1 1/2-inch | |
| | Exposed Outside Building Envelope | All | Internally Lined | 3-inch | Note 5 |
| | Under Slab Ductwork | All | Internally Lined | 2-inch | |
| | Downstream of Air Terminal Units | All | Internally Lined | 1-inch | Note 1 Note 5 |
| | 15 ft upstream and downstream of fans | All | Internally Lined | 1-inch unless otherwise indicated | Note 5 |
| Return Air* (Not insulated except:) | Concealed Outside Building Envelope | All | Externally insulated without vapor barrier | 2-inch | |
| | Exposed Outside Building Envelope | All | Internally Lined | 2-inch | Note 5 |
| | Under Slab Ductwork | All | Internally Lined | 2-inch | Note 5 |
| | 15 ft upstream and downstream of fans | All | Internally Lined | 1-inch unless otherwise indicated | Note 5 |
| Exhaust Air* (Not insulated except:) | 15 ft upstream and downstream of fans | All | Internally Lined | 1-inch unless otherwise indicated | Note 5 |

| System | Location | Duct Type | Insulation Type | Thickness | Notes |
|----------------------------------|--|-------------|--------------------|-----------|--------|
| | In Toilet Rooms, 10 ft downstream of exhaust grilles | All | Internally Lined | 1-inch | Note 5 |
| Outside Air (Untempered) | Exposed or Visible (Including above a cloud ceiling) | Rectangular | Internally Lined | 2-inch | |
| | | Round | Internally Lined | 2-inch | Note 5 |
| | Concealed or in mechanical rooms | All | Fiberglass Blanket | 2-inch | |
| Supply and Return Plenums | All | All | Internally Lined | 2-inch | Note 2 |
| Transfer Air | All | All | Internally Lined | 1-inch | Note 5 |

* In addition to applied locations listed in this table, provide internally lined ductwork where indicated on drawings.

Note 1: Except ductwork downstream of terminal units serving patient care areas in hospitals

Note 2: Insulation not required on factory fabricated insulated housings and plenums (AHP).

Note 3: Where round or oval ductwork is indicated, provide double walled as specified in HVAC Ducts and Casing- Medium Pressure.

Note 4: Use semi-rigid blanket for galvanized sheet metal duct and use semi-rigid board for stainless steel duct.

Note 5: Where round or oval ductwork is indicated, provide double walled round/oval ductwork as specified in HVAC Ducts and Casing- Medium Pressure, or provide internally lined rectangular ductwork with equivalent free area.

3.6 DUCTWORK INSTALLATION

A. General:

1. Install in accordance with manufacturer's instruction.
2. The vapor barrier shall be continuous. Tears, holes, staples, etc. shall be coated with vapor barrier mastic and patch with facing or tape. Joints between insulation and access with vapor barrier mastic.
3. Insulation at access panels to be removable or attached to panel with edges of panel and opening reinforced with metal beading.

B. External Blanket Insulation:

1. Insulation secured to ductwork with 20-gauge snap wires 24 inches on center and at all joints.
2. Joints and seams lapped a minimum of 3 inches and sealed with jacket tape.

- C. Internal Duct Liner:
 - 1. The coated surface shall face air stream.
 - 2. Weld pins spaced maximum of 15-inch on center in both directions and within 2 inches of all corners and joints. Weld pins flush with liner surface.
 - 3. Complete duct surface coated with adhesive and insulation pressed tightly thereto.
 - 4. Edges at terminal points shall be provided with metal beading and heavily coated with adhesive.
 - 5. All joints and corners shall be heavily coated with adhesive.
 - 6. Damaged areas replaced or heavily coated with adhesive.
- D. Plenums: Insulation on floors protected by wire mesh.
- E. Blank Off Panels: Insulation, enclosed with sheet metal on all sides. All joints with vapor barrier mastic and taped.
- F. Volume Dampers: Where volume dampers do not allow for continuous insulation, terminate insulation clear of handle sweep and finish edges to maintain vapor barrier and to prevent damage to the insulation.

3.7 DUCT, PIPE AND TERMINAL UNIT ACOUSTICAL WRAP

- A. Installed in accordance with the manufacturer's instructions.
- B. Applied locations for piping and duct systems:
 - 1. All variable and constant volume terminal units with maximum air volumes over 2000 cfm. Wrap installed such that control devices are easily accessible without circumventing the acoustical value.
 - 2. Where specified or indicated on drawings.

3.8 FIELD QUALITY CONTROL

- A. Field Test: All systems shall be tested and approved prior to installation of insulation.
- B. Existing Insulation:
 - 1. Repair existing insulation damaged during construction.
 - 2. Make neat connections where new and existing insulation meet.
 - 3. Where existing piping, ductwork or equipment is removed, cover existing surfaces neatly to match existing.
 - 4. Where existing insulation is damaged or missing, notify the architect prior to performing to work.

END OF SECTION

SECTION 15105

PIPE AND PIPE FITTINGS PLUMBING

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.
- B. The provisions of Section 15050, Common Work Results for Plumbing apply to work specified in this Section.

1.2 SUMMARY

- A. This Section includes: Furnish piping, pipe fittings, and incidental related items as required for complete piping systems.
- B. Related Sections Include:
 - 1. Section 15185 Plumbing Water Treatment.

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Piping material and installation to meet requirements of the local plumbing, fire, and building codes and serving utility requirements.
 - 2. Provide chlorination of domestic cold and hot water piping in accordance with County and State health requirements.
- B. All grooved joint couplings and fittings shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.
 - 1. All castings used for coupling housings, fittings, valve bodies, etc., shall be date stamped for quality assurance and traceability.
- C. Pipe Cleaning: Should any pipe be plugged or should foaming of water systems occur, disconnect piping, reclean, and reconnect without additional expense to the Owner.
- D. Correct any damage to the building or systems resulting from failure to properly clean the system without additional expense to the Owner.

1.4 SUBMITTALS

- A. Submit the Following:
 - 1. List of piping materials indicating the service it is being used for. (Do not submit piping product data).
 - 2. Product data on mechanical couplings and related components, double wall fuel oil pipe and fittings, and polypropylene waste and vent pipe.

- B. Test Reports and Certificates: Submit certificates of inspections and pipe tests to Owner.
- C. Other: Make certified welders' certificates available.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. As indicated.

2.2 CAST IRON SOIL PIPE, SERVICE WEIGHT (NO-HUB)

- A. General: A code approved hubless system conforming to Cast Iron Soil Pipe Institute Standard 301.
- B. Pipe and Fittings: Service weight hubless cast iron conforming to ASTM A 74, marked with the collective trademark of the Cast Iron Soil Pipe Institute (CISPI) and listed by NSF International. Tyler, AB&I, or Charlotte.
- C. Gaskets: Compression type conforming to ASTM C 564.
- D. Couplings:
 - 1. Above Grade: Band type coupling in conformance with Cast Iron Soil Pipe Institute (CISPI) 310-90, consisting of stainless steel clamp and corrugated shield assemblies with a neoprene sealing sleeve ANSI A21.6, ANSI A21.10 Fittings.
 - 2. Buried: Husky 28 gauge 304 stainless steel hubless type clamp and orange corrugated shield assemblies (80-inch pound torque) with neoprene sealing gaskets (ASTM-C-564), or Clamp-All (125-inch pound torque), 24 gauge 304 stainless steel hubless type clamp, and shield assemblies with neoprene sealing gaskets (ASTM-C-564).
- E. Service:
 - 1. Sanitary, storm, and overflow drain.
 - 2. Vent piping 2 inches and above.

2.3 CAST IRON SOIL PIPE, SERVICE WEIGHT (HUB AND SPIGOT)

- A. General: Code approved hub and spigot pipe and fitting system conforming to ASTM A74 marked with the collective trademark of the Cast Iron Soil Pipe Institute (CISPI) and listed by NSF International.
- B. Gaskets: Compression type gaskets conforming to ASTM C564.
- C. Service:
 - 1. Below Grade: Sanitary waste, storm and overflow drain.

2.4 COPPER PIPE

- A. Pipe: Hard drawn copper tubing, Class L or K, ASTM B 88.

B. Fittings: Wrought copper, 150 psi; ANSI B16.22 for soldered joints, ANSI B16.50 for brazed joints; Chase, Revere, Mueller or approved equal. At contractor's option, a system using mechanically extracted collars in main with branch line inserted to not obstruct flow may be used on domestic water piping above ground, similar to T-drill.

C. Service:

1. Domestic hot and cold water piping below ground (Type K, hard drawn) on piping 3 inches and smaller.
2. Domestic hot and cold water piping above ground (Type L, hard drawn) on piping 4 inches and smaller.
3. Trap priming lines (Type L, annealed).
4. Industrial cold water above grade (Type L) on piping 4-inch and smaller.
5. Pumped waste (DWV).
6. Reclaimed water.
7. Solar hot water.
8. Miscellaneous drains and overflows.

2.5 COPPER PIPE, CLEAN SERVICE

A. Pipe: Hard drawn copper tubing, Class L or K, ASTM B-819, prewashed, degreased, and capped at both ends for oxygen service.

B. Fittings: Wrought copper brazed joint fittings, ANSI B16.50, 150 psi; Chase, Revere, Mueller or approved equal. All clean service copper pipe shall be cleaned and suitable for oxygen service and sealed in polyethylene bags.

C. Service:

1. Oxygen, nitrous oxide, medical air, lab air, and nitrogen, carbon dioxide piping, Type K.
2. Medical and lab vacuum piping, Type L.

2.6 FLANGED JOINTS

A. Flanged Joints: Flanges shall be cast iron or steel for screwed piping and forged steel welding neck for welded line sizes. Pressure rating and drilling shall match the apparatus, valve, or fitting to which they are attached. Flanges shall be in accordance with ANSI B16.1; 150 lb. for system pressures to 150 psig; 300 lb. for system pressures 150 psig to 400 psig. Gaskets for all flanged services, except steam and pumped condensate, shall be Garlock 3700 or equal, 1/8-inch thick, non-metallic type. Gaskets for steam and pumped condensate shall be Flexitaulic Style CG or equal, 1/8-inch thick, semi-metallic type. Make joint using American Standard hexagon head bolts, lock washers, and nuts (per ASTM A307 GR.B) for service pressures to 150 psig; alloy steel stud bolts, lock washer, and American Standard hexagon head nuts (per ASTM A307 GR.B) for service pressures 150 psig to 400 psig. Use length of bolt required for full nut engagement. Provide electro-cad plated bolts and nuts on cold and chilled water lines.

2.7 UNIONS

- A. 150 psi malleable iron, brass to iron seat, ground joint, black or galvanized to match pipe. 200 psi WOG bronze, ground joint, solder type for copper tubing.
 - 1. Unions or flanges for servicing or disconnect are not required in installations using grooved mechanical joint couplings. (The couplings shall serve as disconnect points.)
- B. Dielectric fittings shall be nationally listed, have a dielectric thermoplastic interior lining, and meet requirements of ASTM F-492. Fittings shall be suitable for the pressure and temperature to be encountered.

2.8 SOLDER AND BRAZING

- A. Brazed Joints:
 - 1. Wrought Copper Piping Fittings: Westinghouse Phos-Copper or Dyna-Flow by J.W. Harris Co., Inc.
 - 2. Applied locations:
 - a. All below grade piping.
 - b. All above grade piping larger than 2-inches for the following services: Industrial cold water, domestic hot and cold water, and pumped waste.
 - c. Oxygen, nitrous oxide, carbon dioxide, medical vacuum, lab vacuum and lab air. Braze in accordance with Copper Development Association Copper Tube Handbook using BCUP series filler material.
 - d. Joints in Domestic Hot and Cold Water Piping: Use mechanically extracted collars. Braze in accordance with Copper Development Association Copper Tube Handbook using BCUP series filler material.
 - e. Solar hot water.
- B. Soldered Joints:
 - 1. Wrought Copper Pipe Fittings: All-State 430 with Duzall Flux, Engelhard Silvabrite with Engelhard General Purpose Flux or J.W. Harris Co.
 - 2. Valves, Cast Fittings or Bronze Fittings: Harris Stay-Silv-15 or Handy & Harmon Sil-Fos.
 - 3. Applied locations: Above grade piping 2-inch and smaller for the following services: Industrial cold water, domestic hot and cold water, pumped waste, trap priming lines.

2.9 UTILITY MARKERS

- A. Provide plastic tape utility markers over all buried piping. Provide identification on tape.
- B. Material to be Brady Identoline plastic tape, 6-inch, Seton, or as approved.

2.10 PIPE WRAPPING

- A. For all below ground steel piping and fittings, provide complete covering of Scotchrap No. 51, 20 mil thickness, protective tape applied over Scotchrap pipe primer applied at 1 gal/800 SF of pipe surface.

- B. At Contractor's option as approved, pipe may be furnished with factory applied jacket of "X-tru-coat" with Scotchrap as previously specified for field joints.

2.11 FLEXIBLE CONNECTOR

- A. Expansion Joint/Seismic Connector:
 - 1. T304 stainless steel hose and braid, Schedule 40 radius elbows and 180° bend, flange or weld end Schedule 40 fittings. ASA certified when used for natural gas service. Metraflex Metaloop only.
 - 2. Connector shall accept differential support displacement without damaging pipe, equipment connections, or support connections.
 - 3. In steel piping systems, three Victaulic flexible couplings may be used in lieu of a flexible connector for vibration attenuation and stress relief at equipment connections. The couplings shall be placed in close proximity to the vibration source.
- B. Service:
 - 1. Compressed air piping.
 - 2. Natural gas piping and vent lines.
 - 3. Miscellaneous drains and overflows.
 - 4. Domestic hot and cold water piping.
 - 5. Industrial cold water piping.
 - 6. Fuel oil piping.
 - 7. Fuel oil vent, fill and gauge.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Measurements, Lines and Levels:
 - 1. Check dimension at the building site and establish lines and levels for work specified in this Section.
 - 2. Establish all inverts, slopes, and manhole elevations by instrument, working from an established datum point. Provide elevation markers for use in determining slopes and elevations in accordance with Drawings and Specifications.
 - 3. Use established grid and area lines for locating trenches in relation to building and boundaries.

3.2 EXCAVATION AND BACKFILL

- A. General: Perform all necessary excavation and backfill required for the installation of mechanical work in accord with Division 2. Repair pipelines or other work damaged during excavation and backfilling.
- B. Excavation: Excavate trenches to the necessary depth and width, removing rocks, roots, and stumps. Include additional excavation to facilitate utility crossovers, additional offsets, etc. Excavation material is unclassified. Width of trench shall be adequate for proper installation of piping. The trench shall be widened, if not wide enough for a proper installation.

- C. Bedding: All cast iron, steel, and copper piping shall be full bedded on sand. Place a minimum 4-inch deep layer on the leveled trench bottom for this purpose. Remove the sand to the necessary depth for piping bells and couplings to maintain contact of the pipe on the sand for its entire length. Lay all other piping on a smooth level trench bottom so that contact is made for its entire length.
- D. Backfill: Place in layers not exceeding 8 inches deep, and compact to 95% of standard proctor maximum density at optimum moisture content. Earth backfill shall be free of rocks over 2 inches in diameter and foreign matter. Disposal of excess material as directed.
 - 1. Interior: All backfill under interior slabs shall be bank sand or pea gravel.
 - 2. Exterior: Excavated material may be used outside of buildings at the Contractor's option. The first 4 inches shall be sand, and final 12-inch layer course shall be soil in any event.

3.3 PIPING INSTALLATION

- A. Install unions in all non-flanged piping connections to apparatus and adjacent to all screwed control valves, traps, and appurtenances requiring removal for servicing so located that piping may be disconnected without disturbing the general system.
- B. Install all piping as to vent and drain. Install according to manufacturer's recommendations.
- C. Support all piping independently at apparatus so that its weight shall not be carried by the equipment.
- D. Run piping clear of tube cleaning or removal/replacement access area on heat exchangers, water heaters, etc.
- E. Utility Marking: Installed over the entire length of the underground piping utilities. Install plastic tape along both sides and the center line of the trenches at the elevation of approximately 12 inches above the top of utility.
- F. Underground Water System: Prior to testing pipe provide concrete thrust blocks at changes in direction. Block size as required for types of fittings involved.
- G. Dielectric Fittings: Provide dielectric couplings, unions, or flanges between dissimilar metals. In addition, provide dielectric couplings as required to isolate cathodically protected piping and equipment.
- H. No-Hub Couplings: Install per manufacturer's instructions.
- I. Copper Grooved Piping System: Install in strict accordance with latest manufacturer's published literature.

3.4 PIPING JOINTS

- A. Pipe and fittings shall be joined using methods and materials recommended by manufacturer in conformance with standard practice and applicable codes. Cleaning, cutting, reaming, grooving, etc. shall be done with proper tools and equipment. Hacksaw pipe cutting prohibited. Peening of welds to stop leaks not permitted.

- B. Purge oxygen, nitrous oxide, nitrogen, medical air, lab vacuum, lab air, nitrogen and carbon dioxide piping with nitrogen continuously during the piping installation, and seal each branch outlet with Visqueen and tape or similar method to assure continued cleanliness of interior of piping until system is completed.
- C. Copper Piping: Pipe cut evenly with cutter, ream to full inside diameter; end of pipe and inside of fitting thoroughly cleaned and polished. Joint shall be uniformly heated, and capillary space completely filled with solder or braze material, leaving full bead around entire circumference.
- D. No couplings installed in floor or wall sleeves.
 - a. 60°F.
- E. Flexible Connector: Provide where indicated on the Drawings.

3.5 INSTALLATION, PIPE WRAP

- A. Apply per manufacturer's written instructions.
- B. Apply wrapping to fittings in field after installation.

3.6 ADJUSTING AND CLEANING

- A. General:
 - 1. Clean interior of all piping before installation.
 - 2. Flush sediment out of all piping systems after installation before connecting plumbing fixtures to the piping.
 - 3. When placing the water systems in service during construction, each system shall be cleaned by circulating a solution with 1000 ppm (1#20 gallon) of trisodium phosphate for 24 hours, then drained, flushed and placed in service.
 - 4. Clean all strainers prior to placing in service.

3.7 MEDICAL GAS PIPE CLEANING

- A. Provide system installation in accordance with latest NFPA 99 edition, per Section 5.1.10, level 1 distribution.

END OF SECTION

SECTION 15106

PIPE AND PIPE FITTINGS HVAC

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.
- B. The provisions of Section 15051, Common Work Results for HVAC apply to work specified in this Section.

1.2 SUMMARY

- A. This Section includes: Furnish piping, pipe fittings, and incidental related items as required for complete piping systems, and treatment of HVAC water systems.

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Piping material and installation to meet requirements of the local building codes and serving utility requirements.
- B. All grooved joint couplings and fittings shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.
 - 1. All castings used for coupling housings, fittings, valve bodies, etc., shall be date stamped for quality assurance and traceability.
- C. Pipe Cleaning: Should any pipe be plugged or should foaming of water systems occur, disconnect piping, re-clean, and reconnect without additional expense to the Owner.
- D. Correct any damage to the building or systems resulting from failure to properly clean the system without additional expense to the Owner.

1.4 SUBMITTALS

- A. Submit the Following:
 - 1. List of piping materials indicating the service it is being used for. (Do not submit piping product data).
 - 2. Product data on mechanical couplings and related components, double wall fuel oil pipe and fittings, and polypropylene waste and vent pipe.
 - 3. Certificate of completion
 - 4. Treatment Reports
- B. Test Reports and Certificates: Submit certificates of inspections and pipe tests to Owner.

- C. Other: Make certified welders' certificates available.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. As indicated.

2.2 COPPER PIPE

- A. Pipe: Hard drawn copper tubing, Class L, ASTM B 88.
- B. Fittings:
 - 1. Wrought copper, 150 psi; ANSI B16.22 for soldered joints, ANSI B16.50 for brazed joints; Chase, Revere, Mueller or approved equal.
- C. Service:
 - 1. Refrigerant piping (Type L, hard drawn, ACR cleaned).
 - 2. Coil condensate drains and traps, and other miscellaneous drains.

2.3 SOLDERING AND BRAZING

- A. Brazed Joints:
 - 1. Westinghouse Phos-Copper or Dyna-Flow by J.W. Harris Co., Inc.
 - 2. Applied locations:
 - a. All below grade piping.
 - b. All above grade piping larger than 2-inches for the following services: heating water, chilled water, condenser water, heat recover water.
 - c. Refrigerant piping. Braze in accordance with Copper Development Association Copper Tube Handbook using BCUP series filler material.
- B. Soldered Joints:
 - 1. Wrought Copper Pipe Fittings: All-State 430 with Duzall Flux, Engelhard Silvabrite with Engelhard General Purpose Flux or J.W. Harris Co.
 - 2. Valves, Cast Fittings or Bronze Fittings: Harris Stay-Silv-15 or Handy & Harmon Sil-Fos.
 - 3. Applied locations: Above grade piping 2-inch and smaller for the following services: Heating water, chilled water, condenser water, heat recovery water, industrial cold water, trap priming lines.
- C. Valves, Cast Fittings or Bronze Fittings: Harris Stay-Silv-15 or Handy & Harmon Sil-Fos.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Measurements, Lines and Levels:
 - 1. Check dimension at the building site and establish lines and levels for work specified in this Section.
 - 2. Establish all inverts, slopes, and manhole elevations by instrument, working from an established datum point. Provide elevation markers for use in determining slopes and elevations in accordance with Drawings and Specifications.

3.2 PIPING INSTALLATION

- A. Install unions in all non-flanged piping connections to apparatus and adjacent to all screwed control valves, traps, and appurtenances requiring removal for servicing so located that piping may be disconnected without disturbing the general system.
- B. Support all piping independently at apparatus so that its weight shall not be carried by the equipment.
- C. Run piping clear of tube cleaning or removal/replacement access area on coils, heat exchangers, chillers, etc.
- D. Dielectric Fittings: Provide dielectric couplings, unions, or flanges between dissimilar metals. In addition, provide dielectric couplings as required to isolate cathodically protected piping and equipment.

3.3 PIPING JOINTS

- A. Pipe and fittings shall be joined using methods and materials recommended by manufacturer in conformance with standard practice and applicable codes. Cleaning, cutting, reaming, grooving, etc. shall be done with proper tools and equipment. Hacksaw pipe cutting prohibited. Peening of welds to stop leaks not permitted.
- B. Purge refrigerant piping with nitrogen continuously during the piping installation, and seal each branch outlet with Visqueen and tape or similar method to assure continued cleanliness of interior of piping until system is completed.
- C. Copper Piping: Pipe cut evenly with cutter, ream to full inside diameter; end of pipe and inside of fitting thoroughly cleaned and polished. Joint shall be uniformly heated, and capillary space completely filled with solder or braze material, leaving full bead around entire circumference.
- D. No couplings installed in floor or wall sleeves.
- E. Flexible Couplings: Provide where indicated on the Drawings.

3.4 INSTALLATION, PIPE WRAP

- A. Apply per manufacturer's written instructions.

- B. Apply wrapping to fittings in field after installation.

3.5 ADJUSTING AND CLEANING

A. General:

1. Clean interior of all piping before installation.
2. Flush sediment out of all piping systems after installation before connecting mechanical equipment to the piping.
3. When placing the water systems in service during construction, each system shall be cleaned by circulating a solution with 1000 ppm of trisodium phosphate for 24 hours, then drained, flushed and placed in service.
4. Clean all strainers prior to placing in service.

3.6 INSTALLATION, RADIANT FLOOR HEATING SYSTEM PIPING

- A. Install piping per manufacturer's recommendations.

END OF SECTION

SECTION 15110

GENERAL DUTY VALVES AND SPECIALTIES FOR PLUMBING

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.
- B. The provisions of Section 15050, Common Work Results for Plumbing, apply to work specified in this Section.

1.2 SUMMARY

- A. This Section includes: Valves, general purpose gauge cocks, and balance fittings.

1.3 SUBMITTALS

- A. Submit product data.

1.4 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene copolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- D. NRS: Nonrising stem.
- E. OS&Y: Outside screw and yoke.
- F. RS: Rising stem.
- G. PTFE: Polytetraflouroethylene plastic.
- H. SWP: Steam working pressure.
- I. Lead Free: Refers to the wetted surface of pipe, fittings, and fixtures in potable water systems that have a weighted average lead content $\leq 0.25\%$ per Safe Drinking Water Act as amended January 4th 2011. Section 1417 *Add specific state requirements as needed.

1.5 QUALITY ASSURANCE

- A. ASME Compliance:
 - 1. ASME B16.10 for ferrous valve dimensions.

2. ASME B31.9 for building services piping valves.
- B. NSF Compliance: NSF/ANSI 61 and/or NSF/ANSI 371 for valve materials for potable-water service. Valves for domestic water must be 3rd Party Certified.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURER VALVES

- A. General: Where only NIBCO INC. figure numbers are listed, equivalent products by those specified below are acceptable.
1. Gate, Globe, Swing Check: Victaulic, Crane, Kennedy, Stockham, Milwaukee, Walworth and Hammond.
 2. Silent Check: Mueller, Metraflex, Victaulic, Bell and Gossett, Milwaukee and Gruvlok.
 3. Balancing: DeZurik, Homestead, Bell and Gossett, Armstrong, Walworth, Taco, Wheatley, Tour and Andersson, Victaulic, Gruvlok, and Nibco.
 4. Butterfly: Victaulic, Gruvlok, Crane, Walworth, Milwaukee and Metraflex.
 5. Ball: Gruvlok, Apollo, Crane, Hammond, Milwaukee and Victaulic.
 6. Medical Gas Valves: Hill Rom, Oxequip, Allied (Chemtron), Puritan Bennett, Medaes.
- B. Other Manufacturers: Submit Substitution Request.
- C. All such valves shall be of one manufacturer.
- D. Valve ends may be threaded, flanged, soldered, or grooved, as applicable to piping system. Refer to Section 15105 for allowable fittings.

2.2 GATE VALVES

- A. Bronze Gate: Bronze body, bronze trim, bronze screwed bonnet; solid wedge, 150 psi steam rating, 300 psi WOG, Nibco 134.
- B. Lead Free Bronze Gate: Lead Free Silicon Bronze corrosion resistant body and trim, screwed bonnet; solid wedge, NSR., 300 psi CWP, NIBCO S/T-113-LF.
- C. Iron Gate, OS&Y: Iron body, bronze trim, OS and Y pattern, solid wedge, 150 psi rating; Nibco 637.
- D. Lead Free Iron Gate: Class 125, OS&Y, Cast or Ductile Iron body, Stainless steel or Lead Free silicon bronze corrosion resistant trim, OS and Y pattern, solid wedge, 200 psi rating; NIBCO F-617-O-LF or F-619-RW.

2.3 GLOBE VALVES

- A. Bronze Globe and Angle Globe: Bronze body, bronze mounted, renewable composition disc, 150 psi rating; Nibco 235 or 335.

- B. Bronze Globe and Angle Globe High Pressure: Bronze body, stainless steel disc, union bonnet, 300 psi steam; Nibco 276-AP or 376-AP.

2.4 CHECK VALVES

- A. Horizontal Bronze Swing Check: Bronze body, bronze mounted, regrinding bronze disc, 150 psi steam rating, 300 psi WOG; Nibco 433-Y.
- B. Lead Free Horizontal Bronze Swing Check: Lead Free Silicon Bronze corrosion resistant body, and trim, PTFE renewable seat and disc, 300 psi CWP; NIBCO S/T 413-Y-LF.
- C. Horizontal Iron Swing Check: Iron body, bronze mounted, regrinding bronze disc and seat ring, 125 psi rating; Nibco 918.
- D. Lead Free Horizontal Iron Swing Check: ASTM A 126 gray Iron body, Stainless steel or Lead Free silicon bronze corrosion resistant trim, 200 CWP psi rating; NIBCO F-918-LF.

2.5 BALL VALVES

- A. Bronze Ball: Bronze cast body, chrome-plated full port ball, with handle, Teflon seat, 600 psi WOG, 150 psi steam; Nibco 585-80.
- B. Lead Free Bronze Ball: Two piece, full port, Lead Free silicon bronze body, Stainless steel or silicon bronze trim, Reinforced PTFE or TFE seats, 600 psi CWP NIBCO T/S-585-80-LF or T/S-585-66-LF.
- C. Bronze Ball, Clean Service: Bronze body, union fittings, bronze ball, self-cleaning, Buna-N ball seats 400 psi WOG factory cleaned, capped and bagged for oxygen service in accordance with CGA4.1 (Cleaning equipment for oxygen service) & NFPA 99, Ohmeda 207 series.
- D. PVC Ball: PVC Body, trunion mounted, Teflon seat, Viton seals; True Blue GSR Asahi.
- E. Bronze Ball: Bronze cast body, stainless steel full port ball, with handle, Teflon seat, 600 psi WOG, 150 psi steam; Nibco 585-70-66.

2.6 BUTTERFLY VALVES

- A. Ductile iron body, nickel chrome plated disc and stainless steel shaft, with lever handle and locking feature on valves 6-inches and less, gear operator on valves 8-inches and over; stem neck length to accommodate insulation where applicable, EPDM liner, 200 psi water; Nibco 2000, Nibco 4765.
- B. Lead Free Butterfly Valve: Ductile iron body, Lead Free Aluminum Bronzedisc and stainless steel stem, with lever handle and locking feature on valves 6-inches and less, gear operator on valves 8-inches and over; stem neck length to accommodate insulation where applicable, EPDM liner, 200 psi water; NIBCO LD- 2000N-3/5,

- C. Copper Grooved Piping System Butterfly Valve: Nylon coated or Cast bronze body per Copper Development Agency-836, ductile iron disc encapsulated with EPDM coating, lever handle up to 6-inches, gear operator on valves 8-inches and greater, stem length to accommodate insulation, 300 psi water; Victaulic Series 608, per ASTM A-584
 - 1. Grooved ends shall be manufactured to copper-tubing sizes. Flaring tube or fitting ends to accommodate alternate sized couplings is not permitted.

2.7 BALANCING VALVE

- A. Calibrated:
 - 1. Bronze, Ametal (copper-alloy), or ductile iron body, brass globe or ball, differential pressure readout valves with integral checks, calibrated plate, integral pointer, suitable for tight shutoff, memory stops, threaded, grooved or soldered ends, 250 psi water, Victaulic, Tour Anderson, Bell and Gossett CB.
 - 2. Size balancing valves based on the published performance curve characteristics for the scheduled flow rate for each location to ensure proper operation at design conditions.

2.8 SPECIALTY VALVES

- A. Gas Cock: Forged brass body, hard chromium plated forged brass ball, with handle, rubber seats meeting ASTM D471, 175 psi WOG, entire unit tested to latest version of ANSI Z21.15, AGA and UL listed; Wooster, Parker, Watts, Jamesbury, PGL, ASCO.
- B. Gauge Cocks: Brass, tee handle, male to female, 200 psi working pressure, 1/4 inch; Apollo 41 series.
- C. Drain Valves: Bronze globe valve or full port ball valve, garden hose end, cap and chain 3/4 inch size.

2.9 WATER PRESSURE REDUCING VALVE ASSEMBLY

- A. Acceptable Manufacturers: Watts No. 223S, similar and equal Fisher, Armstrong Cash Acme.
- B. Description: Bronze body with inlet strainer, water tight cage assembly, 200 psi working pressure and suitable for 200°F.

2.10 SYSTEM SPECIALTIES

- A. Manual Air Vents: Coin type; Dole No. 9 or approved equal.
- B. Pressure/Temperature Test Plug:
 - 1. Acceptable Manufacturers:
 - a. Peterson Engineering, Inc., Universal Lancaster, Sisco, Terice.
 - b. Other Manufacturers: Submit Substitution Request.
 - 2. General: 1/2-inch N.P.T. fitting to receive either a temperature or pressure probe 1/8-inch O.D., fitted with a color coded and marked cap with gasket.
 - 3. Material: Solid brass with valve core of Nordel.
 - 4. Rating: Minimum 300 psig at 275°F.

5. Gauges and Thermometers: Supply Owner with two pressure gauge adapters with 1/8-inch O.D. probe and two five-inch stem pocket test thermometers 25°F to 125°F for chilled water, 40°F to 240°F for heating water.

2.11 STRAINERS

A. Acceptable Manufacturers:

1. Armstrong, McAlear, Sarco, Steamflo, Mueller, R.P. & C. Company Titan Flow Control.
2. For Grooved Coupling Systems: Gruvlok or Victaulic.
3. Other Manufacturers: Submit Substitution Request.

B. Wye Pattern:

1. Bronze: Bronze body, 250 psi, 1/16-inch perforated type 304 stainless screen.
2. Ductile Iron: Ductile iron body, 300 psi, 1/16 or 1/8-inch 304 stainless steel screen.
3. Cast Iron: Cast iron body, 125 psi, 1/16-inch perforated type 304 stainless screen.
4. Cast Iron, High Pressure: Cast iron body, 250 psi, 1/16-inch perforated type 304 stainless screen.

2.12 BACKWATER VALVE

A. Acceptable Manufacturers:

1. J.R. Smith, Zorn, Josam.
2. Other Manufacturers: Submit Substitution Request.

B. Description: J.R. Smith 7022Y cast iron backwater valve with threaded cover and no-hub connections. Model 7022S may be substituted for shallow bury applications where vault access is not required.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Provide valves at connections to equipment where shown or required for equipment isolation.
- B. Provide separate support for valves where necessary.
- C. Provide drain valves in all low points in the piping system, at coils and equipment, and as indicated.
- D. Coordinate gas pressure regulator selection with inlet pressure available at the regulator and the capacity and outlet pressure required by the equipment served. Install in accordance with manufacturer's recommendations. All gas cocks and gas regulator shall be located to be readily accessible for servicing. Provide approved gas cock immediately upstream of each gas pressure regulator. Provide separate vent to the outside for each regulator.

3.2 APPLIED LOCATIONS PLUMBING VALVES

A. In piping 2-inches and smaller:

| System | Valve Types | | | | |
|------------------------------|-------------|-------------|-------------|--------------------------|-------------|
| | Gate | Globe | Swing Check | Ball | Butterfly |
| Domestic Hot | Bronze | Bronze | Bronze | Bronze | Not Allowed |
| Domestic Cold | Bronze | Bronze | Bronze | Bronze | Not Allowed |
| Industrial Cold Water | Bronze | Bronze | Bronze | Bronze | Not Allowed |
| Compressed Air | Bronze | Bronze | Bronze | Bronze | Not Allowed |
| Medical Gas | Not Allowed | Not Allowed | Not Allowed | Bronze, Clean Service | Not Allowed |
| Specialty Gas | Not Allowed | Not Allowed | Not Allowed | Bronze, Clean Service | Not Allowed |
| Medical Vacuum | Not Allowed | Not Allowed | Not Allowed | Bronze, Clean Service | Not Allowed |

B. In piping 2-1/2-inches and larger:

| System | Valve Types | | | | |
|------------------------------|-------------|-------------|-------------|--------------------------|--------------|
| | Gate | Globe | Swing Check | Ball | Butterfly |
| Domestic Hot | Iron | Iron | Iron | Not Allowed | Ductile Iron |
| Domestic Cold | Iron | Iron | Iron | Not Allowed | Ductile Iron |
| Industrial Cold Water | Iron | Iron | Iron | Not Allowed | Ductile Iron |
| Compressed Air | Iron | Iron | Iron | Not Allowed | Not Allowed |
| Medical Gas | Not Allowed | Not Allowed | Not Allowed | Bronze, Clean Service | Not Allowed |
| Specialty Gas | Not Allowed | Not Allowed | Not Allowed | Bronze, Clean Service | Not Allowed |
| Medical Vacuum | Not Allowed | Not Allowed | Not Allowed | Bronze, Clean Service | Not Allowed |

C. Calibrated balancing valves on domestic hot water.

D. Silent check valves on pump discharge for domestic cold water, solar hot water, reclaimed water, cold process water, process grey water.

- E. Check valves on vertical discharge of sump pumps and sewage ejector pumps, iron swing check with outside weight and lever. Mount in piping at 45 degree angle.
- F. In Natural Gas Piping:
 1. Gas cock.
 2. Gas pressure regulator.
- G. Provide gauge cock for all pressure gauges.

3.3 VALVE IDENTIFICATION

- A. General: Identify valves to indicate their function and system served.
- B. See Section 15075, Identification for Plumbing Piping and Equipment.

3.4 MEDICAL GAS VALVES IN CEILING SPACE

- A. In accordance with NFPA 99, individual floor medical gas isolation valves located in the ceiling area will be provided in the open position with the handles removed. Provide labels at these locations which note the following:

“Caution - (Name of medical gas) valve
Do not close except in emergency
This valve controls supply to . . . “

3.5 INSTALLATION

- A. Manual Air Vents:
 1. Install at all high points where automatic air vents are not used, where noted, and where required for proper venting of system.
 2. Install in accordance with manufacturer’s recommendations.
- B. Grooved joints shall be installed in accordance with the manufacturer’s published installation instructions. Gaskets shall be molded and produced by the coupling manufacturer, and shall be suitable for the intended service. The coupling manufacturer’s factory trained representative shall provide on-site training for the contractor’s field personnel in the use of grooving tools and installation of grooved joint products. The representative shall periodically visit the project site to ensure best practices in grooved installation are being followed. (A distributor’s representative is not considered qualified to conduct the training of field visits.)
- C. Test Plugs: Install where indicated and in accordance with the manufacturer’s recommendations.
- D. Pressure Reducing Valves:
 1. Install where indicated and in accordance with manufacturer’s recommendations with 3 valve bypass.

- E. Water Relief Valves:
 - 1. Install where indicated, and in accordance with manufacturer's instructions. Pipe discharge to nearest floor drain using Schedule 40 steel pipe.

- F. Strainer:
 - 1. Applied Locations Plumbing:
 - a. Bronze wye, in piping 2-inch and smaller; domestic water, solar hot water, reclaimed water, cold process water, process grey water.
 - b. Cast iron, in piping 2-1/2-inch and larger; solar hot water, reclaimed water, cold process water, process grey water
 - c. Cast iron, high pressure wye, in piping 2-1/2-inch and larger; domestic water.

- G. Backwater Valves:
 - 1. Install backwater within vault indicated. If vault not indicated (shallow bury application), provide soil pipe extension to install ferrule and cover at top and flush with floor surface.

END OF SECTION

SECTION 15111

GENERAL DUTY VALVES AND SPECIALTIES FOR HVAC

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.
- B. The provisions of Section 15051, Common Work Results for HVAC, apply to work specified in this Section.

1.2 SUMMARY

- A. This Section includes: Valves, general purpose gauge cocks, and balance fittings.

1.3 SUBMITTALS

- A. Submit product data.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURER VALVES

- A. General: Where only Nibco figure numbers are listed, equivalent products by those specified below are acceptable.
 - 1. Gate, Globe, Swing Check: Victaulic, Crane, Kennedy, Stockham, Milwaukee, Walworth and Hammond.
 - 2. Butterfly: Victaulic, Gruvlok, Crane, Walworth, Milwaukee and Metraflex.
 - 3. Ball: Gruvlok, Apollo, Crane, Hammond, Milwaukee and Victaulic.
- B. Other Manufacturers: Submit Substitution Request.
- C. All such valves shall be of one manufacturer.
- D. Valve ends may be threaded, flanged, soldered, or grooved, as applicable to piping system. Refer to Section 15106 for allowable fittings.

2.2 CHECK VALVES

- A. Horizontal Bronze Swing Check: Bronze body, bronze mounted, regrinding bronze disc, 150 psi steam rating, 300 psi WOG; Nibco 433-Y.
- B. Horizontal Iron Swing Check: Iron body, bronze mounted, regrinding bronze disc and seat ring, 125 psi rating; Nibco 918.

- C. Iron Swing Check with Lever and Spring: Iron body, bronze fitted, with adjustable lever and spring; Nibco F-918-BL&S.

2.3 BALL VALVES

- A. Bronze Ball: Bronze cast body or forged brass, chrome-plated full port ball, with handle, Teflon seat, 300 psi WOG, 150 psi steam; Nibco 585-70 or Victaulic Series 589.

2.4 SPECIALTY VALVES

- A. Gauge Cocks: Brass, tee handle, male to female, 200 psi working pressure, 1/4 inch; Conbraco 41 series.
- B. Drain Valves: Bronze globe valve or full port ball valve, garden hose end, cap and chain 3/4 inch size.

2.5 SYSTEM SPECIALTIES

- A. Manual Air Vents: Coin type; Dole No. 9 or approved equal.
- B. Automatic Air Vents:
 - 1. Acceptable Manufacturers:
 - a. Hoffman No. 78, Amtrol, Armstrong, Spirax/Sarco, Spirotop.
 - b. Other Manufacturers: Submit Substitution Request.
 - 2. Description: Water main type, cast brass body, built-in check valve, 1/8-inch I.P.S. top tapping for moisture discharge, 3/4-inch size, 150 psi operating pressure.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Provide valves at connections to equipment where shown or required for equipment isolation.
- B. Install all valves and strainers in accessible locations and same size as connected piping (not the size of the equipment connection), except balancing valves shall be sized by the contractor to properly balance the flow.
- C. Provide separate support for valves where necessary.
- D. Provide drain valves in all low points in the piping system, at coils and equipment, and as indicated.

3.2 VALVE IDENTIFICATION

- A. General: Identify valves to indicate their function and system served.

B. See Section 15076, Identification for HVAC Piping and Equipment.

END OF SECTION

SECTION 15185

PLUMBING WATER TREATMENT

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.
- B. The provisions of Section 15050, Common Work Results for Plumbing apply to work specified in this Section.

1.2 SUMMARY

- A. This Section includes: Treatment of domestic water systems and solar hot water systems.

1.3 SUBMITTALS

- A. Submit the following:
 - 1. Shop drawings.
 - 2. Product data.
 - 3. Operating and maintenance data.
 - 4. Certificate of completion.
 - 5. Treatment Reports.

PART 2 - PRODUCTS

2.1 ACCEPTABLE CHEMICAL TREATMENT MANUFACTURER/SUPPLIER

- A. Mount Hood Chemical, Nalco, Mogul, Chemax, Chemcoa, DuBois Chemicals.
- B. Other Manufacturer/Suppliers: Submit Substitution Request.

2.2 PLUMBING WATER TREATMENT

- A. Domestic Water Chlorination:
 - 1. Chlorination shall be accomplished by personnel in employed of firm licensed to do this type of work.
 - 2. As a minimum, potable water systems shall be disinfected prior to use as outlined within the current state or local Plumbing Code or as prescribed by the Health Authority, whichever requirements are more stringent.
 - 3. Chemicals: Sodium Hypochlorite 12.5% EPA registered for drinking water application.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Plumbing Domestic Water Systems:

1. Provide 1/2-inch injection point on incoming water line immediately after the backflow device.
2. Flush system with fresh water to remove all dirt and construction debris.
3. Open all fixtures to develop slow rate of flow through system.
4. Inject Sodium Hypochlorite solution at a rate to achieve greater at 100ppm chlorine at all fixtures.
5. Flush entire system so no chlorine is present.
6. Bacteriological samples shall be submitted to a certified laboratory who shall certify that the water is suitable for drinking. The certificate stating purity of water shall be delivered to the Architect.

3.2 FINAL ADJUSTMENT

- A. When the systems are accepted by the Owner the chemical treatment supplier shall make final adjustments in the required concentrations.
- B. Submit report of indicating initials and final concentrations and system chemistry.

END OF SECTION

SECTION 15400
PLUMBING EQUIPMENT

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.
- B. The provisions of Section 15050, Common Work Results for Plumbing, apply to work specified in this Section.

1.2 SUMMARY

- A. This Section includes: Water heaters, domestic water expansion tanks, backflow preventers, utility vaults, oil/water separators, catch basin, heat trace, acid neutralization systems, pH monitoring system, fuel oil fill stations.
- B. Related Sections include:
 - 1. Section 15410 Plumbing Fixtures.

1.3 QUALITY ASSURANCE

- A. Regulatory Requirements: Water heaters to meet state energy code requirements.

1.4 SUBMITTALS

- A. Submit the following:
 - 1. Product data for each item specified.
 - 2. Operating and maintenance data.

PART 2 - PRODUCTS

2.1 HEAT TRACE CABLE (FREEZE PROTECTION)

- A. Acceptable Manufacturers:
 - 1. Chromalox, Raychem.
 - 2. Other Manufacturers: Submit Substitution Request.
- B. Cable: Self-regulating flat, flexible, low-heat density, parallel electric heater strip consisting of (2) stranded circuit conductors enclosed in a semi-conductive, polymer core insulated with a plastic jacket protected with a tinned-copper braid. Cable shall have capability of being overlapped without creating hot spots and shall be suitable for application on plastic, copper or steel pipe. Raychem XL-Trace, Chromalox SRF or approved equal.

- C. Voltage: Cable shall operate on single phase line voltage of 208 VAC without transformation. Provide power connections, end seals, splices tap-offs and tees as furnished by the manufacturer for this system.
- D. Controls: System control for freeze protection shall include a thermostat with fixed setpoint of 40°F. Thermostat shall have nickel-plated copper bulb at end of 36-inch capillary and shall be enclosed in a NEMA 4 enclosure. Raychem AMC-F5, Chromalox PIT or approved.

PART 3 - EXECUTION

3.1 HEAT TRACE CABLE (FREEZE PROTECTION)

- A. Location: Provide heat trace on all piping in unheated spaces as shown or required to prevent freezing.
- B. Install heat trace cable on pipes indicated to maintain a minimum of 35°F in an ambient temperature of 0°F. Lay cable parallel on pipe or spiral wrap to maintain adequate temperature as required by pipe size and thermal properties of the pipe insulation to be applied.
- C. Attach heat trace cable to pipe with polyester tape at increments not exceeding 1'-0".
- D. Install thermostat capillary and bulb to pipe with polyester tape assuring a firm bulb contact with pipe. Bulb shall not be in contact with heat cable.
- E. Install thermostat at accessible location adjacent to pipe with a minimum of exposed capillary. Tape capillary to pipe run under insulation to bulb.
- F. The installer shall be responsible for affixing an "Electric Traced" label to the outside of the pipe's thermal insulation on alternating sides at intervals of five to fifteen feet immediately after the piping has been insulated.
- G. Coordinate installation with work under Division 15 for adequate electrical service to each thermostat.

END OF SECTION

SECTION 15410
PLUMBING FIXTURES

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.
- B. The provisions of Section 15050, Common Work Results for Plumbing apply to work specified in this Section.

1.2 SUMMARY

- A. This Section includes:
 - 1. Plumbing fixtures.
 - 2. Fixture trim.
 - 3. Drainage products.
 - 4. Miscellaneous plumbing items.

1.3 SUBMITTALS

- A. Submit the following:
 - 1. Product data for each item specified.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturers stated for each fixture specified and the following manufacturers are approved for bidding except when indicated "only". Final approval for the installation based upon approval of submittal data.
- B. Drainage Products and Carrier Products: J.R. Smith, Josam, Zurn, Wade, Sioux Chief, Watts Drainage.
- C. Fixtures: American Standard, Kohler, Eljer.
- D. Seats: Olsonite, Church, Beneke, Bemis.
- E. Electric Water Coolers: Elkay, Halsey Taylor, Oasis, Sunroc, Haws.
- F. Mixing Valves: Powers, Leonard, Symmons, Chicago.
- G. Emergency Fixtures: Haws, Bradley, Speakman, Encon.

- H. Emergency Fixture Mixing Valves: Leonard, Bradley, Lawler.
- I. Stainless Steel Products: Elkay, Just.
- J. Mop Sinks: Fiat, Williams, Mustee.
- K. Faucets: Chicago, Delta Commercial, Grohe, Moen Commercial, T&S Brass.
- L. Metering Faucets: Chicago, Symmons.
- M. Disposals and Hot Water Dispenser: In-Sink-Erator.
- N. Flush Valves: Sloan, Zurn.
- O. Sensor Operated Flush Valves: Sloan Optima, Zurn.
- P. Sensor Operated Faucets: Sloan Optima, Moen Commercial, T&S Brass.
- Q. Shock Arrestors: PPP, J.R. Smith.
- R. Trap Primer Stations: PPP.
- S. Exposed Waste and Supply Piping Insulation Kits: Truebro, McGuire.
- T. Other Manufacturers: Submit Substitution Request.

2.2 FIXTURE TRIM

- A. Supply Stops: Chicago No. 1006 cast brass flexible riser supplies with loose key angle stops, wall flanges, NPT female inlet, all chrome plate finish; equivalent NPT McGuire (H21 LK series) or NPT stops by fixture supplier.
- B. Traps:
 1. For floor drains, provide coated cast iron P-trap; recessed, screw jointed or bell and spigot.
 2. For other fixtures, provide 17 gauge, chrome plated cast brass P-Traps with solder bushings, and clean-out.
- C. Support Rims: Hudee s/s rims, if sink not furnished with integral rim.
- D. Vacuum Breakers: Chicago Faucet, A.W. Cash or Febco chrome plated.

2.3 PLUMBING FIXTURES

- A. WC-1 Water Closet (ADA):
 1. American Standard Afwall 2257.103, vitreous china, wall hung, elongated, siphon jet action, 1-1/2-inch top spud.
 2. Sloan 111 diaphragm type flush valve (1.6 gpf).
 3. Olsonite #95 white open-front seat.

4. J.R. Smith Series 200 chair carrier.
- B. L-1 Lavatory (ADA):
1. American Standard Lucerne 0355.012 20x18-inch, vitreous china, 4-inch centers, wall hung, concealed arm support, 2411.015 grid drain.
 2. Chicago No. 802A-E28 faucet with dual lever handles, 1/2 GPM laminar outlet, vandal proof.
 3. J.R. Smith Series 700-Z concealed arm, floor mounted carrier or Smith series 800 wall plate.
- C. S-1 Sink:
1. Elkay ELU129, 12x9x7-inch single compartment 18 gauge, type 304, undermount stainless steel sink with bottom grid and drain.
 2. Chicago No. 2300-8-CP-E32 single lever mixing valve faucet, 8-inch trim plate, 2 GPM laminar flow outlet, vandal proof.
 3. Insinkerator instant hot water dispenser Indulge Modern F-HC3300 with HWT-F1000S tank and filter.
- D. S-2 Sink:
1. Elkay LR-3321, 33x21x7-1/2-inch double compartment 18 gauge, type 302, 3-hole, self rimming stainless steel sink, each compartment 14x14x7-1/2-inch deep (2) LK-18 grid strainers.
 2. Chicago No. 2301-8-CP-E32 single lever mixing valve faucet, 8-inch trim plate, 2 GPM laminar flow outlet, vandal proof.
 3. Insinkerator instant hot water dispenser Indulge Modern F-HC3300 with HWT-F1000S tank and filter.
- E. DF-1 Drinking Fountain: Brita Hydration Station 2000S with filter.
- 2.4 DRAINAGE PRODUCTS
- A. HB-1 Hose Bibb: Chicago 952, chrome-plated, loose key, 3/4-inch hose thread, integral vacuum breaker.
- B. WH-1 Wall Hydrant: J.R. Smith Fig. 5609QT, bronze finish, loose key, 3/4-inch hose thread, integral vacuum breaker, freeze proof.
- C. FD-1 Floor Drain: J.R. Smith Fig. 2005-U-A, round nickel bronze vandalproof grate, cast iron body with flashing collar and adjustable strainer head.
- D. WCO Wall Cleanout: J.R. Smith Fig. 4530-U, round stainless steel vandalproof cover and screw.
- E. FCO Floor Cleanout: J.R. Smith Fig. 4020-U, round vandalproof, nickel bronze top.

- F. Trap Priming Valves: Precision Plumbing Products Prime-time electronic trap priming manifold including but not limited to: atmospheric vacuum breaker, pre-set 24 hour clock, manual over ride, 120V solenoid valve, calibrated manifold for equal water distribution, 3/4-inch water hammer arrestor. Components pre-installed in recessed steel cabinet with SS access door.
- G. Water Hammer Arrestor: Precision Plumbing Products Model SC (Maintenance-Free).

PART 3 - EXECUTION

3.1 FIXTURE TRIM

- A. Provide plumbing fixture trim where applicable on fixtures, including but not limited to supply stops, traps, support rims, flush valve, and vacuum breakers.
- B. Provide rough-in and final piping connection to fixtures. Carefully review all construction documents to assure that all fixtures are provided with necessary services for a complete operating system.
- C. Rigidly secure rough-in piping, carriers and supports, and other service piping to structure.

3.2 PLUMBING FIXTURES

- A. Americans with Disabilities Act:
 - 1. Those fixtures indicated by “ADA” shall comply with and be installed in accordance with Americans with Disabilities Act Guidelines (A.D.A.A.G.). Where applicable building code requirements are more stringent than ADAAG guidelines, building code requirements shall be followed.
 - 2. Water Closets: Mount flush valve for ADA water closets on wide side of enclosure.
 - 3. Lavatories: Provide insulation kits on exposed hot water and waste piping beneath ADA lavatories.
 - 4. Sinks: Provide insulation kits on exposed hot water and waste piping beneath ADA sinks.
- B. Mounting Heights: All fixtures standard rough-in catalogued heights unless shown otherwise on the Architectural Drawings.
- C. Water Supplies: When both hot and cold water to a fixture is required, connect the hot on the left and the cold on the right.
- D. Floor Mounted Supports and Chair Carriers: Secure floor mounted supports and chair carriers to slab with a minimum of 1/2-inch bolts. Install supports and carriers per manufacturer’s installation instructions.
- E. Lavatories and Urinals with Electronic Sensors:
 - 1. Install lavatory and urinal sensors, wiring and piping as recommended by manufacturer.
 - 2. Mount lavatory wiring box on bottom of countertop for total concealment. Coordinate with Division 26 for plug-in transformer and receptacle locations.

3. Provide vandalproof screws on wiring boxes for lavatories and sensor boxes for urinals.
 4. Reference electrical drawings for 120 volt power to urinal electrical boxes. Provide (1) 24 volt transformer for each bank of (10) urinal flushometers.
- F. Floor Drain and Floor Sinks:
1. Set top flush with finished floor.
 2. Provide flashing clamp for all drain bodies installed in floors provided with waterproof membranes.
- G. Cleanout:
1. Where shown or required.
 2. Cover set flush with finished surface.
- H. Roof and Area Drains: Provide sump receivers for all drains except poured in place installations. Provide extension section as required to compensate for the specified insulation thickness above the roof slab or deck.
- I. Water Hammer Arresters: Provide where shown and where recommended by Plumbing Drainage Institute (PDI).
- J. Water Coolers:
1. All water-bearing materials shall comply with the Safe Drinking Water Act of 1986 and the Lead Contamination Control Act of 1988. The waterway system of the unit shall be manufactured of copper components and other completely lead-free materials.
 2. All water cooler refrigerants will be non-CFC.
- K. Mixing Valves: Provide piping connections per manufacturer's installation instructions. Provide spring check valves on hot and cold water inlets when not provided integral to valve.

3.3 PRIMING VALVES

- A. All floor drains, floor sinks and similar traps shall be primed. Use minimum 3/8-inch type K annealed copper tubing. Primer line to be continuous and without joints.
- B. Where priming valves are installed in finished rooms, conceal in wall and provide access panel.
- C. Coordinate locations of electronic trap primer stations with electrical contractor for 120V service.

END OF SECTION

SECTION 15739

DECENTRALIZED UNITARY HVAC EQUIPMENT

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.
- B. The provisions of Section 15051, Common Work Results for HVAC apply to work specified in this Section.

1.2 SUMMARY

- A. This Section includes:
 - 1. Ceiling mounted packaged air conditioning units and heat pumps.
 - 2. Floor mounted packaged air conditioning units and heat pumps.
 - 3. Condensing unit.
 - 4. Fan coil unit.
 - 5. Wall mounted split system air conditioning units.
- B. Related Sections include:
 - 1. Section 16265 Variable Frequency Drives for HVAC Equipment.
 - 2. Section 15072 Vibration and Seismic Controls for HVAC Piping and Equipment.

1.3 SUBMITTALS

- A. Submit the following:
 - 1. Shop drawings showing details of construction, dimensions, arrangement of components, isolation, filters, etc.
 - 2. Product data showing performance data, standard items and accessories, operating weight.
 - 3. Operating and maintenance data.

PART 2 - PRODUCTS

2.1 AIR COOLED CONDENSING UNIT

- A. Acceptable Manufacturers:
 - 1. Carrier, Trane, McQuay, York.
 - 2. Other Manufacturers: Submit Substitution Request.

- B. Description: Provide air cooled condensing units designed for outdoor installation with factory supplied supports, properly assembled and tested at the factory. Unit shall be completely weatherproofed and include compressor, condenser coils, condensing fans, motor, refrigerant reservoir, charging valve, all controls, and a holding charge of R410A. Provide guards on condenser fans and coil guard.
- C. Compressors: Furnish hermetically sealed type with isolation and sound muffling. Units shall have overload and inherent winding thermostat protection to prevent burn out. Provided crankcase heater. Multiple compressors shall be manifolded for single joint connection on liquid and suction lines.
- D. Refrigeration Circuits: Unit shall include back seating service valve and gauge ports in liquid and suction lines. Provided refrigerant filter-dryer.
- E. Condenser Coil: Non-ferrous construction consisting of aluminum plate fins mechanically bonded to seamless copper tubes and circuited for sub-cooling.
- F. Condenser Fans and Motors: Direct driven propeller type fans with permanently lubricated motors.
- G. Sizing: Select units for actual refrigerating capacities at coil including line losses. See schedule on drawings.
- H. Controls: Complete, factory-installed control system with all operating and safety controls. Provide high and low pressure cutouts, contractors and internal overload protection on all motors. Provide low ambient operation to [50°F] [0°F] outside to maintain condensing temperature on part load operation. Provide short cycle timer. Include all remote sensors and devices for field installation.
- I. Controls Interface: The packaged equipment controls shall be equipped with a network port and shall have a network type data transfer interface with the DDC controller. The following interface shall be required:
 1. Coordinate with owner for preferred protocol compatible with the system specified in Section Instrumentation and Controls for HVAC.
 2. All alarms shall be read to the DDC controller.
 3. The following status signals shall be read to the DDC controller as a minimum: Compressors, condensers.
- J. Supports: Provide structural steel support, submit for review before fabrication.

2.2 FAN COIL UNIT

- A. Acceptable Manufacturers:
 1. Carrier, Trane, McQuay, York.
 2. Other Manufacturers: Submit Substitution Request.
- B. Description: Furnish complete unit including cabinet, fan and motor assembly, electric heating, cooling coil and filter. Unit U.L. approved for application and wired per NEC.

- C. Cabinet: 18 gauge steel, removable panels for access to components.
- D. Fan and Motor: Centrifugal type, belt driven, permanently lubricated motor.
- E. Filters: Throwaway type, 1-inch thick fiberglass.
- F. Refrigerant Coil: Non-ferrous construction with aluminum fins mechanically bonded to seamless copper tubing with all joints brazed.
- G. Electric Heating: Factory installed with capacity and stages as indicated on the drawings, heavy duty nickel chromium elements, internal delta connected on three phase units, automatically resetting high limit controls on each heating unit contactor, individual fusing, conforming to all NEC requirements.
- H. Drain Pan: Galvanized steel drain pan with copper drain connection. Pan to extend under coil for proper drainage of condensate.
- I. Configuration: Horizontal unit, ducted inlet and outlet connection.
- J. Controls: Complete, factory-installed control system with all operating and safety controls. Include all remote sensors and devices for field installation.
 - 1. Provide programmable 7-day thermostat with automatic change over, fan on-auto switch, system off-auto switch, and individual set point for heating and cooling. Provide with minimum of four independent programmable temperature periods per day.
- K. Electrical: Furnish magnetic contactors. Arrange for single point electrical connection. Provide all field wiring.

PART 3 - EXECUTION

3.1 AIR COOLED CONDENSING UNIT

- A. Install units per manufacturer's installation instructions.
- B. Mount condensing unit on concrete pad and provide vibration isolation as indicated on Drawings.
- C. Install expansion valve for each coil and sight glass for each system in accordance with recommended industry practices. Provide gauge tap on suction line at each coil connection.
- D. Make refrigerant piping connection, install refrigeration accessories and charge system. Provide additional refrigerant as required for proper operation at design capacities.

3.2 FAN COIL UNIT

- A. Installation:
 - 1. Install in location shown on the Drawings. Level unit and secure to structure.

2. Make piping connection and unit installation per manufacturer's recommendations and installation guides.
3. Pipe condensate pan to floor drain per manufacturer's installation guide. Provide minimum 2-inch trap seal on all condensate drain connections.

B. Start-Up:

1. General: Comply with manufacturer's instructions.
2. Install filters before operating unit.
3. Ensure proper refrigerant and air flow before operating unit compressor.

END OF SECTION

SECTION 15810

HVAC DUCTS AND CASING-LOW PRESSURE

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.
- B. The provisions of Section 15051, Common Work Results for HVAC apply to work specified in this Section.

1.2 SUMMARY

- A. This Section includes: Low pressure ductwork and fittings.
- B. Related Sections include:
 - 1. Section 15072 Vibration and Seismic Controls for HVAC Piping Equipment.
 - 2. Section 15081 Insulation for HVAC.
 - 3. Section 15820 Air Duct Accessories.

1.3 QUALITY ASSURANCE

- A. Installer Qualifications: Work performed by qualified, experienced mechanics, in accordance with the manual of Duct and Sheet Metal Construction of the Sheet Metal and Air Conditioning Contractors National Association and these Specifications.
- B. Regulatory Requirements:
 - 1. Entire ductwork system, including materials and installation, installed in accordance with NFPA 90A.
 - 2. Ductwork and components shall be listed as U.L. 181, Class I air duct, flame rating not to exceed 25 and smoke rating not to exceed 50.

1.4 SUBMITTALS

- A. Submit the following:
 - 1. Provide catalog data on each product specified hereunder.
 - 2. Schedule of duct construction standards.
 - 3. Provide shop drawings showing materials and construction details for single wall housing plenum.
 - 4. Provide shop drawings showing construction details, support and seismic restraint of ductwork distribution systems.

PART 2 - PRODUCTS

2.1 SUPPORTS, ANCHORAGE AND RESTRAINTS

A. General:

1. When supports, anchorages, and seismic restraints for equipment, and supports and seismic restraints for ductwork are not shown on the Drawings, the contractor shall be responsible for their design.
2. Seismic restraints and anchorages shall resist seismic forces as specified in the latest edition of the International Building Code for the seismic zone in which the project is constructed.
3. Seismic restraints shall follow the provisions described in Section 15072, Vibration and Seismic Control for HVAC Piping and Equipment.
4. Seismic restraints shall not introduce stresses in the ductwork caused by thermal expansion or contraction.
5. Connections to structural framing shall not introduce twisting, torsion, or lateral bending in the framing members. Provide supplementary steel as required.

B. Suspended Ductwork: Seismic restraints shall be in accordance with the latest edition of the SMACNA "Seismic Restraint Manual - Guidelines for Mechanical Systems" for the seismic hazard level corresponding to the seismic zone in which the project is constructed.

C. Engineered Support Systems: The following support systems shall be designed, detailed, and bear the seal of a professional engineer registered in the State having jurisdiction:

1. Supports and seismic restraints for suspended ductwork and equipment.
2. Support frames for ductwork and equipment which provide support from below.
3. Equipment and ductwork support frame anchorage to supporting slab or structure.

2.2 SHEETMETAL DUCTWORK

A. Fabricate from galvanized steel, unless noted otherwise.

B. Minimum gauge, duct construction, joint reinforcing, fittings, hangers and supports shall be in accordance with SMACNA "HVAC Duct Construction Standards", Third Edition, 2005.

C. Duct Classification: Ducts shall be considered low pressure when design velocities are 2000 fpm or less and maximum static pressure is 2 inches W.G. positive or negative.

1. The following ductwork constructed in accordance with minimum reinforcement requirements for static pressure class of 1/2-inch W.G. positive or negative.
 - a. Supply ductwork downstream from terminal units.
 - b. Supply, return or exhaust ductwork serving fans scheduled to operate at less than 1/2-inch W.G.
 - c. Supply, return, or exhaust branch ductwork which serves one or two inlets/outlets.
2. The following ductwork constructed in accordance with minimum reinforcement requirements for static pressure class of 1-inch W.G. positive or negative.
 - a. Supply, return, or exhaust ductwork serving fans scheduled to operate at less than 1 inch W.G. On supply fans pressure drops for louvers, coils, clean filters, and sound traps may be deleted from scheduled fan static.

- b. Supply, return, or exhaust ductwork serving multiple duct branches where contractor can demonstrate that pressures will not exceed 1 inch W.G. positive or negative.
 - 3. The following ductwork constructed in accordance with minimum reinforcement requirements for static pressure class of 2 inches W.G., positive or negative.
 - a. Supply, return, or exhaust ductwork serving fans scheduled to operate at pressures greater than 1 inch W.G. positive or negative.
- D. Longitudinal seams on rectangular duct shall be Pittsburgh or Button punch snap lock. Snap lock seams for round duct may be used only on ducts classified for 1/2 inch W.G. Longitudinal seams for round ducts using lap and rivet, spot weld, or fillet weld may be used only on ducts classified for statics 1 inch W.G. or less.
- E. Joining and reinforcing systems manufactured by Ductmate, Roloc, or TDC are acceptable. Ductmate 35 is equivalent to SMACNA "J", and Ductmate 25 is equivalent to SMACNA "F".
- F. Use of adjustable round elbows not permitted.

2.3 SINGLE WALL HOUSING PLENUMS

- A. Fabricate from galvanized steel, unless otherwise noted.
- B. Minimum gauge not less than 18 gauge except panels 10'-1" or longer 16 gauge.
- C. Housing panels constructed in accordance with the latest edition of SMACNA "HVAC Duct Construction Standards".
- D. Minimum pressure classification for single wall housing panels is 2 inches W.G. positive or negative.
- E. Maximum allowable panel width 24 inches with standing interlocking seams.
- F. Openings in panels for air inlets/outlets, or access doors reinforced per SMACNA standards.
- G. Provide intermediate reinforcing and/or bracing when spans are 8 feet or longer.
- H. Line all interior surfaces of single wall plenums with minimum of 2-inch thick acoustical lining.
- I. Access Doors: Construct of 20-gauge galvanized steel, double wall construction. Install in opening in plenum panel reinforced with 10-gauge channel. Doors mounted on three hinges and shall seat against neoprene gaskets. Doors in plenums at humidifiers shall have 12-inch x 12-inch double glass inserts from observation. Doors 24-inch x 60-inch height unless otherwise indicated.

2.4 FLEXIBLE DUCTS

- A. Acceptable Manufacturers:
 - 1. Thermaflex M-KE, Gen Flex IMP-25S.
 - 2. Other Manufacturers: Submit Substitution Request.

- B. Description: Flexible air duct with CPE or metal film liner permanently bonded to coated spring steel wire helix with 1-inch thick fiberglass insulation blanket covered with fiberglass reinforced metal film vapor barrier jacket. Duct rated for 6-inch W.G. positive and 1-inch W.G. negative.

2.5 ACOUSTICAL LINED PLENUMS

- A. Panels: Double wall insulated panel consisting of 20-gauge galvanized steel perforated interior panel, 4-inch thick fiberglass insulation, and 18-gauge outer panel. Panels located downstream of final filters shall have solid inside panel or sheet mylar liner between inside perforated panel and insulation.
- B. Panels of tongue and groove construction with adjacent panels held rigidly in position by self-interlocking joint effective inside or out. As alternate panels may be joined with H-channels.
- C. Housing construction shall be capable of withstanding pressures up to 4-inches WG positive on supply ductwork and 4-inches WG negative on return and exhaust ductwork. Deflection at design pressure shall not exceed 1/200 of span.
- D. For spans 12-feet or greater, provide additional structural reinforcement.

2.6 EXPOSED OR VISIBLE DUCTWORK IN FINISHED SPACES

- A. Round:
 - 1. Material: Round or flat oval, machine formed, spiral lock-seam galvanized sheet metal ductwork of thicknesses as listed for sheet metal duct. Paintable surface.
 - 2. Fittings: Machine formed, shop fabricated, with welded seams, designed for easiest air flow, similar to United Sheetmetal numbers listed.
 - a. Mitered Elbow with Turning Vanes: Type EV-90-2.
 - b. Radius Elbows: Type E090-5. Similar for less than 90 degree elbows.
 - c. Tees: Type Con-T-1.
 - d. Reducing Fittings: May be used unless noted otherwise.
- B. Rectangular: Same as for sheet metal ductwork but paintable surface. All reinforcing shall be inside. Use special care to prevent imperfections in the metal surface.

PART 3 - EXECUTION

3.1 APPLIED LOCATIONS

- A. Supply ductwork on downstream side of terminal box. Galvanized sheet metal ductwork, lined where indicated on the Drawings or as specified in Section 15081.
- B. Supply Ductwork from Spin-In Fittings to Supply Outlet Collar Connection: Flexible duct, maximum 4'-0" length.
- C. Return Air Trunk Ductwork from End Run to Unit Connection: Galvanized sheet metal ductwork, lined where indicated on the Drawings or as specified in Section 15081.

- D. Exhaust Ductwork: Galvanized sheet metal ductwork, lined where indicated on the Drawings or as specified in Section 15081.
- E. Ductwork between Transfer Grilles: Galvanized sheet metal ductwork, lined where indicated on the Drawings or as specified in Section 15081.
- F. Exposed or Visible Ductwork in Finished Spaces: Sheet metal as specified for application, lined where indicated on the Drawings or as specified in Section 15081.

3.2 INSTALLATION

- A. Ductwork:
 1. Seal traverse joints with an approved mastic during joining procedure or tape after joining to provide airtight duct system.
 2. Low pressure ductwork hanger and support systems in accordance with SMACNA "HVAC Duct Construction Standards". Wire supports are not allowed.
 3. Provide supplementary steel for support of ductwork in shafts and between building structural members.
 4. Fabricate changes in direction to permit easy air flow, using full 1.5D radius bends or fixed turning vanes in square elbows. Radius elbows less than 1.5D radius shall have splitter vanes.
 5. Change in duct size or shape necessitated by interference made using rectangular equivalents of equal velocity.
 6. Where pipe, structural member, or other obstruction passes through a duct, provide streamlined sheet metal collar around member and increase duct size to maintain net free area. Fit collar and caulk to make air tight.
- B. Sound Attenuation (Internal Insulation):
 1. Provide sound attenuation duct where shown and as specified under Section 15081.
 2. Duct dimensions shown are net inside attenuating material.
- C. Dampers: Install where shown and where necessary to complete final balancing of system. Install regulators as specified in Section 15820 for each specific project condition. Leave all dampers locked wide open in preparation for balancing.
- D. Flexible Connectors: Make connections to fans and other rotating equipment with flexible connectors with 2-inch minimum clearance between casing and ductwork. Not required on internally spring isolated units.
- E. Spin-in Fittings:
 1. Install at branch takeoffs to outlets using round or flex duct.
 2. Connect to flexible duct with draw band strap and minimum of two wraps of duct tape.
 3. Leave all dampers locked wide open.
- F. Flexible Ducts:
 1. Make connections at ends using draw band strap and a minimum of 2 wraps of duct tape.
 2. Suspend center spans from structure above using wire as required by code. Connect to manufacturer's eyelet on jacket or use 1-inch wide galvanized steel strap with single loop at top and smooth edges.

3. Suspending duct by laying it on the ceiling is prohibited.
4. Avoid crimping flex duct. All changes in direction shall be made using 2D radius. Duct connections to grilles, registers and diffusers using less than 2D radius bends are not acceptable. Where space is constricted, use sheet metal elbows or Thermaflex Flex Boots (or equal).

G. Ductwork, Exposed or Visible in Finished Areas:

1. Use extreme care in handling and installing.
2. Replace all dented or damaged sections.
3. Install ductwork straight and true, parallel to building lines.
4. Make all connections with pop rivets using couplings where applicable. Grind all raw edges smooth and apply paintable sealant to cover imperfections.
5. Remove all excess sealant to provide a finished joint.
6. Provide floor, wall, and ceiling plates as specified in Section 15051.
7. Finish, clean and prime all ductwork and hangers for painting.

H. Single Wall Housing Plenums:

1. Install housing plenums in accordance with SMACNA HVAC Duct Construction Standards, latest edition.
2. All joints and seams sealed with high pressure duct sealer or gaskets and fastened with bolts, screws, or pop rivets.
3. Pipe, duct, conduit, and control penetrations sealed to prevent air leakage using close off sheets and strips.
4. Securely anchor housing panels to floor or roof curbs.
5. Block outside air or return air dampers open to prevent damage during construction until automatic control system is operational and adjusted.
6. Provide access doors where indicated on drawings and where required to provide access for cleaning and maintenance. Access doors installed to open against air pressure.
7. Slope plenum and connected ductwork to drain towards the exterior louver or building exterior opening.
8. For single wall plenums installed behind exterior louvers or wall openings, slope plenum floor and connected ductwork at 1/4-in/ft to drain towards the exterior louver or opening.

I. Aluminum Duct:

1. Slope minimum of 1/4 inch per foot of run toward the grille.
2. Install similar to galvanized duct work per SMACNA standards.
3. Provide dielectric protection when joining aluminum duct to steel duct by utilizing neoprene flexible connections or other approved method.
4. Use aluminum straps and hangers to support aluminum, ductwork.

3.3 FIELD QUALITY CONTROL

A. Coordination with Balance Agency:

1. Provide services of a sheet metal person familiar with the system ductwork to provide assistance to the balancing agency during the initial phases of air balancing in locating all sheet metal dampers.

2. Install missing dampers required to complete final balancing.

END OF SECTION

SECTION 15820

AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. The provisions of Section 15051, Common Work Results for HVAC apply to work specified in this Section.

1.2 SUMMARY

- A. This Section includes: Medium and low pressure duct accessories, sealants and tapes, flexible connectors, fire dampers, smoke dampers, combination smoke and fire dampers, access doors, spin-in, extractors, automatic dampers, drain pans, eliminators, back draft dampers.
- B. Related Sections include:
 - 1. Section 15810 HVAC Ducts and Casing-Low Pressure.

1.3 QUALITY ASSURANCE

- A. Work performed by qualified, experienced mechanics in accordance with the manual of Duct and Sheet Metal Construction of the National Association of Sheet Metal and Air Conditioning Contractors and these Specifications.
- B. Install entire ductwork system, including materials and installation, in accordance with NFPA 90A.
- C. Flexible connectors, flexible equipment connections, tapes and sealants listed as UL 181, Class I air duct. Flame spread rating not to exceed 25 and smoke developed rating not to exceed 50.

1.4 SUBMITTALS

- A. Submit the following: Product data for Duct Accessories.
 - 1. Medium Pressure Duct Accessories:
 - a. Acoustical Turning Vanes
 - b. Access Doors
 - c. Bell Mouth Fittings
 - 2. Low Pressure Duct Accessories:
 - a. Access Doors
 - b. Backdraft Dampers
 - c. Ceiling Radiation Dampers
- B. Operation and Maintenance Data: Ceiling Radiation Dampers.

PART 2 - PRODUCTS

2.1 LOW PRESSURE DUCT ACCESSORIES

- A. Acceptable Manufacturers:
1. As indicated.
 2. Other Manufacturers: Submit Substitution Request.
- B. Damper Regulators:
1. Ventlok model numbers used, similar products by Young, Durodyne or approved equal are acceptable.
 2. Dial Regulator: Concealed or exposed duct in unfinished spaces, blade lengths 18-inch and less, 3/8-inch, Ventlok 635 or 638 for insulated duct. For blade lengths, 19 inches and above, similar except 1/2-inch shafts.
 3. Dial Regulator: Exposed duct finished space, 3/8-inch, Ventlok 640.
 4. Dial Regulator: Concealed, not accessible, blade lengths 18-inch and less, 3/8-inch Ventlok 666 regulator with 680 mitered gear assembly where right angle turn is necessary. Blade lengths 19 inches and above, similar except 1/2-inch shafts.
 5. End Bearings: For ducts rated to 1 inch WG, open end, Ventlok 607. For ducts rated above 1 inch WG, closed end, Ventlok 609. Exposed ductwork, finished spaces, Ventlock 609. Spring end bearings not allowed.
- C. Volume Damper Fabrication:
1. Single blade dampers reinforced or crimped for rigidity, with pivot rod extending through duct. Dampers over 12 inches high use multiple opposed blade damper. Single blade damper no larger than 12 inches x 48 inches. Multiple blade damper factory fabricated, Ruskin MD-35 or equal.
 2. Minimum gauge and duct construction in accordance with SMACNA "HVAC Duct Construction Standards", latest edition.
 3. Splitter and butterfly dampers fabricated of 18 gauge galvanized steel.
 4. Dampers of length suitable to close branch ducts without damper flutter.
 5. Damper blade must be aligned with handle and index pointer.
- D. Flexible Equipment Connections: 30 oz. Ventfabrics Ventglas or Duro Dyne neoprene coated fire retardant glass fabric or approved equal.
- E. Spin-in Fittings:
1. Sheet Metal Duct: Straight pattern sheet metal spin-in fitting with scoops designed for connection to sheet metal ductwork, volume damper, and locking quadrant. Construction with spot welds or rivets. "Button-punch" fabrication prohibited.
 2. Fiberglass Duct: Straight pattern sheet metal spin-in fitting with scoops designed for connection to fiberglass ductwork volume damper, and locking quadrant. Construction shall be with spot welds or rivets. "Button-punch" fabrication prohibited.
- F. Duct Sealer:
1. Based On: McGill Airseal Zero.
 2. Description: Suitable for indoor/outdoor use, rated to 10-inch WG, Maximum Flame Spread/Smoke Developed Rating of 25/50, maximum VOC of 30 g/L less water. SCAQMD Rule 1158 compliant.

- G. Duct Tape for Sheet Metal: ARNO C520 duct tape similar United, Duro Dyne, Nashua, Polymer Adhesive.
- H. Tape and Adhesive/Activator System for Sheet Metal: Hardcast, Polymer Adhesive.
- I. Turning Vane Assemblies:
 - 1. Sheet Metal Vanes: Multiple radius hollow vane air foil type 2-inch (small vane) or 4-1/2-inch (large vane) inside radius, galvanized steel construction.
 - 2. Runners: Push-on type.
 - 3. Acoustical Vanes: Multiple radius air foil type, perforated steel construction with fiberglass fill. AirSan Acoustiturn or as approved.
- J. Access Doors:
 - 1. Manufacturer: Air Balance, Ruskin, Metco, Durodyne, Cesco, Nailor-Hart or approved equal.
 - 2. Doors complete with steel frame, steel door with backing plate, cam latches (two on units 14-inch x 14-inch and larger), hinge and gasketing. Doors on insulated or lined ducts shall be insulated.
- K. Backdraft Dampers:
 - 1. Manufacturer: Air Balance, Ruskin, Cesco, Advanced Air, Nailor-Hart or approved equal.
 - 2. Description: Gravity operated, vinyl edged, metal bladed backdraft dampers.
- L. Drip Pans: Provide Type 304 stainless steel drip pans for cooling coils and exhaust heat recovery coils on built-up units as indicated.
- M. Louver Blank-off Panels: At air intake or exhaust louvers which are only partially active area, blank off inactive area with sheet metal closure panels caulked airtight, secured to louver frame and insulated with 2" rigid fiberglass insulation per Section 15081 Insulation for HVAC.

2.2 FIRE AND SMOKE DAMPERS

- A. Acceptable Manufacturers: Where Ruskin is the only manufacturer indicated, equivalent products may be furnished.
- B. Combination Fire and Smoke Dampers:
 - 1. Multiblade damper with linkage, extended control rod and damper operator with UL Fire Damper Label. Provide round or oval duct connections where required. Operator to be factory-installed, electric type, 120V with spring return to closed position. Stall type motors are not acceptable.
 - 2. Low pressure, 1-1/2 hour: for use in partitions up to 2-hour rating. Ruskin Model FSD36.
 - 3. Low pressure, 3-hour: for use in partitions over 2-hour rating. Ruskin Model FSD60-3.
- C. Ceiling Fire Damper: Fabricate from 20 gauge galvanized steel blades, 212°F fusible link, U.L. 555C listed, Ruskin CFD (R) 2 or CFD (2) 3. Provide thermal blanket.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install all devices as shown on the Contract Drawings and per manufacturer's recommendations.
- B. Ceiling Fire Dampers:
 - 1. Install dampers in accordance with NFPA 90A and manufacturer's written recommendations.
 - 2. Size and locate dampers as shown on Drawings.
- C. Smoke Dampers and Combination Fire and Smoke Dampers:
 - 1. Install dampers in accordance with NFPA 90A and manufacturer's written recommendations.
 - 2. Size and locate dampers as shown on Drawings.
 - 3. Where dampers are not accessible for servicing by removing an outlet, provide access doors for servicing. Doors shall be compatible with the duct in which they are installed.
- D. Access Doors: Install where indicated and at all duct mounted coils, humidifiers, automatic control dampers, smoke dampers, fire dampers, air flow stations, to provide access for cleaning and maintenance.
- E. Drip Pans: Install under each cooling coil and exhaust heat recovery coil as indicated. Provide drain connection from each drip pan and pipe to nearest floor drain through trap. Drip pans over 6 feet in length require drain connections from both ends. Pitch drip pans in direction of air flow and to drain.
- F. Louver Blank-off Panels: Install blank-off panels on unused portions of louvers.

END OF SECTION

SECTION 15830

HVAC FANS

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.
- B. The provisions of Section 15051, Common Work Results for HVAC apply to work specified in this Section.

1.2 SUMMARY

- A. This Section includes: Ceiling exhaust fans.

1.3 SUBMITTALS

- A. Submit the following:
 - 1. Shop Drawings: Showing dimensions, details of construction.
 - 2. Product Data: Showing performance of fans.
 - 3. Operation and maintenance data.
 - 4. Submit certified sound power ratings for each fan.

PART 2 - PRODUCTS

2.1 CEILING EXHAUST FANS

- A. Acceptable Manufacturers:
 - 1. Penn, Greenheck, Carnes, Cook, Acme.
 - 2. Other Manufacturers: Submit Substitution Request.
- B. General Description: Centrifugal direct drive cabinet fan, AMCA rated.
- C. Fan: Double width, double inlet forward curved aluminum blade wheel, integral backdraft damper. Provide duct mounted automatic motorized damper where indicated or required by code.
- D. Casing: Fabricated acoustically insulated steel casing, steel scroll with inlet cone and steel base, factory standard finish.
- E. Motor: Integrally mounted, 1050 RPM nominal, lubricated sleeve bearing, internal disconnect plug. Refer to Section 15051 for energy efficient motor requirements.
- F. Vibration Isolation: Factory mount motor on double deflection neoprene mounts.

- G. Inlet and Outlet: Provide egg crate inlet grille. Provide discharge with backdraft damper. Arrange for access to fan and motor through grille.
- H. Accessories: Provide wall louvered discharge, sized to match fan discharge, built in bird screen and damper, aluminum construction. Provide line voltage t-stat where indicated in equipment schedules.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Provide flexible connections on all inlet and discharge duct connection.

3.2 CEILING EXHAUST FANS

- A. Install fan in ceiling with inlet grille tight to surface.
- B. Make connection from fan outlet to ductwork.

END OF SECTION

SECTION 15081 - AIR OUTLETS AND INLETS

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.
- B. The provisions of Section 15051, Common Work Results for HVAC apply to work specified in this Section.

1.2 SUMMARY

- A. This Section includes: Ceiling diffusers, sidewall grilles.
- B. Related Sections include:
 - 1. Section 15820 Duct Accessories.

1.3 SUBMITTALS

- A. Submit the following:
 - 1. Shop Drawings: Showing dimensions and details of construction.
 - 2. Product Data.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Where only Titus figure numbers are listed, equivalent products by Carnes, Price, Krueger, Tuttle & Bailey, Anemostat, Nailor are acceptable.
- B. All such products shall be of one manufacturer.
- C. Other Manufacturers: Submit substitution Request.

2.2 PERFORMANCE

- A. Unit sizing is based on air being introduced at 20°F temperature differential and being diffused at the 5-foot level to a velocity not greater than 50 FPM and a temperature differential not greater than 1.5°F. Units are also selected so as not to exceed the NC-30 curve.

2.3 DIFFUSERS AND GRILLES

- A. Ceiling Supply Diffuser (C-1): Perforated face modular diffuser with adjustable modular core, steel panel, square or rectangular neck size as indicated, discharge pattern as indicated, lay-in tee bar ceiling, or surface mounted as required (coordinate with architectural reflected ceiling plan), white baked enamel finish, Titus PMC. Provide with ceiling radiation damper.

- B. Ceiling Return/Exhaust Grille (C-2): Perforated face modular ceiling grille, steel panel, with duct adapters for round or rectangular as indicated, lay-in tee bar ceiling, or surface mounted as required (coordinate with architectural reflected ceiling plan), white baked enamel finish, Titus PAR. Provide with ceiling radiation damper
- C. Ceiling Supply Diffuser (C-3): Thermally powered variable air volume module. Shall be a complete VAV terminal and thermostat self-contained in a nominal 24' round. Module shall vary the supply air volume to provide both VAV heating and VAV cooling, Acutherm Therma-Fuser STR-HC with remote setpoint. Provide with ceiling radiation damper
- D. Wall Exhaust Grille (H-1): Steel 45 degree fixed single deflection, horizontal blades, 3/4-inch spacing 1-1/4-inch border, gasketed around face flange, white baked enamel finish, Titus Model 23RL.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install all diffusers tight to their respective mounting surfaces.
- B. Installed plumb and true with room dimensions and accurately centered on projections as shown on the Architectural reflected ceiling plans.
- C. Install extractors behind all duct mounted sidewall supply grilles, and where shown. Turning vanes allowable if condition is the last outlet on a branch.
- D. Set pattern control for directions of throw as shown on Drawings prior to air balancer arriving on Project.
- E. Paint ductwork behind all outlets flat black.

END OF SECTION

SECTION 15950

TESTING, ADJUSTING AND BALANCING

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.
- B. The provisions of Section 15051, Common Work Results for HVAC apply to work specified in this Section.

1.2 SUMMARY

- A. This Section includes:
 - 1. Testing and balancing of air systems.
 - 2. Testing and balancing of miscellaneous mechanical equipment.
- B. Scope of Work:
 - 1. Balancing shall include but not be limited to the following:
 - a. Prebalance of existing conditions: Balancer shall measure and record all airflows for existing conditions in the areas of work to include supply, return, exhaust, and outside air flows. This shall include all existing fan units on the third floor and two terminal units on the second floor. This does not include dual duct terminal units on the third floor outside the area of work.
 - b. Final Balance: Shall include all units as described above.

1.3 QUALITY ASSURANCE

- A. Testing and Balancing Firm Qualifications:
 - 1. The Contractor shall procure the services of an independent balance and testing agency, approved by the Architect, which specializes in the balancing and testing of plumbing, heating, ventilating, and air conditioning systems, to balance, adjust and test water circulating and air moving equipment and air distribution or exhaust systems as herein specified.
 - 2. The testing agency shall provide proof of having successfully completed at least five projects of similar size and scope. Testing and balancing work shall be done under direct supervision of registered professional engineer who has been employed by the Agency a minimum of one year prior to start of project.
- B. Industrial Standards: Testing and Balancing shall conform to NEBB, American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE), and American National Standards Institute (ANSI) as follows:
 - 1. NEBB: Comply with Procedural Standards for Testing, Adjusting Balancing of Environmental Systems.

2. ASHRAE: Comply with recommendations pertaining to measurements, instruments, and testing, adjusting and balancing.
3. ANSI:
 - a. S1.4 Specifications for sound level meters.
 - b. S1.11 Specifications for Octave-Band and Fractional-Octave-Band analog and digital filters.
- C. Instrument Certification: All instruments used shall be accurately calibrated and certified within six months of balancing and maintained in good working order.
- D. Test Observation: If requested, the tests shall be conducted in the presence of the Architect or the Architect's representative.
- E. Pre-Balancing Conference: Prior to starting balancing, general techniques shall be reviewed with the Engineer. This conference must occur prior to measuring existing conditions. Measuring of existing conditions must occur prior to any demolition or new work. The conference will review existing conditions and systems to be affected by the project

1.4 SUBMITTALS

- A. Submit the following:
 1. Balancing Log: Include all air and water outlets, actual field measured air and water volume, and percentage of design volumes. Provide drawings identifying location of all outlets.
 2. Equipment Data Sheets: Indicate actual equipment performance, model numbers, bearing and belt data, motor nameplate data, and final balanced motor data.
 3. Additional Data: Submit all additional data as provided by Associated Air Balance Council (AABC) Standard forms.
 4. Number of Copies: Submit six (6) copies of the above completed information to the Engineer for review and insertion into the Operating and Maintenance Data.
 5. Instrument Certification: When requested, submit certificate of calibration for all equipment to be used.
- B. Record data on NEBB forms or forms approved by the Architect.

1.5 PROJECT CONDITIONS

- A. Where existing systems are to be adjusted, establish flow rates in all branches prior to making any modifications to system. Submit preliminary report indicating existing conditions prior to making any modifications to existing systems. Adjust central equipment as required and restore all unmodified branches and outlets to original condition. Obtain existing system drawings from Owner and become familiar with extent and nature of existing systems.
- B. Do not perform final testing, adjusting, and balancing work until heating, ventilating, and air conditioning equipment has been completely installed and operating continuously as required.
- C. Conduct air testing and balancing with clean filters in place. Clean strainers, etc., prior to performing hydronic testing and balancing.

1.6 WARRANTIES

- A. In addition to the Requirements of the Contract, include an extended warranty of six months after completion of test and balance work during which time the Architect at his discretion may request a recheck or resetting of any equipment or device listed in the test reports.

PART 2 - PRODUCTS – NOT APPLICABLE

PART 3 - EXECUTION

3.1 AIR SYSTEMS

- A. General: Make measurements in accord with Industrial Standards specified above. Record on appropriate forms.
- B. Preliminary:
 - 1. Identify and list size, type, and manufacture of all equipment to be tested including air outlets and inlets.
 - 2. Use manufacturer's ratings for equipment to make required calculations except where field test shows ratings to be impractical.
- C. Central System:
 - 1. Adjust fan speeds and motor drives for required air volume within $\pm 5\%$ maximum. Set speed to provide air volume at farthest run without excess static pressure. Provide additional sheaves and belts as required to accomplish speed adjustment.
 - 2. Read and adjust air supply, return, and exhaust fan units to deliver design conditions at minimum O.S.A. and at 100% O.S.A.
 - 3. Adjust all automatic dampers, outside air, return air, and exhaust dampers for design conditions.
 - 4. Read static air pressure conditions on all air handling equipment including filter and coil pressure drops and total pressure across the fan. A Dwyer Series 400 air velocity meter only shall be used for final static pressures at equipment and where critical readings are required.
 - 5. Measure temperature conditions across all outside air, return air, and exhaust dampers to check leakage.
 - 6. Read and record motor data and amperage draw.
 - 7. For variable volume systems, establish minimum static pressure required at sensing point to permit operation over entire VAV range. Adjust supply and return fan speed so that at maximum demand the associated VFD is controlling the motor of motor nameplate RPM to 100%. Adjust return fan speed so that return air volumes track with supply air volume minus exhaust air volume.
 - 8. Assist controls contractor in establishing minimum outside air damper positions.
- D. Distribution:
 - 1. Read and adjust all air outlets to design air volumes within $\pm 10\%$ maximum. Advise Engineer if deficiencies are generally noted to enable proper corrective actions.

2. Evaluate all building and room pressure conditions to determine adequate supply and return air conditions. Generally, the building shall be balanced to be slightly positive to outdoors.
3. Evaluate all building and room pressure conditions to determine adequate performance of the system to maintain temperatures without draft.
4. Perform multipoint pitot traverses to confirm instrumentation, shaft tightness, fan operation, etc. Pitot traverses shall be performed using a Dwyer Series 400 air velocity meter only with applicable duct probe.
5. Mark all balancing dampers.

3.2 ELECTRIC HEATING EQUIPMENT

- A. Test and record voltage and amperage readings at each electric heating device while fully energized and at part load conditions (each step) to verify proper operation.
- B. Record data on appropriate forms.

3.3 AUTOMATIC CONTROL SYSTEM

- A. In cooperation with control manufacturer's representative, set and adjust automatically operated devices to achieve required sequence of operations.
- B. Testing organization shall verify all controls for proper calibration and list controls requiring adjustment by control system installer.

3.4 COORDINATION

- A. Coordinate work with other trades to ensure rapid completion of the project.
- B. Deficiencies noted during the course of air balancing in the mechanical installation shall be promptly reported to the Architect to allow corrective action to proceed.
- C. Periodic review of progress shall be provided as requested.

END OF SECTION

SECTION 15960

PRESSURE TESTING FOR PLUMBING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. The provisions of Section 15050, Common Work Results for Plumbing apply to work specified in this Section.

1.2 SUMMARY

- A. This Section includes: Pressure testing of piping systems.

1.3 QUALITY ASSURANCE

- A. Code Compliance: Perform required tests in the presence of the authority having jurisdiction.
- B. Owner Witness: Perform all tests in the presence of the Owner's representative.
- C. Engineer Witness: The Engineer or Engineer's representative reserves the right to observe all tests or selected tests to assure compliance with the specifications.
- D. Simultaneous Testing: Test observations by the authority having jurisdiction, the Owner's representative and the Engineer's representative need not occur simultaneously.

1.4 SUBMITTALS

- A. Submit the following:
 - 1. Test Reports:
 - a. Submit certificate of completion, inspection and test by authority having jurisdiction on required piping systems.
 - b. Submit certificate of test approval by Owner's representative on all systems.
 - c. The Engineer's representative will record witnessed tests.

PART 2 - PRODUCTS – NOT APPLICABLE

PART 3 - EXECUTION

3.1 GENERAL

- A. Piping: Test prior to concealment, insulation being applied, and connection to equipment, fixtures, or specialties. Conduct tests with all valves but those used to isolate the test section 10% closed.
- B. Leaks: Repair all leaks and retest until stipulated results are achieved.
- C. Notification: Advise the Architect 72 hours in advance of each test. Failure to so notify will require test to be rescheduled.
- D. Testing Equipment: Provide all necessary pumps, gauges, connections and similar items required to perform the tests.

3.2 TESTING REQUIREMENTS

- A. Sanitary and Roof Drainage Systems: Test entire system or sections of system by closing all openings in piping except highest opening and filling system with water to point of overflow. If system is tested in sections, plug each opening except highest opening of section under test and fill each section with water, but none with less than 10-foot head of water. Keep water in system or in portions under test for at least 45 minutes before inspection starts. Test for two (2) hours with no drop allowed. Locate and repair leaks.
- B. Domestic and Reclaimed Water Systems: Test per current State and local codes.
- C. Piping - General: Test all piping as noted below, with no leaks or loss in pressure for time indicated. Repair or replace defective piping until tests are completed successfully:

| Plumbing Systems | Test Pressure | Test Medium | Test Duration |
|-------------------------|----------------------|--------------------|----------------------|
| Industrial water | 150 psig | Water | 4 hours |
| Natural gas piping | 60 psig | Air | 4 hours |

- D. Piping - High Purity:
 - 1. General: All materials and quality of work shall be subject to inspection and examination by the Owner or Owner's representative at any place where fabrication or erection are carried on.
 - a. Prior to testing operation, all valves shall be opened and all pipelines shall be blown out to remove all foreign matter which may have accumulated in the pipes. Lines may be purged out by progressively opening and closing valves.
 - b. Testing shall be done in the presence of the Owner's representative.
 - c. Use only high purity cryogenic nitrogen for leak pressure testing. Unless otherwise specified, the test gas for H₂ lines shall be argon. The test gas for O₂, N₂, specialty gases, and high purity compressed air shall be nitrogen. (Nitrogen from plant system shall not be used without the written consent of the Owner.)
 - d. Test high purity piping systems as follows:

| System | Test Pressure | Test Duration |
|----------------------------|----------------------|----------------------|
| Oil free compressed air | 150 psig | 24 hours |
| High purity compressed air | 150 psig | 24 hours |
| Oxygen | 200 psig | 24 hours |
| Nitrogen | 200 psig | 24 hours |
| Hydrogen | 200 psig | 24 hours |
| Specialty gases | 200 psig | 24 hours |

- e. No pounding or hammering on any joints or equipment shall be performed unless specifically authorized by Owner's representative.
 - f. Due regard for safety shall be constantly observed. Hydrogen and oxygen are hazardous gases, and extreme care must be exercised in all work associated with them.
2. Testing Procedure:
- a. Check all systems to assure compliance with revision Drawings. Check pressure and temperature rating of all valves to assure compliance with Owner's design standard.
 - b. Check all safety valves for pressure settings. In the event adjustments or corrections are required to assure conformance with drawings, they should be made prior to proceeding with the testing activity. Do not exceed pressure ratings of installed equipment.
 - c. Test gauges shall be installed and test medium source connections shall be made to convenient process connections. After completion of testing, the gauges and source connection shall be removed and the specified process attachments replaced as shown on drawings.
 - d. All joints shall be tested with bubble leak detecting solution when pressure reading indicates leakage. The specified test pressure shall be held as previously specified without loss in pressure.
 - e. Only gauges cleaned for O₂ service shall be used.

3.3 MEDICAL GAS TESTING

- A. All medical gas system testing shall meet all requirements of current NFPA 99 and NEC Class II signal requirements.
- B. The testing of altered medical gas systems in addition to the new systems is required. The tests shall include but not be limited to the following:
 - 1. Installer Performance Testing (Piped Gas Systems):
 - a. Test conducted prior to required test listed:
 - 1) Blow down
 - 2) Initial pressure test
 - 3) Standing pressure test
 - 4) Piping purge test
 - 5) Cross-connection test

2. System Verification (Piped Gas Systems):
 - a. Test conducted after required test listed:
 - 1) Standing pressure test
 - 2) Cross-connection test
 - 3) Valve Test
 - 4) Alarm testing
 - 5) Piping purge test
 - 6) Piping particulate test
 - 7) Piping purity test
 - 8) Final tie-in test
 - 9) Operational pressure test
 - 10) Medical gasses concentration test
 - 11) Medical air purity test.

C. Contractor shall forward the following certifications:

1. Certification of the medical gas brazing is being performed by individuals who are qualified per NFPA 99.
2. Certification of the medical gas and vacuum system installer performance testing per NFPA 99.
3. Certification of the medical gas and vacuum system verification testing per NFPA 99.

END OF SECTION