

University of Houston Master Specification

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SECTION 23 0300 - BASIC MATERIALS AND METHODS

Maintain Section format, including the UH master spec designation and version date in bold in the center columns of the header and footer. Complete the header and footer with Project information.

Edit and finalize this Section, where prompted by Editor's notes, to suit Project specific requirements. Make selections for the Project at text identified in bold.

Verify that Section titles referenced in this Section are correct for this Project's Specifications; Section titles may have changed.

Delete hidden text after this Section has been edited for the Project.

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.
- B. The Contractor's attention is specifically directed, but not limited, to the following documents for additional requirements:
 - 1. The current version of the *Uniform General Conditions for Construction Contracts*, State of Texas, available on the web site of the Texas Facilities Commission.
 - 2. The University of Houston's Supplemental General Conditions and Special Conditions for Construction.

1.2 DESCRIPTION OF WORK:

- A. Work Included: Provide basic materials and methods for mechanical construction as shown, scheduled, indicated, and specified.
- B. Types: The types of basic materials and methods required for the project include, but are not limited to:
 - 1. General piping installation.
 - 2. Hangers and supports.
 - 3. Miscellaneous steel.
 - 4. Sleeves.
 - 5. Escutcheon plates.
 - 6. Exposed piping.
 - 7. Pipe cleaning and sterilization.
 - 8. Openings, cutting and patching.
 - 9. Excavation, trenching, and backfilling.
 - 10. Access doors.
 - 11. Firestopping for piping and ductwork.
 - 12. Fire-rated partitions.
 - 13. Flame spread properties of materials.

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14. Penetrations, flashing, and seals.
15. Cleaning and painting of mechanical work.
16. Mechanical system identification.
17. Warning signs and operational tags.
18. Prohibited markings.
19. Tamper resistant fasteners.
20. Equipment connections.
21. Rotating shafts.
22. Belt and coupling guards.
23. Bearings.
24. Equipment housekeeping pads and anchor bolts.
25. Miscellaneous curbs and supports.
26. Device mounting heights.
27. [Demolition and work within existing buildings.]

1.3 SUBMITTALS:

- A. Shop Drawing submittals shall include, but not be limited to, the following:
 1. Pipe fabrication drawings.
 2. Cut sheets on pipe hangers and supports, escutcheons, access doors, fire stopping materials, and miscellaneous curbs and supports.
 3. [Excavation and trenching plan, designed and sealed by a registered professional engineer. Refer to Division 1 for additional submittal requirements.]
 4. Cut sheets and samples of mechanical identification products.
 5. Additional information as required in Section 23 01 00.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING:

- A. Deliver components in factory-fabricated, water resistant packaging.
- B. Handle components carefully to avoid damage to components, enclosures, and finish.
- C. Store components in a clean, dry space and protect from weather.

PART 2 - PRODUCTS

2.1 MATERIALS:

- A. General: Refer to Part 3 of this Section and other Division 23 sections for basic mechanical products and materials.

PART 3 - EXECUTION

3.1 GENERAL PIPING INSTALLATION:

- A. General: The Contractor shall provide all piping system components as shown on the Drawings or necessary to complete the working system in accordance with the intent of the Drawings and Specifications, a complete system of piping, all valves as indicated or as necessary to completely control the entire apparatus and all appurtenances. The Piping Drawings are diagrammatic and indicate the general location and connections.

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- B. Erection: Piping shall be properly supported and adequate provisions shall be made for expansion, contraction, slope and anchorage. All piping shall be cut accurately for fabrication to measurements established at the construction site. Pipe shall be worked in place without springing or forcing. Cutting or other weakening of the building structure to facilitate installation will not be permitted. All pipes shall have burr and cutting slag removed by reaming or other approved cleaning methods. All changes in direction shall be made with fittings, except that bending of pipe will be permitted provided a hydraulic pipe bender is used. Bent pipe showing kinks, wrinkles, or other malformation will not be acceptable.
- C. Concealed and Exposed Piping: All piping in finished areas shall be concealed, unless otherwise noted. Piping exposed in mechanical rooms and other locations as noted shall be installed in an orderly manner and parallel with or perpendicular to building lines. Exposed piping in occupied areas shall be routed tight to the structure or as high as is possible.
- D. Grading: All piping shall be carefully installed so as to eliminate traps and pockets in pressurized lines and to maintain flow in gravity flow lines. Where air pockets and traps cannot be avoided, provide valved hose connections for water traps and valved, automatic air vents for air traps. The Contractor shall consider pipe grading requirements when coordinating pipe routing for the project. Pipe slope shall be maintained throughout the project. Waste and vent piping shall be sloped in accordance with the applicable codes. Pressurized plumbing piping systems shall be sloped to drain points. HVAC water piping systems shall be graded up 1/16" per 10 lineal foot of horizontal run to air vent locations and down 1/16" per 10 lineal feet of horizontal run to drain locations. Grade all steam piping 1/4" per 10 lineal feet of horizontal run toward steam traps and slope all steam condensate piping 1/4" per 10 lineal feet of horizontal run toward condensate receivers.
- E. Arrangement: Flanges or unions, as applicable for the type of piping specified, shall be provided in the piping at connections to all items of equipment. All valves and specialties shall be placed to permit easy and proper operation and access, and all valves shall be regulated, packed and glands adjusted at the completion of the work before final acceptance. Tapered reducers shall be used wherever changes in pipe sizes occur in mains. Bushings will not be permitted. The use of bull head tees or other high pressure drop configurations will not be permitted.
- F. Welding: All welded joints in piping shall be continuous metallic arc or gas fusion welds connecting pipe ends which are beveled to 37-1/2 degrees before welding. The use of backing rings will not be acceptable. All taps shall be made using proper weld fittings. No "burn-ins" will be allowed. Gas torch cuts shall be true and free from burned metal. Clean pipe surfaces to be welded immediately prior to welding. Welded pipe joints shall be properly aligned with no weld material or bead projects in into the pipe. All weld procedures shall be in accordance with requirements of the American Welding Society and shall be performed by certified welders. Documentation of welder certification shall be available if requested. All welding operations shall conform to the latest recommendations of the American Welding Society and to Section Six of Power Piping, ANSI B31.1 1973; B31.3 for steam piping. All qualifying tests, welding and stress relieving procedures, shall, moreover, be in accord with Standard Qualification for WELDING PROCEDURES, WELDERS AND WELDING OPERATORS, APPENDIX A, SECTION 6 of the Code, current edition. In no cases shall Schedule 40 pipe be welded with less than three passes including one tack, one filler, and one lacer. Schedule 80 pipe shall be welded with not less than four passes including one tack, two fillers and one lacer. Welds lacking penetration shall be removed. Internal and external cracks shall be ground down and removed.

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1. All weld fittings shall be USA factory made wrought carbon steel butt-welding fittings conforming to ASTM A234 and ASME/ANSI B16.9 latest edition, as made by aNVIL, Tube Turn, Hackney, Taylor Forge, or Ladish Company. Long radius fittings shall be provided for all 90-degree and 45-degree elbows. Each fitting shall be stamped as specified by ASME/ANSI B16.9 and, in addition, shall have the laboratory control number metal stenciled on each fitting for ready reference as to physical properties required for any fitting selected at random. Complete test reports may be required for any fittings selected at random. Only one manufacturer of weld fittings will be approved for each project. Fittings which have been machined, remarked, printed or otherwise produced domestically from imported forgings or materials will not be acceptable. Each fitting shall have the manufacturer's trademark permanently identified in accordance with MSS SP-25. Markings shall be placed on the fittings at the farthest point from the edge to be welded to prevent disfiguring from the welding process. Submittal data for these fittings shall include a letter signed by an official of the manufacturing firm certifying compliance with these Specifications.
2. Piping and fittings shall be welded and fabricated in accordance with ASME/ANSI and the latest edition of Standard B31.1 from the Code for Pressure Piping for all systems, and B31.3 for Steam and Condensate systems. Machine beveling in shop is preferred. Field beveling may be done by flame cutting to recognized standards.
3. Ensure complete penetration of deposited metal with base metal. Contractor shall provide filler metal suitable for use with base metal. Keep inside of fittings free from globules of weld metal.
4. Align piping and equipment so that no part is offset more than 1/16". Set all fittings and joints square and true, and preserve alignment during welding operation. Use of alignment rods inside pipe is prohibited.
5. Do not permit any weld to project within the pipe so as to restrict it. Tack welds, if used, must be of the same material and made by the same procedure as the completed weld. Otherwise, remove tack welds during welding operation.
6. Contractor shall not split, bend, flatten or otherwise damage piping before, during or after installation. Remove dirt, scale, and other foreign matter from inside piping before tying in sections, fittings, valves or equipment.
7. In no case shall Schedule 40 pipe be welded with less than three passes including one stringer/root, one filler and one lacer. Schedule 80 pipe shall be welded with not less than four passes including one stringer/root, two fillers and one lacer. In all cases, however, the weld must be filled before the cap weld is added.
8. All welds are subject to inspection, visual and/or X-ray, for compliance with specifications. The Owner will, at the Owners option, provide employees or employ a testing laboratory for the purposes of performing said inspections and/or X-ray testing. Initial visual and X-ray inspections will be provided by the Owner. The Contractor shall be responsible for all labor, material and travel expenses involved in the reinspection and retesting of any welds found to be unacceptable. In addition, the Contractor shall be responsible for the costs involved in any and all additional testing required or recommended by ASME/ANSI Standards B31.1 and B31.3 due to the discovery of poor, unacceptable, or rejected welds.
9. Welds lacking penetration, containing excessive porosity or cracks, or are found to be unacceptable for any reason, must be removed and replaced with an original quality weld as specified herein. All qualifying tests, welding, and stress relieving procedures shall, moreover,

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be in accord with Standard Qualification for Welding Procedures, Welders and Welding Operators, Appendix A, Section 6 of the Code, current edition.

- G. Screw Pipe Fittings: All screw joints shall be made with taper threads, properly cut. Joints shall be made tight with teflon applied to the pipe threads only and not to fittings. When threads are cut on pipes, the ends shall be carefully reamed to remove any burrs. Before installing pipe that has been cut and threaded, the lengths of pipe shall be upended and hammered to remove all shavings and foreign material.
- H. Assembling Other Joints: Procedures for assembling joints in cast iron and copper lines have been set forth elsewhere in these Specifications. For any special materials, consult the manufacturers for the recommended procedures in assembling the joints.
- I. Expansion and Contraction: Provisions for expansion and contraction of piping shall be provided by expansion loops, bends or expansion joints to prevent injury to connections, piping, equipment or the elements of the building.
- J. Anchors: Pipe anchors shall be provided and installed at each end of piping runs which require expansion loops or joints, and where indicated on Drawings. Anchors shall be fabricated of rigid structured steel members firmly secured to the building structure.
- K. Guides: Pipe guides shall be provided and installed on piping as shown on Drawings and as necessary to properly fulfill function of expansion loops.
- L. Unions: Shall be installed on all bypasses, ahead of all traps, at all connections to equipment, where shown on the Drawings or where required to facilitate removal of equipment.
- M. Escutcheons: Spring clamp plates (escutcheons) shall be provided where pipes are exposed in finish locations of the building and run through walls, floors, or ceilings. Plates shall be chrome plated spun brass of plain or approved pattern and shall be set tight on the pipe and to the building surface.
- N. Protection: All open ends of pipes and equipment shall be properly capped or plugged during construction to keep dirt and other foreign materials out of the system. Plugs of rags, wool, cotton, waste or similar materials are not acceptable.
- O. Pipe Sizes: If the size of the piping is not clearly evident in the Drawings, the Contractor shall request instruction as to the proper sizing.
- P. Connections Between Copper and Steel Pipes: Connections shall be made with dielectric couplings, flanged dielectric unions, CTS copper flanged adapter or nylon bushings temperature and pressure rated for the service at the point of installation.
- Q. Exterior Underground Piping: All exterior underground piping shall be installed with a minimum of 30" of earth or equivalent cover, except where specifically shown otherwise or permitted by the Architect/Engineer. Generally, more cover shall be provided if the grades of the lines involved and the finished grade elevations established at the site will permit.
- R. Pipe Layout: All piping shall be installed in accordance with Plans and Specifications and according to all applicable local and state codes. Minor piping revisions due to substituted equipment are acceptable provided they are indicated on piping fabrication drawings. All the various piping systems shall be made up straight and true and run at proper grades to permit proper flow of the contained material. Lines shall also be graded for proper drainage. Piping shall follow as closely as possible the routes shown on Drawings which take into consideration conditions to be met at the site. Should any unforeseen conditions arise, lines shall be changed or rerouted as required after proper approval has been obtained. All piping shall be installed with due regard to expansion and contraction and so as to prevent excessive strain and stress in the piping, in connections, and in equipment to which the lines

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are connected. All piping shall be clean when it is installed. Before installation it shall be checked, upended, swabbed, if necessary, and all rust or dirt from storage or from laying on the ground shall be removed.

- S. Piping fabrication drawings shall be submitted for all piping in the Central Plant, mechanical rooms, and for equipment connections and all other areas requiring coordination with other trades.
1. Pipe fabrication drawings shall be double line drawings to scale on 1/4" scale building floor plans and shall indicate pipe size, fittings, valves, accessories, connections, system type, insulation, hangers, support requirements, anchors, guides, expansion joints and loops, pipe elevations and other information required for coordination with other trades and fabrication of piping.
 2. Pipe fabrication drawings shall be coordinated with other trades and building construction prior to submittal for approval. Refer to Section 23 0100 "Mechanical General Provisions" for additional shop drawing requirements.

3.2 HANGERS AND SUPPORTS:

- A. General: Provide pipe hangers and supports as specified. All horizontal and vertical piping shall be thoroughly and substantially supported in ANSI B31.1 Standard Code for Pressure Piping and Manufacturers' Standardization Society MSS SP-69 Pipe Hangers and Supports - Selection and Application. Comply with local codes and standards for pipe and equipment support and anchorage. Pipe supports shall be of material that will prevent electrolytic action. The design, type, spacing and application of all hangers, supports, anchors and guides shall comply with the above standards. Hanger rod clamps and inserts shall be as recommended by the clamp or insert manufacturer for the intended use and shall be approved in writing by the Structural Engineer. All methods of attachment to the structure and the use of after-set inserts shall be approved in writing by the Structural Engineer. **The load and spacing on each hanger and/or insert shall not exceed the safe allowable load for any component of the support system, including the concrete which holds the inserts.** Reinforcement at inserts shall be provided as required to develop the strength required.
- B. MSS Standard Compliance: Provide pipe hangers and supports of materials, design, and manufacture which comply with ANSI/MSS SP-58, SP-59, SP-89, and SP-90.
- C. Acceptable Manufacturers: The model numbers listed in the Specification establish a level of quality and material. The following manufacturers are acceptable subject to compliance with the requirements of this Specification:
1. Anvil International.
 2. B-Line.
 3. Central Iron Manufacturing Company.
 4. F & S Manufacturing Company.
 5. Hubbard Enterprises/Holdrite
 6. The Michigan Hanger Company.
- D. Inserts: Provide Anvil Fig. 282 or equal inserts for all pipe, ductwork and equipment suspended from new concrete construction. Where inserts are placed in the bottom faces of concrete joists which are too narrow to provide adequate strength of concrete to hold the insert properly or where a larger insert would require displacement of the bottom joist steel, the hanger rod shall be suspended from the center of a horizontal angle iron, channel iron, I-beam, and similar items spanning across two adjacent joists. The horizontal support shall be bolted to nonadjustable concrete inserts of the "spot" type, of physical size small enough to avoid the bottom joist steel. All inserts shall be galvanized.

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Cast-in-place concrete inserts are preferred over powder-actuated fasteners or expansion anchors, especially in post-tension slab applications. Place cast-in-place anchors prior to concrete pour. For small-bore piping, use Hubbard Enterprises/HOLDRITE #125 series brackets or owner approved equipment.

- E. Fasteners: Fastening of pipes, conduits, and similar items in the building shall be as follows: To wood members - by wood screws; to masonry - by threaded metal inserts, metal expansion screws, or toggle bolts, whichever is appropriate for the particular type of masonry; to steel - machine screws or welding (when specifically permitted or directed), or bolts, and to new concrete by suitable inserts anchored to reinforcing steel, and poured in place unless other means are indicated on the plans. All fasteners shall be cadmium plated or galvanized. **Power-actuated fasteners (shooting) will not be acceptable under any circumstances.**
- F. Piping in Multiple Parallel Runs: Provide galvanized structural channels or angles with Anvil Fig. 137/137 C or equal galvanized U-bolt clamps, supported as trapeze hangers where multiple parallel runs of piping are shown. Coated U-bolts shall be provided for uninsulated glass or copper pipe. Select and size members for weights to be carried and span dimensions between supports.
- G. Piping in Single Runs: Provide Anvil Fig. 260 or equal adjustable clevis hangers with a nut above and below the hanger on the hanger rod. All hangers shall be galvanized.
- H. Copper Pipe Hangers: Hangers supporting and contacting brass or copper lines 3" in size and smaller shall be Anvil Fig. CT 99C or equal, adjustable plastic coated, copper-plated tubing rings. Hangers supporting and contacting brass or copper lines 4" and larger shall be Grinnell Fig. 260 or equal, galvanized, adjustable clevis, with a nut above and below the hanger on the support rod and approved neoprene isolating material between pipe (or tubing) and hanger. For insulated copper or brass domestic water lines, hangers for all sizes of pipe shall be Anvil Fig. 260 or equal, galvanized, adjustable clevis, with a nut above and below the hanger on the support rod and sized to fit the outside diameter of the insulation and hanger. Isolate all copper or brass lines from ferrous metals with approved dielectric materials.
- I. Hanger Rod: Provide cadmium-coated or galvanized hanger rods and nuts of required length. Rods shall be coated or galvanized after threading. Rods shall be cold galvanized after cutting. All hanger rods shall be trimmed neatly so that no more than one inch (1") of excess hanger rod protrudes beyond the hanger nut. In the event a rod is intentionally but temporarily left excessively long (for sloped or insulated lines for example), the Contractor shall take appropriate measures to protect the pipe or other materials from damage. Rod diameters shall be as follows:

<u>Pipe Sizes</u>	<u>Rod Diameter</u>
3/4 - 2"	3/8"
2-1/2 - 3"	1/2"
4 - 5"	5/8"
6"	3/4"
8 - 12"	7/8"
14 - 18"	1"

- J. Riser Clamps: Provide Anvil Fig. 261/261 C or equal galvanized riser clamps with equal bearing on each end. Riser clamps for copper tube shall be plastic coated.
 1. Riser clamps shall be isolated from the structure by use of Hubbard Enterprises Holdrite #274 or #278 riser pad or equal.

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- K. Pipe Supports in Chases and Partitions: Horizontal and vertical piping chases and partitions shall be supported by hangers or other suitable support. Pipes serving plumbing fixtures and equipment shall be securely supported near the point where pipes penetrate the finish wall. Supports shall be steel plate, angles or special channels such as Unistrut mounted in vertical or horizontal position. Pipe clamps such as Unistrut P2426, P2008, P1109 or other approved clamps shall be attached to supports. Supports shall be attached to wall or floor construction with clip angles, brackets, or other approved method. Supports may be attached to cast iron pipe with pipe clamp or other approved method. All copper or brass lines shall be isolated from ferrous metals with electrical tape or other dielectric materials to prevent electrolytic action.
- L. Saddles and Shields:
1. Saddles for Horizontal Insulated Piping without Vapor Barrier: At each hanger or support on horizontal runs, provide Anvil Fig. 160 or equal black steel saddles, as applicable. Shields as described below may be used instead of the saddles. **[On heating water systems below 140°F (60°C), hangers may be sized for the pipe size and of a material compatible with the pipe. Where dissimilar materials are used, provide dielectric separation. Carry insulation over the hanger and seal where hanger is sized for pipe.]**
 2. Shields for Horizontal Insulated Water Piping with Vapor Barrier: At each hanger or support for water piping, provide a half section of preformed cellular glass or rigid calcium silicate blocking, with jacket of adjacent insulation brought across unbroken, supported on Anvil Fig. 167 or Anvil 260 ISS or equal semicircular galvanized steel shields. Shields for pipe 4" and smaller shall be 12" long; shields for pipe 5 to 8" shall be 18" long; and shields for larger pipe shall be 24" long.
- M. Roller Supports: Provide Anvil Fig. 171/177 or equal adjustable, cast iron pipe roll supports for support of horizontal piping installed in racks, beam supports, suspended and where shown on the Drawings.
- N. Guides: Install pipe guides complying with the manufacturer's published product literature. Where not otherwise indicated, install pipe guides near expansion loops, expansion joints, and ball joints.
- O. Anchors: Install anchors at the proper locations to prevent stresses from exceeding those permitted by ANSI B31 and to prevent the transfer of loading and stresses to connected equipment. Anchors shall include vibration isolation in accordance with the pipe support system specified. Where the piping system is floating, the anchors shall be termed restraints or braces.
1. Where expansion compensators are indicated, install anchors in accordance with the expansion unit manufacturer's written instructions, to limit movement of piping and forces to the maximums recommended by the manufacturer of each unit.
 2. Where not otherwise indicated, install anchors at the ends of principal pipe runs and at intermediate points in pipe runs between expansion loops and bends. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.
- P. Provisions for Movement:
1. Movement: Install hangers and supports to allow controlled movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate the action of expansion joints, expansion loops, expansion bends, and similar units.
 2. Load Distribution: Install hangers and supports so piping live and dead loading and stresses from movement will not be transmitted to any pipe or connected equipment. Pipe supports shall properly transmit the weight of the pipe and its contents to the building structure, or to independent posts, piers, or foundations.

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3. Pipe Slopes: Install hangers and supports to provide the indicated pipe slopes so maximum pipe deflections allowed by ANSI B31 are not exceeded.
- Q. Spacing: Install hangers and supports in piping systems to remove stress from equipment flanges and rotating equipment. The following table gives maximum hanger spacing for copper and steel lines. Hangers shall be more closely spaced where required by the conditions of the installation in order to prevent sagging, excess load on structure and hangers, undue strain on equipment, noise transmission, etc. A hanger shall be placed within 2' of each elbow or tee with a minimum support of one hanger per joint or fitting and at each rise, drop, and trap. Maximum hanger and support spacing shall be as follows and as specified elsewhere:

Trade Pipe Size	Maximum Spacing
1/2"*	5'
3/4"	6'
1" and 1-1/4"	7'
1-1/2"	9'
2"	10'
2-1/2"	11'
3"	12'
4"	14'
5"	16'
6"	17'
8"	19'
10"	22'
12"	23'
14"	25'
16"	27'
18"	28'

* Includes all sizes of cast iron and nonmetallic piping. Cast iron pipe sections exceeding 5 feet in length can be supported on maximum 10-foot centers provided hangers are installed within 18 inches of each joint and fitting. Provide rolled, galvanized sheet metal pipe shields between nonmetallic pipe hangers as required to prevent any visible nonmetallic pipe sag between hangers.

- R. Sway Bracing: Where hanger lengths for cast iron piping exceed 18 inches, sway bracing shall be provided per CISPI recommendations, to prevent pipe shear.
- S. Leveling: Adjust hangers and supports and place grout as required under supports to bring piping to proper levels and elevations.
- T. Midspan Support: For vertical midspan support of piping 4" and under, use Hubbard Enterprises/Holdrite Stout Brackets TM in conjunction with Hubbard Enterprises/HOLDRITE Stout clamps or two-hole pipe clamps (MSS Type 26).
- U. Vibration Isolation: Refer to Section 230548, "Vibration Isolation", for additional information and support requirements. Pipe hangers made of wood, wire, or sheet iron shall not be permitted.
- V. Riser Supports: Vertical piping shall be secured at sufficiently close intervals to keep the pipe in alignment and carry the weight of the pipe and contents.
1. Cast iron soil pipe shall be supported at the base and at each story level, but in no case at intervals greater than 25'.

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2. Steel pipe shall be supported at the base and at not less than every other story level, but in no case at intervals greater than 30', except that grooved-piping systems shall be supported at each pipe section.
3. Copper tube shall be supported at each story level, but in no case at intervals greater than 25'.
4. Plastic pipe shall be supported at mid-point between floors to prevent movement, but in no case at intervals greater than 10 feet.

W. Tunnel Pipe Racks: All piping in utility tunnels and all stacked piping in pump rooms shall be supported using floor-supported galvanized steel pipe racks. Anchor pads for attaching racks to the tunnel wall, floor and ceiling structure shall be cast in concrete and shall be adequate to properly distribute the rack load. Racks shall be constructed of galvanized channel as manufactured by Unistrut or Superstrut or hot-dip galvanized steel shapes and shall be adjustable for grading of piping.]

X. Finish: All steel and iron hangers on piping including clevis hangers, rods, inserts, clamps, stanchions, brackets, shall be hot dip or electro-galvanized after fabrication for indoor applications and hot dip galvanized after fabrication for exterior applications. Rods shall be electro-galvanized or cadmium plated after threading, for indoor applications and hot dip galvanized after fabrication for outdoor applications. Universal concrete inserts shall be galvanized.

Y. Fire Protection Piping Support: Support fire sprinkler and standpipe piping independently of other piping in accordance with NFPA-approved methods and local codes and standards, using UL-listed and labeled support components. Refer to Division 21 "Fire Suppression" for additional requirements.

Z. Secondary Pipe Positioning and Supports: Makeshift, field devised methods of plumbing pipe support, such as with the use of scrap framing materials, are not allowed. Support and positioning of piping shall be by means of engineered methods that comply with IAPMO PS 42-96. These shall be Hubbard Enterprises/HOLDRITE support system or owner approved equipment.

3.3 MISCELLANEOUS STEEL:

A. All miscellaneous steel members, angles, rods, supports, and similar items specified or required for this project shall be galvanized for indoor use or hot dipped galvanized for exterior use and where exposed to ambient conditions.

3.4 SLEEVES:

A. General: Provide sleeves around all piping passing through masonry, CMU and concrete walls and partitions, suspended slabs, plaster or dry wall ceilings, structural members, other building features and where shown on the drawings. No sleeves shall be installed through any concrete beam or other deep projections without written approval of the Architect/Engineer.

B. Partitions: Sleeves shall be required for piping passing through rated dry wall and plaster partitions. Sleeves shall be set in dry wall mud or plastered in and the pipe passing through the sleeve shall be sealed as outlined in Piping Fire Stops and Seals. Sleeves are not required for piping passing through nonrated dry wall or plaster partitions. Non-isolated piping shall be mudded in and isolated piping shall have the opening mudded to within 1/2" of the pipe and an elastomeric caulk shall be installed in the opening around the pipe or insulation.

C. Plumbing Storm, Waste and Vent: Sleeves shall not be required for storm, waste or vent piping through slabs on grade or for piping passing through precast structure. Where piping passes vertically through precast structures without sleeving, adequate provisions shall be made to prevent water leakage through slabs where applicable.

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- D. Placement: This Contractor shall be responsible for the timely placement of sleeves in construction. If sleeves are not placed during construction, this Contractor shall secure written permission to perform a core drill or cut and patch installation at no cost to the Owner. No piping shall pass through the above obstructions without sleeves, unless noted otherwise.
- E. Sizing: Sleeves shall be one size larger than the pipe passing through the sleeve, except where larger sizes are required for mechanical seals. Where insulated piping passes through construction, sleeves shall be one size larger than the outside diameter of the insulation. All sleeves in floors shall extend 2" above the finished floor. Sleeves through vertical construction shall be minimum 18-gauge galvanized steel. Sleeves through horizontal construction shall be minimum 16-gauge galvanized steel except at pipe riser supports. Sleeves at riser supports for 3" and smaller pipe shall be Schedule 40 galvanized pipe sleeves. Sleeves for riser supports for 4" and larger pipe and for pipe passing through exterior building construction below grade shall be Thunderline Corporation Type WS or an approved equal.
- F. Installation: At no point shall the pipe or its insulation touch the sleeve it passes through. Seal all sleeves which are not in exterior construction below grade or rated construction with an approved non-hardening mastic. Seal sleeves through fire rated construction as specified under "FIRE STOPPING FOR PIPING AND DUCTWORK" and as detailed on the Drawings. Sleeves below grade shall be sealed with segmented annular seal. Refer to the paragraph "PENETRATIONS, FLASHING, AND SEALS" below.
- G. Existing Construction: Sleeves are not required where new openings are core-drilled into existing construction, unless noted otherwise on the Drawings.

3.5 ESCUTCHEON PLATES:

- A. General: Except as otherwise noted, provide chrome-plated brass floor and ceiling escutcheon plates around all pipes, and similar items passing exposed through walls, floors, or ceilings, in any finished spaces except under floor and attic spaces. Plates shall be sized to fit snugly against the outside of the conduit. Plates will not be required for piping where pipe sleeves extend above finished floor. Provide sheet metal trim plates at all penetrations exposed to view of building occupants, unless directed otherwise by the Architect. **[All equipment rooms are classified as finished spaces.]**
- B. Type: Escutcheon plates shall be Dearborn Brass Company, Fig. No. 1149 through 1152.

3.6 EXPOSED PIPING:

- A. General: All exposed piping to plumbing fixtures and connected equipment in finished areas shall be polished chrome plated unless noted otherwise on the drawings. This shall include piping, fittings and valves. Polished chrome plated sleeves may be used over supply, waste and vent piping provided that the finished installation presents the appearance of a fully chrome plated system.

3.7 PIPE CLEANING AND STERILIZATION:

- A. HVAC Piping: All piping shall be cleaned following successful pressure testing of pipe. Piping shall be completely drained following pressure testing and then filled with clear water and pipe cleaning treatment (Mogel C641 or approved equal) to the supplier's recommended concentration required to rid the system of rust, dirt, piping compound, mill scale, oil, grease, and any other foreign material. Do not use in-house pumps during flushing of piping. The system shall then be circulated per the supplier's recommendations. Following cleaning, each system shall be drained, refilled and then continuously filtered or flushed until clean water is obtained. Strainers shall be removed and cleaned after each flushing. Refer to Section 23 2500 "Water Treatment Systems" for water treatment for these systems. After the system has been pressure tested, treated with pipe cleaning treatment and

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rinsed with clear water to remove the cleaning treatment, a 5-micron inline filter may be installed in the system, in lieu of continuous water flushing, to clear the piping of construction debris. Each system being filtered shall be pumped continuously and the filter shall be cleaned once every 24 hours until no visible filtered matter is present in the filter after 24 hours of circulation. After the cleaning process is complete, the filters shall be removed from the system and all strainers shall be cleaned prior to putting the piping system into operation. **[Provide temporary loop piping and fill/drain valves as required to allow building piping to be flushed and circulated until the system is clean, prior to making connections to the [complex] [campus] utility piping system.] [Piping mains shall be cleaned and flushed (or circulated and filtered) with coil and equipment isolation valves closed, until fully clean. When the mains are fully cleaned, then coil and equipment isolating and control valves shall be opened, air shall be removed from coils via air vents, and the system shall be cleaned and flushed (or circulated and filtered), until fully clean. Temporary loop connections shall be provided as required to circulate all main piping with coil and equipment isolation valves closed.]**

- B. Domestic Water Piping: All potable water piping and tanks shall, after successful pressure testing, be thoroughly flushed with clear water and then sterilized. Sterilization shall be with either liquid chlorine or chlorine gas of adequate volume to give a concentration of 50 ppm based upon the volume of the system being treated. A minimum residual chlorine level of 5 ppm shall remain in each system for a minimum of 24 hours. After sterilization, all piping shall be thoroughly flushed. The above are minimum requirements and all sterilization procedures shall be in strict accordance with all local codes and authorities having jurisdiction.

3.8 OPENINGS, CUTTING AND PATCHING:

- A. General: The Contractor shall be responsible for coordinating openings in the building construction for installation of mechanical systems. Coordinate penetrations and place equipment in time to avoid cutting new construction. Comply with the requirements of Division 1 for the cutting and patching of other work to accommodate the installation of mechanical work. Except as individually authorized by the Architect/Engineer, cutting and patching of mechanical work to accommodate the installation of other work is not permitted.
- B. Cut and Patch: Cut and patch walls, floors, and similar items resulting from work in existing construction or by failure to provide proper openings or recesses in new construction.
- C. Methods of Cutting: Openings cut through concrete and masonry shall be made with masonry saws and/or core drills and at such locations acceptable to the Architect/Engineer. Impact-type equipment shall not be used except where specifically acceptable to the Architect/Engineer. Openings in precast concrete slabs for piping and similar items shall be core drilled to exact size.
- D. Approval: If holes or sleeves are not properly installed and cutting and patching becomes necessary, it shall be done at no change in Contract amount. Undertake no cutting or patching without first securing written approval from the Architect/Engineer. Patching shall create a surface which is structurally and aesthetically equal to the surface surrounding the area patched and shall be performed by the trade whose work is involved, at no change in the Contract amount.
- E. Protection: Openings through exterior walls or roofs shall be provided with suitable covers while they are left open to protect the property or materials involved. Any openings through walls below grade shall be properly protected to prevent entrance of water or other damaging elements.
- F. Restoration: All openings shall be restored to "as-new" condition under the appropriate Specification Section for the materials involved, and shall match remaining surrounding materials and/or finishes.

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Restoration work shall be performed by the trades who originally installed the work being restored and shall be performed at no cost to the Owner or Architect/Engineer.

- G. Masonry: Where openings are cut through masonry walls, provide and install lintels or other structural supports to protect the remaining masonry. Adequate supports shall be provided during the cutting operation to prevent any damage to the masonry occasioned by the operation. All structural members, supports, and similar items shall be of the proper size and shape, and shall be installed in a manner acceptable to the Architect/Engineer.
- H. Plaster: All electrical work in areas containing plaster shall be completed prior to the application of the finish plaster coat. Cutting of finish plaster coat will not be permitted.
- I. Special Note: No cutting, boring, or excavating which will weaken the structure shall be undertaken.

3.9 EXCAVATION, TRENCHING AND BACKFILL:

- A. General: The work hereunder includes whatever excavating and backfilling is necessary to install the mechanical work. Coordinate the mechanical work with other work in the same area, including excavating and backfilling, dewatering, floor protection provisions, other temporary facilities, other underground services (existing and new), landscape development, paving, structural foundations, and floor slabs on grade. Coordinate with weather conditions and provide temporary facilities needed for protection and proper performance of excavating and backfilling.
- B. Standards: Except as otherwise indicated, comply with the applicable provisions of Division 2 for mechanical and plumbing work excavating and backfilling. Refer instances of uncertain applicability to the Architect/Engineer for resolution before proceeding with the Work.
- C. The bottoms of trenches shall be excavated to required depths, slope and grade. The bottom of the trench shall be accurately excavated to provide firm, uniform bearing for the bottom of the pipe. Where mud or unstable soil is encountered in bottom of trench, it shall be removed to firm bearing and the trench shall be backfilled with bedding sand to proper grade and tamped to provide uniform firm support.
- D. The bottom of trenches shall be accurately graded to provide proper fall and uniform bearing and support for each section of the pipe on undisturbed soil or 2" of sand fill at every point along its entire length.
- E. Exercise care not to excavate below required depth, leaving a flat bed of undisturbed earth, firm and secure, before laying pipe. In the event rock is encountered, excavate 6" below required depth and backfill to required depth with bedding sand, and compact to minimum 95% compaction.
- F. All grading in the vicinity of excavation shall be controlled to prevent surface ground water from flowing into the excavations. Any water accumulated in the excavations shall be removed by pumping or other acceptable method. During excavation, material suitable for backfilling shall be stacked in an orderly manner a sufficient distance back from edges of trenches to avoid overloading and prevent slides or cave-ins. Material unsuitable for backfilling shall be wasted and removed from the site and properly disposed of.
- G. The Contractor shall be fully responsible for the safety of persons, materials and equipment in or near trenches or other excavations and provide all required sloping, shoring, railings and other protective provisions. The Contractor shall provide a trench shoring plan and design which is sealed by a registered professional engineer. Refer to Divisions 1 and 2 for additional requirements.
- H. If any unknown and/or uncharted utilities are encountered during excavation, promptly notify Architect/Engineer and wait for his instructions before proceeding.

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- I. If such unknown utilities are encountered and work is continued without contacting the Architect/Engineer for instructions, and damage is caused to said utilities, the Contractor shall repair at his own expense, such damage to the satisfaction of the Owner or utility company concerned.
 - J. Trenches shall not be backfilled until all required tests have been made by the Contractor and approved by the Architect/Engineer and any local authorities having jurisdiction.
 - K. Backfill shall be compacted or cement stabilized sand up to 6" above the top of piping. Backfill up to grade shall be in maximum 6" lifts with minimum 95% compaction of lifts. Refer to Division 2 or elsewhere in Contract Documents for additional trenching and backfill requirements.
 - L. Opening and Reclosing Pavement, Landscape Areas, and Lawns: Where excavation requires the opening of existing walks, street, drives, other existing pavement or lawns, such surfaces shall be cut as required to install new piping and to make new connections to existing piping. The sizes of the cut shall be held to a minimum, consistent with the work to be accomplished. After the installation of the new work is completed and the excavation has been backfilled and flooded, the area shall be patched or replaced, using materials to match those cut out or removed. Patches shall thoroughly bond with the original surfaces, shall be level with them, and shall meet all the requirements established by the authorities having jurisdiction over such areas. All removed work shall be replaced by craftsman who regularly install the types of work being replaced.
 - M. Excavation in Vicinity of Trees: All trees including low hanging limbs within the immediate area of construction shall be adequately protected to a height of at least 5' to prevent damage from the construction operations and/or equipment. All excavation within the outermost limb radius of all trees shall be accomplished with extreme care. All roots located within this outermost limb radius shall be brought to the attention of the Architect before they are cut or damaged in any way. The Architect will give immediate instructions for the disposition of same. All stumps and roots encountered in the excavation, which are not within the outermost limb radius of existing trees, shall be cut back to a distance of not less than 18" from the outside of any concrete structure or pipeline. No chips, parts of stumps, or loose rock shall be left in the excavation. Where stumps and roots have been cut out of the excavation, clean compacted dry bank sand shall be backfilled and tamped.
- 3.10 ACCESS DOORS:
- A. General: This Contractor shall provide wall or ceiling access doors for installation in finished surfaces for unrestricted access to all concealed items of mechanical equipment.
 - B. Types: Doors shall be factory-finished as noted below and turned over to the General Contractor for installation, refer to finish painting requirements specified herein below. Doors shall be as manufactured by Inryco/Milcor or an approved substitution in the following styles:
 - 1. Drywall Construction Inryco/Milcor Style DW with gray prime finish.
 - 2. Finished Acoustical Ceiling Tile Inryco/Milcor Style AT with door designed for tile insert.
 - 3. Finished Plaster Ceiling or Walls Inryco/Milcor Style WB-PL with door designed for finish plastering.
 - 4. Masonry Walls Inryco/Milcor Style M with gray prime finish.
 - 5. Fire Rated Construction Inryco/Milcor Fire Rated Access Door with gray prime finish.
 - 6. Fire Rated Ceiling or Ceiling Assembly Inryco/Milcor Style ATR with door designed for tile insert.

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- C. Selection: Access doors shall be furnished with a continuous piano hinge with screwdriver-operated flush locks and shall be a minimum of 12" x 12". Larger sizes shall be furnished where required for proper access.
- D. Approval: Access doors shall not be installed until location and style have been approved by the Architect.

3.11 FIRESTOPPING FOR PIPING AND DUCTWORK:

- A. General: Provide a UL Systems Classified, intumescent material capable of expanding up to eight to ten times when exposed to temperatures beginning at 250°F for sealing all holes or voids created to extend mechanical system piping, ductwork and other components through fire-rated floors and walls and other fire rated construction to prevent the spread of smoke, fire, toxic gas and water. The fire barrier system shall meet the fire test requirements and hose stream test requirements of ASTM E119-73.
- B. Fire barrier products shall be used to create through-penetration fire stop systems as required, with a minimum fire rating equal to the rating of the construction being penetrated. All fire stop systems shall be listed in the Underwriter's Laboratories Building Materials Directory, Through Penetration Firestop Systems (XHEZ).
- C. The products manufactured by 3M/Electrical Products Division or an approved equal are acceptable subject to Shop Drawing submittal approval.
- D. Install fire stop materials according to the following UL Systems Classifications and manufacturer's recommendations:

<u>OPENING TYPE</u>	<u>UL SYSTEM CLASSIFICATION NUMBER</u>
Metal Pipe Through Round Openings	No. 49, No. 95, and No. 147
Insulated Metal Pipe Through Round Openings	No. 91, No. 147, and No. 64C
Metal Pipe Through Large Openings	No. 93
Blank Openings	No. 92, No. 102, and No. 61
Glass Pipe Through Opening	No. 90b
Plastic Pipe Through Opening	No. 64b and No. 148
All Other Firestop Systems	Per manufacturer's recommendations

- E. Provide fire rated insulation blankets around ductwork and piping where shown on Drawings. Blankets shall be one inch (1"), eight-pound density thermo ceramic material, Thermo Ceramics Kas-Wool Fire Master Series thermal blankets or and approved equal. Blankets shall be wrapped to provide continuous coverage and be secured with stainless steel bands in accordance with the manufacturer's UL-listed installation instructions.

3.12 FIRE-RATED PARTITIONS:

- A. Coordinate locations of piping in fire-rated partitions so as not to affect the fire rating of the partition. Notify the Architect/Engineer in writing where additional construction is required to maintain the partition fire rating.

3.13 FLAME SPREAD PROPERTIES OF MATERIALS:

- A. Materials and adhesives incorporated in this project shall conform to NFPA Standard 255 (1984), "Method of Test of Surface Burning Characteristics of Building Materials". The classification shall not exceed a flame spread rating of 25 for all materials, adhesives, finishes, and similar items specified for each system, and shall not exceed a smoke-developed rating of 50.

3.14 PENETRATIONS, FLASHING, AND SEALS:

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- A. Pipe sleeves, pitch pockets, and flashings compatible with the roofing and waterproofing installation shall be provided for all roof and wall penetrations and roof-mounted equipment and supports. Coordinate flashing details with the Architectural details and the roofing/waterproofing Contractors.
- B. Segmented Annular Seals: Seal the openings around piping which penetrate the exterior construction using segmented annular seals to prevent the entry of water and other foreign material. Segmented annular seals shall be Thunderline Corporation Type LS Series link seals or an approved equal. Seals shall be Style C insulating type for standard service at temperatures up to 250°F. Seals shall be Style T high temperature service at temperatures up to 450°F. Sleeves for use with annular seals shall be Thunderline Corporation Type WS or an approved equal.

3.15 CLEANING AND PAINTING OF MECHANICAL WORK:

- A. Prime, protective and touch-up painting is included in the Work of this Division. Finish painting in equipment spaces, concealed locations, and other locations not exposed to the view of building occupants is included in the work of this Division. Finished painting in areas exposed to the view of building occupants is specified under Division 9.
- B. All equipment furnished by the mechanical subcontractor shall be delivered to the job with suitable factory protective finish.
- C. Mechanical equipment with suitable factory-applied finishes shall not be repainted; except for aesthetic reasons where located in finished areas as directed by the Architect and in a color selected by the Architect. Where factory-applied finishes are damaged in transit, storage or installation, or before final acceptance, they shall be restored to factory-fresh condition by competent refinishers using the spray process.
- D. All equipment not finished at the factory shall be given a prime coat and then finish painted with two coats of enamel in a color as directed by the Architect/Engineer. No nameplates on equipment shall be painted, and suitable protection shall be afforded such plates to prevent their being rendered illegible during the painting operations.
- E. All uninsulated black steel piping, hangers, supports, and similar items shall be given two coats of primer. Where exposed to outdoor weather or exposed to view in equipment rooms, uninsulated black steel piping shall be primed and finished with two coats of enamel in colors as directed by the Architect/Engineer.
- F. Concealed fire protection and plumbing piping shall **[not be painted] [be primed, unless insulated.]** Uninsulated plumbing and fire protection piping, where exposed to view in equipment rooms, shall be primed and finished with two coats of enamel in colors as directed by the Architect/Engineer. The fire pumps and all related fire protection piping in **[the fire pump room] [the Central Plant] [and all other mechanical spaces]** shall be primed and finish painted red.
- G. All uninsulated black steel pipe direct buried shall be given two coats of primer and then coated with 3M Scotchwrap Pipe Insulation #50 applied in strict accordance with manufacturer's published recommendations (machine wrapping of pipe is acceptable) prior to burial in the ground.
- H. All insulated piping and equipment in the Central Plant[, **tunnels**] and other mechanical/electrical rooms where exposed to view shall be primed and finish painted with two coats of enamel in colors as directed by the Architect/Engineer or Owner's Representative; and where concealed in furring, chases, or suspended ceilings, piping need not be painted.
- I. All grilles and registers will be furnished with a factory-applied finish. Should the plans indicate that certain grilles and registers be furnished with a factory-applied prime coat for field painting, the cores shall be removed for painting under Division 9. The frames, after installation, shall be given two coats

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of enamel. The cores shall be spray painted with two coats of enamel, and shall be reinstalled in the frames only after both cores and frames are thoroughly dry. In such cases the color of the enamel finish shall be as directed by the Architect/Engineer.

- J. All equipment in the Central Plant, whether insulated or not, shall be field painted with two coats of suitable enamel in a color as directed by the Architect/Engineer.
- K. The surfaces to be finish-painted shall be prepared as follows:
 - 1. Galvanized and black steel surfaces shall be fully cleaned and painted with one coat of galvanized metal primer.
 - 2. Aluminum surfaces shall first be fully cleaned painted with one coat of zinc chromate primer.
 - 3. Cast iron pipe shall first be fully cleaned and painted with a "non-bleed" primer.
 - 4. Insulated surfaces shall be sized and primed using materials recommended by the insulation manufacturers.
- L. All ferrous metal surfaces without a protective finish and not galvanized in exposed and concealed areas including chases, under floor and above ceilings shall be painted with two coats of zinc chromate primer as the construction progresses to protect against deterioration.
- M. No nameplates on equipment shall be painted, and suitable protection shall be afforded to the plates to prevent their being rendered illegible during the painting operation.
- N. Before painting, all surfaces to be painted shall be suitably prepared. This shall include removing all oil, rust, scale, dirt, and other foreign material. Surfaces shall be made smooth by grinding, filing, brushing, or other approved method. In the painting operations, the primer for metal surfaces shall be of the zinc dust type unless specified otherwise, and where finish painting is specified, it shall be painted using materials and colors selected and approved by the Architect/Engineer. Refer to Division 9 for additional requirements.

3.16 MECHANICAL SYSTEM IDENTIFICATION:

A. Identification of Equipment:

- 1. All pieces of major mechanical, plumbing and fire protection equipment shall have a manufacturer's label identifying the manufacturer's address, equipment model and serial numbers, equipment size, and other pertinent data. Care shall be taken not to obliterate this nameplate in any way.
- 2. The Contractor shall make it possible for the personnel operating and maintaining the equipment and systems in this project to readily identify the various pieces of equipment, controls, devices and similar items by marking them. All items of equipment, controls, devices and similar items shall be clearly marked using engraved nameplates as hereinafter specified. The item of equipment shall indicate the same designation as shown on the Drawings, where applicable.
- 3. Equipment nameplates shall be three ply laminated plastic, a minimum of 3/32" thick, black-white-black for equipment on normal power, red-white-red for equipment on emergency power, and blue-white-blue for equipment on UPS power. Letters shall be similar to Roman Gothic of a size that is legible (1/2" minimum for description and 3/8" minimum for supplementary text) and appropriate to the application. Attachment of nameplates shall be by stainless steel screws. Rivets or adhesives are not acceptable. **[Nameplates on equipment installed in finished areas shall be installed as directed by the Architect. Verify location with the Engineer.]**

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- a. Mechanical, Plumbing and Fire Protection equipment to be identified includes: All chillers, cooling tower cells, boilers, pumps, condensate return units, boiler feed units, blowdown separators, converters, heat exchangers, expansion/compression tanks, control air compressors, air handling units, fan coil units, rooftop units, condensing units, filter housings, computer room air conditioning units, CPU chillers, dry coolers, HVAC terminal units, fans, water heaters, tanks, water softeners, air compressors, vacuum pumps, control panels, fire dampers, fire/smoke dampers, motorized automatic dampers, and other major pieces of mechanical equipment.
 - b. Nameplates on powered equipment shall indicate the source feeding equipment and shall indicate variable speed, time delay operation, firefighter's override operation, etc., where applicable.

Example:

AHU 28
Fed from DPA-3
Room 1.102
Two Speed
 - c. Individual controls and pilot lights on controllers and control panels shall have nameplates showing the device function.
 - d. HVAC terminal units shall be identified with a permanently attached engraved name tag, as specified for equipment. In addition, the terminal unit designation shall be clearly marked in 6" high letters on the bottom of the unit using a black felt tipped marker.
- B. Valves [**and Steam Traps**]: Valves [**and steam traps**] shall be marked with 1-1/2" diameter aluminum or engraved plastic tags securely attached to valve stems with "S" hooks.
1. Prepare and install, in a suitable glazed frame, typewritten valve charts giving the number, location and function of each line valve installed under this Contract. Each valve shall be numbered on these charts in accordance with the system of which it is a part of its location. For example, valves in different systems would be designated as follows:
 - a. HPS-1-3 High Pressure Steam - 1st Level - Valve No. 3.
 - b. CHS-2-4 Chilled Water Supply - 2nd Level - Valve No. 4.
 2. Provide and install identification tags lettered and numbered to correspond to the information shown on the charts described above. These tags are to be affixed to only those valves the functions of which are not obvious. For example, it would not be expected that valves at a pressure reducing station in a machine room would be tagged.
 3. Valves at water heaters and steam PRV stations, valves associated with condensate, gas, water meters, and other valves as specified shall also be tagged with standardized color-coded plastic tags. These tags shall be 2-1/2" wide by 1-1/2" high with these color codes: red = normally closed; green = normally open; blue = open in winter, closed in summer; and yellow = closed in winter, open in summer. Tags should be engraved on both sides.
- C. Piping: Piping at major equipment, in all equipment rooms where exposed, where concealed in accessible locations and where concealed behind access doors or panels shall be color coded as to type of use, service and direction of flow in accordance with the latest edition of ANSI A13.1. Markers shall be located at each valve, at entries through walls and on 20'centers on straight runs of pipe. Piping concealed in accessible locations shall be marked on 50'centers on straight runs of pipe

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and at all changes in direction. Labels shall have color coded backgrounds with 1/2" to 2" high lettering, depending on pipe size.

1. Markers shall be located on the two lower quarters of the pipe where view is unobstructed.
 2. Use Seton Setmark Type SNA or Brady snap-on type identification for all piping systems, 3/4" through 6". For piping systems larger than 6", use Seton or Brady strap on markers.
 3. Pipe Markers shall conform to ANSI A 13.1-1981 "Scheme for the Identification of Piping Systems". Arrow markers must have same ANSI background colors as their companion pipe markers, or be incorporated into the pipe identification marker.
 4. Pipe markers, zone identification and arrow markers shall be provided on, but not limited to, piping of the following systems:
 - a. Chilled water supply.
 - b. Chilled water return.
 - c. Condenser water supply.
 - d. Condenser water return.
 - e. Heating hot water supply.
 - f. Heating hot water return.
 - g. Low pressure steam.
 - h. Medium pressure steam.
 - i. High pressure steam.
 - j. Gravity steam condensate.
 - k. Pumped steam condensate.
 - l. Atmospheric relief.
 - m. Instrument air.
 - n. Domestic cold water supply.
 - o. Industrial cold water supply.
 - p. Domestic hot water supply.
 - q. Domestic hot water return.
 - r. Industrial hot water supply.
 - s. Industrial hot water return.
 - t. Domestic chilled drinking water supply.
 - u. Domestic chilled drinking water return.
 - v. Treated water.
 - w. Sanitary sewer/vent.
 - x. Acid waste/vent.
 - y. Roof/storm drain.
 - z. Laboratory air.
 - aa. Laboratory vacuum.
 - bb. Natural gas.
 - cc. Fire protection.
- D. Underground Pipe Identification: Bury a continuous, preprinted, bright colored plastic ribbon cable marker, Brady No. 91600 Series or an approved equal with each underground pipe (or group of pipes). Locate each directly over piping, 6" to 8" below finished grade. Ribbons shall be detectable from above grade using a pipe locator.
- E. Manufacturers: Acceptable manufacturers are Seton Nameplate Corporation, W.H. Brady Company or Westline Company.

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F. Piping Drawings: Provide a schematic diagram of each piping system [**and mechanical room**], showing each valve with its tag designation and location. Laminate diagrams and install under framed polycarbonate at locations as directed by the Owner.

G. Records: Nameplate[, **steam trap**] and valve designation data shall be recorded on record drawings and on itemized listing by equipment types and valve number sequence. Itemized listings shall include designation, device description and device location.

3.17 WARNING SIGNS AND OPERATIONAL TAGS:

A. Warning Signs: Provide warning signs where there is hazardous exposure associated with access to or operation of mechanical facilities. Provide text of sufficient clarity and lettering of sufficient size to convey adequate information at each location; mount permanently in an appropriate and effective location. Comply with recognized industry standards for color and design.

B. Operational Tags: Where needed for proper and adequate information on operation and maintenance of mechanical systems, provide tags of plasticized card stock, either preprinted or hand printed. Tags shall convey the message, example: "DO NOT OPEN THIS SWITCH WHEN BURNER IS OPERATING".

3.18 PROHIBITED MARKINGS:

A. Prohibited Markings: Markings which are intended to identify the manufacturer, vendor, or other source from which the material has been obtained are prohibited for installation within public, tenant, or common areas within the project. Also prohibited are materials or devices which bear evidence that markings or insignias have been removed. Certification, testing (example, Underwriters' Laboratories, Inc.), and approval labels are exceptions to this requirement.

3.19 TAMPER RESISTANT FASTENERS:

A. All exposed fasteners utilized shall be of a tamper resistant design. All fasteners shall be of the same type whenever possible. Coordinate fastener selection with other trades to provide similar fastener types whenever possible. A minimum of three tools for use with each type of tamper resistant fastener shall be furnished to the Owner at the time of substantial completion.

3.20 EQUIPMENT CONNECTIONS:

A. Alignment: All piping connecting to pumps and other equipment shall be installed without strain at the piping connection. The Contractor may be required as directed to remove the bolts in these flanged connections or disconnect piping to demonstrate that piping has been so connected.

B. Connections Different from Those Shown: Where equipment requiring different arrangement or connections from those shown is approved, it shall be the responsibility of the Contractor to install the equipment to operate properly and in harmony with the intent of the Drawings and Specification. When directed by the Architect/Engineer, the Contractor shall submit drawings showing the proposed installation.

C. Equipment Guards: Provide easily removable expanded metal guards for all belts, couplings, exposed fan inlets and outlets and other moving parts of machinery. Provide access holes to motor and fan shafts on all belt drive and variable speed equipment.

D. Supports: The Contractor shall support plumb, rigid and true to line all work and equipment furnished under his division. The Contractor shall study thoroughly all Architectural, Structural, Mechanical and Electrical drawings, shop drawings and catalog data to determine how equipment is to be supported, mounted or suspended, and shall provide all bolts, inserts, pipe stands, brackets and accessories for proper support

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3.21 ROTATING SHAFTS:

- A. General: Shafts for rotating equipment, such as fans, shall be designed, sized, and fabricated so the shaft will not pass through the first critical speed when accelerating from rest to normal operating speed. This provision shall include the effect of the driven equipment, such as fan blades and related appurtenances, that may influence performance.

3.22 BELT AND COUPLING GUARDS:

- A. General: Provide metal belt guards for all belt-driven equipment. Construct guards sufficiently rigid to provide the required protection and be noise free when the equipment is in operation. Provide coupling guards for all flexible couplings. Coupling guards and belt guards may be perforated metal to allow visual inspection. Belt guards shall have openings to allow measurement of pulley rpm without removal of the guard.
- B. Belt Drives: Belt Drives have been selected as accurately as possible under design conditions. Whenever, in the course of balancing a system, it is determined that a drive change is required, the Contractor shall furnish one completed drive change without additional cost to the Owner or Architect/ Engineer. Multiple belt drives shall have matched belt sets.

3.23 BEARINGS:

- A. General: All ball bearings shall be of radial and/or thrust type, and enclosed in a dust and moisture-proof housing. All bearings shall be B-10 minimum life 100,000 hour type selected in accordance with AFBM ratings and arranged for lubrication through Alemite fittings. Bearings shall be standard cataloged items and replacement shall be locally stocked.

3.24 EQUIPMENT HOUSEKEEPING PADS AND ANCHOR BOLTS:

- A. Concrete pads for equipment (housekeeping pads) will be furnished under **[another] [this]** Division. Pads shall be provided **[in the central plant and in other]** in locations where floor mounted equipment is to be installed.
- B. Pads shall be **[nominal 6" high in the central plant and]** nominal 3-1/2" high **[in all other locations]** and shall extend a minimum of 3" beyond all equipment and supports while generally conforming to the shape of the equipment. **[Provide pad heights to match existing pads where located in the same room.]**
- C. Pads shall be minimum 2500 psi (28 day) concrete reinforced with No. 6 - 6" x 6" welded wire mesh. Pad tops and sides shall be hard troweled smooth with a 3/4" bull nose on all external corners. Refer to Division 3 for additional requirements.
- D. Furnish galvanized anchor bolts with layout templates for installation in equipment pads. Bolts shall be of the size and quantity recommended by the manufacturer and where vibration isolators are used, they shall be anchor bolted to the equipment pad.

3.25 MISCELLANEOUS CURBS AND SUPPORTS:

- A. General: Where required, curbs and supports shall be of box section design, heavy gauge galvanized steel construction, continuous mitered and welded corner seams, integral base plate, factory installed wood nailer, and shall be insulated with 1-1/2" thick, rigid fiberglass board insulation. Curbs and supports shall be mounted and flashed according to manufacturer's recommendations. Curbs and supports shall be as manufactured by the Pate Company of the style as outlined below or approved equal.
- B. Utility Fan Curbs: Shall be Style PC-1A, 12" high.

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- C. Duct Curbs: Where ducts are required to penetrate the roof without passing through an equipment curb, Pate Style PC-1A, 12" high curbs shall be used.
- D. Piping Curbs: Where piping penetrates the roof without passing through an equipment curb, Pate Style PCA-1, 12" high curbs shall be used.
- E. Equipment and Piping Supports: Roof mounted equipment and piping routed across the roof shall be supported using Pate Style ES-1A equipment supports with provisions for securing equipment and piping as required. Equipment curbs shall be 12" high. Piping curb height shall be as required to maintain piping slope.

3.26 DEVICE MOUNTING HEIGHTS:

- A. Refer to architectural drawings to determine whether devices occur in wainscot or cabinet spaces and coordinate mounting heights as required by architectural form. For example, mounting heights of devices occurring in a tile or brick wall should be adjusted so that the device will occur entirely within a single course. However, all devices in a given space shall be mounted at the same height.
- B. In general, unless noted otherwise on Architectural or Mechanical Drawings, mounting heights to device center line shall be as follows **[devices occurring in tile walls shall be shifted, slightly, to allow mounting at the best suitable point in a particular tile]**:

1. Wall mounted thermostats/temperature sensors **[45"] [48"] [In general, locate thermostats/sensors 6" from room light switches and at the same vertical centerline height as switches]**
2. Wall mounted air devices As noted on Drawings or as directed by the Architect/Engineer
3. Wall hung lavatories 34" to top of lavatory unless noted otherwise on Drawings
4. Wall hung water closets (Standard rough-in) 17" to top of toilet seat unless noted otherwise on Drawings
5. Wall hung water closet (Handicapped rough-in) 17" to top of toilet seat unless noted otherwise on Drawings. Flush valves shall be mounted with the operating handle to the wide side of the toilet stall and no more than 44" above the finished floor.
6. Wall hung urinals 17" to top of elongated rim on fixture. Flush valve controls shall be a maximum of 44" above the finished floor.

3.27 DEMOLITION AND WORK WITHIN EXISTING BUILDINGS:

- A. The Contractor shall be responsible for loss or damage to the existing facilities caused by him and his workmen, and shall be responsible for repairing or replacing such loss or damage. The Contractor shall send proper notices, make necessary arrangements, and perform other services required for the care, protection and in-service maintenance of all mechanical, plumbing and fire protection services for the new and existing facilities. The Contractor shall erect temporary barricades, with necessary safety devices, as required to protect personnel from injury, removing all such temporary protection upon completion of the work.

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- B. The Contractor shall provide temporary or new services to all existing facilities as required to maintain their proper operation when normal services are disrupted as a result of the work being accomplished under this project.
- C. Where existing construction is removed to provide working and extension access to existing utilities, Contractor shall remove doors, piping, air conditioning ductwork and equipment, and similar items to provide this access and shall reinstall same upon completion of work in the areas affected.
- D. Where partitions, walls, floors, or ceilings of existing construction are indicated to be removed and reinstalled, this Contractor shall remove and reinstall, in locations approved by the Architect, all devices required for the operation of the various systems installed in the existing construction.
- E. Outages of services as required by the new installation will be permitted but only at a time approved by the Owner. The Contractor shall allow the Owner 2 weeks advance notice in order to schedule required outages in accordance with Utilities Department Outage Notification policy.
- F. The time allowed for outages will not be during normal working hours unless otherwise approved by the Owner. All costs of outages, including overtime charges, shall be included in the contract amount.
- G. The Contractor shall modify, remove, and/or relocate all materials and items so indicated on the Drawings or required by the installation of new facilities. All removals and/or dismantling shall be conducted in a manner as to produce maximum salvage. Survey the project with the Owners representative before demolition begins and determine all materials which the Owner specifically chooses to have salvaged. Pre-establish with the Owner locations where salvaged materials are to be stored. Salvage materials shall remain the property of the Owner, and shall be delivered to such destination as directed by the Owner. Materials and/or items scheduled for relocation and which are damaged during dismantling or reassembly operations shall be repaired and restored to good operative condition. The Contractor may, at his discretion and upon the approval of the Owner, substitute new materials and/or items of like design and quality in lieu of materials and/or items to be relocated.
- H. All items which are to be relocated shall be carefully removed in reverse to original assembly or placement and protected until relocated. The Contractor shall clean and repair and provide all new materials, fittings, and appurtenances required to complete the relocations and to restore to good operative order. All relocations shall be performed by workmen skilled in the work and in accordance with standard practice of the trades involved.
- I. When items scheduled for relocation are found to be in damaged condition before work has been started on dismantling, the Contractor shall call the attention of the Owner to such items and receive further instructions before removal. Items damaged in repositioning operations are the Contractor's responsibility and shall be repaired or replaced by the Contractor as approved by the Owner, at no additional cost to the Owner.
- J. Service lines and piping to items to be removed, salvaged, or relocated shall be removed to points indicated on the Drawings, specified, or acceptable to the Owner. Service lines and wiring not scheduled for reuse shall be removed to the points at which reuse is to be continued or service is to remain. Such services shall be sealed, capped, or otherwise tied-off or disconnected in a safe manner acceptable to the Owner. All disconnections or connections into the existing facilities shall be done in such a manner as to result in minimum interruption of services to adjacent occupied areas. Services to existing areas or facilities which must remain in operation during the construction period shall not be interrupted without prior specific approval of the Owner as hereinbefore specified.

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- K. During the construction and remodeling, portions of the project shall remain in service. Construction equipment, materials, tools, extension cords, and similar items shall be arranged so as to present minimum hazard or interruption to the occupants of the building.
- L. Certain work during the demolition and alteration phase of construction may require overtime or nighttime shifts or temporary evacuation of the occupants. Coordinate and schedule all proposed down time with the Owner's Representative at least 72 hours in advance.
- M. Make every effort to minimize damage to the existing building and the Owner's property. Repair, patch, or replace as required any damaged which might occur as a result of work at the site. Care shall be taken to minimize interference with the Owner's activities during construction. Cooperate with the Owner and other trades in scheduling and performance of the work.
- N. Include in the contract price all rerouting of existing ductwork, piping, air devices, fixtures, and similar items and the reconnecting of existing fixtures and devices as necessitated by field conditions to allow the installation of the new systems. Furnish all temporary ductwork and piping, and similar items as required to maintain service for the existing areas with a minimum of interruption.
- O. All existing air devices materials, equipment and appurtenances not included in the remodel or alteration areas are to remain in place and shall remain in service.
- P. Mechanical equipment and building systems equipment, and similar items which are to remain but which are served by piping that is disturbed by the remodeling work, shall be reconnected in such a manner as to leave it in proper operating condition.
- Q. Existing plumbing fixtures, registers, grilles, and diffusers shown to be removed and indicated to be reused, shall be cleaned, repaired and provided with such new accessories as may be needed for the proper installation in their new locations.
- R. Within the remodeled or alteration areas where existing ceilings are being removed and new ceilings are installed, all existing air devices, other ceiling mounted devices and their appurtenances shall be removed and reinstalled into the new ceiling, unless otherwise shown or specified.
- S. Within the remodeled or alteration areas where existing walls are being removed, all existing fixtures, thermostats, other materials and equipment and their appurtenances shall be removed, where required by the remodel work either shown or specified.
- T. Any salvageable equipment as determined by the Owner, shall be delivered to the Owner, and placed in storage at the location of his choice. All other debris shall be removed from the site immediately.
- U. Equipment, piping or other potential hazards to the working occupants of the building shall not be left overnight outside of the designated working or construction areas.
- V. All existing air handling equipment which is shown as being reused shall have coils cleaned and shall be equipped with new filters by this Contractor.
- W. No portion of the fire protection systems shall be turned off, modified or changed in any way without the express knowledge and written permission of the Owners representative.
- X. Refer to Architectural "Demolition" and "Alteration" plans for actual location of walls, ceilings, and similar items being removed and/or remodeled.
- Y. [Drawings do not fully indicate conditions nor existing obstructions or utilities. Visit the site and examine work to be removed and become familiar with conditions affecting work.]
- Z. **[Asbestos removal, if any, is not part of this Contract.]**

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