

## Design and Construction Standards

### Division 22 – Plumbing

#### General

1. In general, follow the guidelines below when designing, specifying and installing plumbing systems. Unless specifically indicated otherwise, these guidelines are not intended to restrict or replace professional judgment.
  - a. For work associated with public utilities or services, coordinate all designs, specifications and construction with the EMU Physical Plant and Health and Safety Department. For reference, other associated entities may include (but are not limited too):
    - i. Water mains: YCUA, City of Ypsilanti, and City of Detroit
    - ii. Sanitary Sewer: City of Ypsilanti and State of Michigan
    - iii. Storm Sewer: City of Ypsilanti & County Drain Commission
    - iv. Steam: EMU Heating Plant
    - v. Gas: DTE Energy
  - b. The University shall generally rely on the expertise of the Design Professional, however when possible, care in pipe sizing shall be used to allow for possible future growth and ease of maintenance. Sanitary and storm sewer lines shall be “oversized” a nominal amount, possibly one pipe size, where cost effective to account for potential of clogs or future added flow.
2. Design the plumbing system to comply with the current applicable State of Michigan Plumbing Code and the Design and Construction Standards. Design shall also meet the provisions of the current edition of the National Fire Codes as published by the National Fire Protection Association (NFPA), unless EMU criteria indicate otherwise. State or local codes will be used if they are more stringent than above requirements, discuss with EMU.
3. Show plumbing work on drawings using a minimum scale of 1/8" = 1'0". Exceptions shall be indicated at a scale of 1/4" = 1'0".
4. Identify rooms on plans with name and number.
5. Investigate and, if feasible, connect new services to existing; otherwise, provide new services.
6. Identify on the plumbing drawings all equipment requiring connections to the plumbing systems by appropriate symbol number.
7. Due to the space requirements of plumbing systems and ductwork, closely coordinate the layout of these systems. Where areas of interference are apparent, prepare cross section of building showing method of installation.
8. Piping over electrical rooms containing main distribution panels or motor control centers shall be avoided where possible. When piping is necessary in these areas, indicate leakage protection on drawings or in specifications.
9. Provide schedules, including capacity, control settings, services and sizes, for Plumbing Fixtures and Water Heaters.

10. Provide diagrams for the following systems installed within the buildings: Soil, waste and vent; reagent grade water; cold water; hot water; hot water return; laboratory gas and vacuum; fuel gas; storm water; compressed air; RO and DI water; all others.
11. Riser diagrams may be shown flat, or in isometric projection. Show story heights, size of all horizontal and vertical piping, fixture numbers being served, and means of connection between fixtures and the stacks and mains. Show each system complete and continuous including, but not limited to, valves, sensors, flow controls and specialties.
12. Provide cleanouts on storm and sanitary lines on building exterior where leaving building.

#### **Section 22 00 06      Criteria Unique to EMU**

1. Plumbing design and plumbing seismic design shall only be indicated on "P-Series" Drawings.
2. Piping shall be shown on the same plan as the fixtures being served.
3. Pipe size shall be indicated on both floor plan and riser diagram.
4. The following shall be indicated on the plumbing drawings:
  - a. Drainage area in square meters (footage) for each roof drain and totals for building at outside building wall.
  - b. Fixture unit count at base of each soil and waste stack and for each sanitary sewer at outside building wall.
  - c. Invert elevations for all sewers at outside building wall.
  - d. Centerline elevation for all pressure systems at outside building wall.
  - e. Floor elevation at each level.
5. Sub-soil drainage is not a plumbing item and shall be indicated on architectural and structural drawings. Plumbing drawings shall show the drain tile connections and indicate all piping and accessories downstream.
6. Investigate if credit can be obtained from the public utility company for water consumed, but not discharged into the sanitary sewerage system. If so, and if adequate pressure is available, provide meters for these uses.
7. Floor drains shall not be installed in individual toilet rooms with water closets unless required by code. Provide in public toilet rooms containing two or more water closets or a combination of one water closet and one urinal

#### **Section 22 00 07      Testing**

1. At each type of service, appropriate testing shall be performed and certified. Minimum requirements shall be as follows:
  - a. All testing shall be performed in compliance with the current applicable Michigan Plumbing Code.
  - b. Domestic Water Supply Piping: Flush and sterilize under the supervision of a qualified consultant. Provide the Physical Plant with written certification of sterility and confirm that the piping system is clean and safe to transmit water for human consumption. The sterilization method to be followed shall be that prescribed by the health authority having jurisdiction or water purveyor

- having jurisdiction, or in the absence of a prescribed method, the procedure as described in the Michigan Building Code, whichever is the more stringent.
- c. Gas Service Piping and Interior Gas Piping: Test with nitrogen for a period of 24 consecutive hours in conformance with the rules and regulations of the local gas supplier. Submit test report.
  - d. A minimum of 48 hours' notice shall be given in writing to the Physical Plant prior to the purging of lines. Purging shall be performed in conformance with recommendations of and under supervision of the local gas supplier. Venting during purging operations shall be to the outside of buildings at a safe location.
  - e. Exterior Storm and Sanitary Sewers: Test according to the requirements of the Washtenaw County Drain Commission, Michigan Plumbing Code, or to the Authority Having Jurisdiction, whichever is the most stringent.

### **Section 22 00 09 Related Work in General Construction**

1. All Plumbing systems shall be coordinated and designed with appropriate routing, clearances, and access space necessary to install and maintain the plumbing system.
2. Group equipment or fixtures where possible to minimize plumbing runs. Provide access panels, or small closets for access to valves, mains and equipment.
3. Design Professional shall coordinate proper supports, transitions, and routings. Sleeves at wall and floor/roof penetrations shall also be appropriately designed and located as part of the design coordination. Provide reinforcing, frames, or supports at penetrations as necessitated by scope. Provide all necessary details on the drawings.
4. At Water Supply Piping installations:
  - a. At exterior or unheated locations, provide a minimum of 60 inches cover over pipe to prevent freezing.
  - b. Provide concrete anchors and steel yokes on all fittings with over 1/16 bend.
  - c. A 2-foot-wide by 1-foot-thick reinforced concrete bridge beam shall be keyed into the foundation wall immediately under any water service line to the building. This beam will be carried out from the building wall to firm support beyond the excavation for the building wall.
5. At Gas Piping Installations:
  - a. Specify that no backfill operations be performed until piping installation has been tested and approved.
    - i. Use only clean sand, free of rubble and rocks.
    - ii. Installation of Backfill: Deposit sand to a depth of 6 inches above and below piping. Caution the contractor to exercise care to prevent breaking of wires and displacement of anodes. Remainder of backfill shall be made with clean excavated material free of rubble, rocks, bricks, wood or debris placed and compacted in accordance with requirements stated in these guides. Grits are prohibited.
6. Cleaning, Painting, and Labeling:
  - a. Cleaning of fixtures and equipment shall be included in the Plumbing Contract.

- b. Painting may be a divided responsibility of the General Contractor and the Plumbing Contractor. The Professional shall coordinate the specifications to clearly indicate each contractor's responsibilities in order to avoid double costs for identical work or total omission of the work. Refer to Division 9 for Painting standards.
- c. All pipe mains shall be labeled with appropriate stickers denoting the directional arrow of flow, and materials within the pipe. These stickers shall be placed at regular intervals, major crossings, and at penetrations through perimeters of rooms. Verify labeling method with the Owner prior to installation. Labels shall be located every 50 feet, piping change of direction and at partition penetrations.

### **Section 22 05 00 Common Work Results for Plumbing**

1. General Requirements:
  - a. Piping intended to be exposed or in equipment rooms and service areas shall be at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
  - b. Piping and valves above accessible ceilings shall have adequate space for removal of ceiling panels.
  - c. Piping shall have adequate clearances for installation of insulation.
  - d. Isolate piping from building construction to prevent transmission of vibration to the structure and to eliminate noise.
  - e. Eccentric reducing couplings shall be provided in all cases where air or water pockets would otherwise occur due to a reduction in pipe size. Eccentric couplings shall make the pipe flush on the top of water lines.
2. Meters, Gauges and Thermometers:
  - a. Meters:
    - i. Permanent utility services to each building require permanent metering.
    - ii. Water supply metering shall: Conform to requirements of the utility system providing the water, read in cubic feet, permit connection of a remote readout register, and be flanged and valved to permit convenient replacement of metering.
    - iii. Gas supply metering shall: Conform to requirements of the utility system providing the gas, be located in a boiler room or outside of the building, and be valved to permit convenient replacement of metering. Venting pipes shall be vented to outside of the building.
  - b. Gauges:
    - i. Gauges shall be 4-1/2 inches in diameter liquid filled type with recalibration adjustment in the dial face and with gate valve shut-off. Tailor the range to the application. Gauges shall not be positioned over 6 feet above the floor; install remote sensing gauges as required to conform to this restriction. Digital gauges are also acceptable.

- ii. Water supply: Locate a pressure gauge at the water service entrance and elsewhere as needed to properly identify pressure within the piping system.
  - iii. Domestic hot water: Locate pressure gauges on suction and discharge sides of pumps and elsewhere as needed to properly identify pressure within the piping system. When hot water is supplied by the power plant, provide gauges on both supply and return.
  - iv. Gas service: Locate pressure gauges at the service entrance and upstream and downstream of pressure reducing valves.
  - v. Other piped systems: Locate vacuum or pressure gauges as required to properly identify pressure within each system. Provide pressure gauges at entrance and exit locations for steam supply, condensate return, hot water supply and hot water return.
- c. Thermometers:
- i. Thermometers shall be mercury-free, red-reading-in-glass type with 9-inch magnified column, Fahrenheit scale, recalibration feature, and adjustable head. Tailor the range to the application. Installation shall be in brass or stainless steel pressure tight separable well with heat transfer paste. Thermometers shall not be positioned over 6-feet above the floor; install remote head type of thermometers as required to conform to this restriction.
  - ii. Piped systems and storage tanks: Locate thermometers as required on all systems or tanks where temperature should be identifiable for operation and maintenance. Provide at building entrance and exit locations for steam supply, condensate return, hot water supply and hot water return.
- d. Valves:
- i. Proprietary specifications: All valve-types (e.g. flush valves, ball valves, balance valves, etc.) provided for a single project shall be products of a single manufacturer. Specify three (3) proven equal manufacturers for the contractor to select from.
  - ii. Valve tags: Specify that each valve in each piping system be tagged with a brass or aluminum tag numbered consecutively for each system and attached to the valve with a brass or aluminum chain. Valve tags shall have stamped abbreviations of the system in addition to the valve number.
  - iii. Valve chart: The Associate shall determine the location for installation of a valve chart and shall specify that a typewritten directory of all valve numbers (by system, describing location) be furnished, framed under glass, and installed in the equipment room where indicated. A copy of the valve directory shall be bound in a hard fiber binder and delivered to the Associate for forwarding to the Physical Plant's Office.
  - iv. Design requirements:

1. Shut-off valves shall be provided on all branches off main water lines. Branches shall be provided with drain valves to facilitate drainage of branches.
  2. Fixture Stops: Each fixture and piece of equipment shall be provided with a fixture stop. Groups of fixtures shall be valved separately. Stops for flush valves shall be all brass with brass or stainless steel stem, packing nut and screwdriver stops with protective caps; all other shall be handwheel stops. Quarter turn valves are not permitted.
  3. Unions and Fittings: A union or bolted flange fitting shall be provided downstream of, and within approximately 12 in. of each valve, and adjacent to both inlet and outlet of pumps and other equipment.
  4. Flush Valves: Expose for easier maintenance.
- e. Gate Valves:
- i. 2-1/2 inches and smaller, brass or bronze body, trim and stem, solid wedge, rising stem, union bonnet, 125 pounds screwed ends.
  - ii. 3 inches and larger, iron body, bronze trimmed, O.S. & Y. 125 or 250 pounds flanged as project requires.
- f. Valve Boxes:
- i. Valve boxes shall be furnished on all valves of water service piping. Boxes shall be extended to final grade or pavement. The word "WATER" shall be cast in the cover.
  - ii. A 3 inches galvanized steel pipe shall be installed in each valve box to prevent misalignment.
  - iii. Liners shall be removed as the last item of work at the installation.
- g. Gas Cocks:
- i. 1-1/2 inches and smaller, screwed, all brass 150 lb. WOG.
  - ii. 2 inches and larger, lubricated types, 175 pounds WOG.
  - iii. Valves shall be labeled as required to be compliant with all requirements of the International Fuel Gas Code (IFGC), as referenced within the Michigan Building Code.
- h. Globe and Angle Valves:
- i. 2-1/2 inches and smaller, brass or bronze body, trim and stem, union bonnet, 125 pounds screwed ends.
  - ii. 3 inches and larger, iron body, bronze trimmed, 125 pounds flanged.
- i. Check Valves:
- i. 2-1/2 inches and smaller, swing check type, brass or bronze, renewable, disc, 125 pounds screwed ends.
  - ii. 3 inches and larger, swing check type, iron body, bronze trimmed, bolted cap, 125 pounds flanged ends.
  - iii. Spring loaded check valves, flanged silent center guide, 250 lb. semi-steel body, bronze stem, 1/16 inch raised face.
  - iv. Provide unions adjacent to all screwed joint unions.

- j. Ball Valves:
  - i. 2 inch and smaller, two or three-piece bronze body, screwed ends, chrome plated brass or stainless steel ball, steel stem, reinforced TFE packing and seat ring with appropriate pressure and temperature rating for specific application.
- k. Butterfly Valves:
  - i. 2 inch and larger, ductile iron disc and body, extended neck, geometric drive, molded-in seat liner, stainless steel stem, EPDM or Viton liner and seat, 125 pounds. Lug or wafer style.
- l. Backflow Prevention Devices:
  - i. As required and specified per Michigan Building Code, Michigan Plumbing Code and all referenced ASSE standards. Provide 3/4-inch minimum size drain line to floor drain. Units must be removable and accessible for maintenance. Code-approved air gaps are recommended and pumping units with code-approved air gaps are also recommended. Where air gaps and vacuum breakers are not acceptable, products of the following manufacturers of backflow prevention devices are approved.
  - ii. Where possible, backflow prevention devices for lawn irrigation shall be located indoors.
  - iii. All coffee makers and carbonated beverage systems shall be provided with backflow prevention devices.
  - iv. Fire protection systems shall be provided with approved double check valve assembly. High hazard systems, i.e. fire protection system with antifreeze added, shall be provided with a reduced pressure backflow prevention device.
  - v. Size in Inches Model Manufacturer:
    - 1. 1/2-inch thru 2-inch: Watts Regulator Co. PVB #800 and #900.
    - 2. 1/2-inch thru 8-inch: Watts Regulator Co. 909QT, 909OSY, 009QT and 007QT.
    - 3. 4-inch thru 8-inch: Watts Regulator Co. 757DCDA.

### **Section 22 05 48 Vibration and Seismic Controls for Plumbing Piping and Equipment**

- 1. General:
  - a. Earthquake-resistive design shall comply with the requirements of all applicable codes and standards.
  - b. Plumbing equipment and piping shall be braced in accordance with the most current edition of Seismic Restraint Manual Guidelines for Mechanical Systems (SMACNA) and National Uniform Seismic Installation Guidelines (NUSIG).
- 2. Design Requirements: Specify sound emission and transmission controls as required to meet standards indicated in the Table entitled, "Ranges of Design Limits for Sound Control" to meet Federal standards.

3. Water Supply Piping: Shock absorbers shall be provided in accordance with the Plumbing and Drainage Institute Standard PDI-WH201. Shock absorbers shall have stainless steel air chamber and brass, bronze, or stainless steel body with valves.
4. Compressed Air Systems: Vibration isolators or inertia pads shall be provided under air compressors. Flexible connectors shall be provided on discharge line of compressor.
5. Domestic Hot Water Systems: Branch connections to hot water risers shall be designed with adequate provision for movement.
6. Vacuum Pumps: Shock absorbers shall be provided similar to those for Water Supply Piping.

### **Section 22 06 00 Schedules for Plumbing**

1. During the course of Design Development, and as part of the documents for review by the University, the Professional shall prepare a preliminary schedule of fixtures. Provide copies of all cut sheets for review. Final schedules and cut sheet / manufacturers information shall be provided to the Owner with the completion of Construction Documents.

### **Section 22 07 00 Plumbing Insulation**

1. Plumbing Equipment Insulation:
  - a. STORAGE TANK INSULATION: Insulation for hot water and cold water storage tanks shall comply with Federal Specifications HH-I-530A.
    - i. For domestic hot water storage tanks: Recommended thickness 2 inch, density 6 pounds/cubic foot, compressive strength 300 psi at 10% deformation, thermal conductivity .32 Btu/(hour) (square foot) (F degrees/inch) at 175 degrees mean temperature.
    - ii. For cold water tanks: Recommended thickness 2 inch, density 9 pound/cubic foot, compressive strength 530 psi at 10 percent deformation.
  - b. FLUE INSULATION: Domestic hot water heater flues shall be insulated when required for safety or for reducing heat transfer.
  - c. PIPING INSULATION: Fibrous glass, or equal mineral fiber, molded sectional type covering. Asbestos is expressly prohibited and water-soluble treatment of insulation jacket to impede or retard flame or smoke is also prohibited. Insulation thickness and R-value shall be as required by the Michigan Energy Code.
    - i. Concealed locations: Insulation for cold water piping shall be provided with a factory-applied fire retardant vapor barrier jacket with self-sealing lap; insulation for domestic hot water piping shall be provided without vapor barrier.
    - ii. Exposed locations: Insulation for both cold and hot water piping in exposed locations shall be of 7-pound density and jacket shall have pre-sized glass cloth.
    - iii. Barrier Free / ADA required locations: At restrooms or similar areas where piping is exposed, provide protective insulation



- meeting the requirements of ADA and Michigan Barrier Free. Finished surface shall be presentable for public viewing.
- iv. Insulation for interior downspout piping, roof drain sumps, water cooler wastes, and chilled water wastes shall be of 7-pound density, with or without jacket as required for the location.
  - v. Thicknesses:
    1. Insulation on cold water piping, interior downspout piping, roof drain sumps, water cooler wastes, and chilled water wastes shall be at least ½ inch thick. Insulation on piping 3 inch and larger shall be at least ¾ inch thick.
    2. Insulation on domestic hot water lines 2 inch and smaller shall be 1 inch thick. Insulation on piping 2 ½ inch and larger shall be 1 ½ inch thick.
    3. Installations: Insulation shall be installed over hangers and supports and shall be carried continuous through all sleeves. In addition to the following requirements, specify any other insulation required. All of the following piping shall be insulated:
      - a. Cold Water Lines.
      - b. Domestic hot water lines, including recirculating lines and storage lines.
      - c. Horizontal runs from roof drains and horizontal downspouts, inside buildings.
      - d. Roof drain sumps, inside buildings.
      - e. Exposed horizontal waste lines from water coolers and lines carrying chilled water waste.

### **Section 22 10 00 Plumbing Piping**

1. Pipe and Pipe Fittings
  - a. Prohibited Installations:
    - i. Water, sewer, drain, steam, condensate and gas lines shall not be designed for installation over electrical switchgear and transformers, or in elevator or electrical equipment rooms and shafts. This is not intended to prohibit sprinklers in electrical equipment rooms.
    - ii. Bullhead connections in any piping service are expressly prohibited except air, gas or cold water lines.
    - iii. Glass waste piping under slabs or underground is prohibited.
  - b. Steel Pipe: A120/A53 is acceptable in lieu of either A120 or A53 Type F, provided that all of the other restrictions governing the use of either grade are followed. If the dual graded pipe is to be used in place of A53, Type F, the vendor will provide mill certification signed by the manufacturer's chief metallurgist. Said certification shall conform to the ASTM A-53 requirements for chemistry, tensile, bending/flattening, and hydrostatic

testing. It is strongly recommended that, if dual graded pipe is specified, that it be specified as domestically produced so that the University has recourse in event of nonspecification compliance.

- c. **Underground Water Pipe**
  - i. **Underground Water Pipe (Exterior)** underground water distribution system shall be designed to the City of Ypsilanti Construction and Material Specifications, most current version.
  - ii. Sizes 4 inch and under -- hard drawn type K copper tubing with minimum number of cast bronze or wrought copper class 150 lb. socket solder fittings.
  - iii. Sizes 5 inch through 20 inch (4 inch optional) ductile iron, manufactured and labeled as AWWA C151; AWWA C115 from the factory and labeled with the words, "DUCTILE IRON". Pipe shall be furnished with a thin bituminous-coated cement lining and with an outside coating of bitumastic enamel, or approved equal. Physical properties and wall thicknesses shall be:
    - 1. Tensile strength 50,000 psi minimum
    - 2. Yield strength 42,000 psi minimum
    - 3. Elongation in 2 inch 10% minimum
    - 4. Hardness Rockwell B-90 maximum
  - iv. **Nominal Size Class Wall Thickness**
    - 1. 4 inch 53 0.32 inch
    - 2. 8 inch 53 0.36 inch
    - 3. 12 inch 54 0.43 inch
    - 4. 20 inch 54 0.48 inch
  - v. Pipe shall have slip ring joints and fittings shall be Class 250 grey cast iron with mechanical joints.
- d. **Interior Cold Water and Domestic Hot Water Piping:** Connections to valves or equipment shall be flanged. Branch off with valves to isolate areas of the building so that the entire water supply does not have to be shut off during repairs.
  - i. All piping shall be hard drawn type L copper tubing, with cast bronze or wrought copper class 150 lb., socket solder fittings.
- e. **Drip Lines:** Type L copper tubing with copper fittings.
- f. **Special Piping**
  - i. **Distilled water:** Schedule 80 CPVC, "Orion White Line" or Enfield "Purity Sustained" polypropylene plastic or tin-lined copper pipe with appropriate fittings may be used. If plastic is used, quality control of joint fusing is critical to performance.
  - ii. **Compressed air piping:** Seamless hard-copper tubing, type L or K, with cast bronze or wrought copper class 150 lb. socket solder fittings, or Schedule 40 A120/A53 or ASTM A120 galvanized steel pipe with screwed galvanized fittings, class 150 lb.

- iii. Other: Pipe and fittings for acid distribution, alkaline distribution, process piping, lubricating oil, high pressure, unusual gases, etc. shall be individually reviewed with the Physical Plant.
- iv. Medical Gas piping: Medical gas designs, materials, and installations shall be compliant per Michigan Building Code, Michigan Plumbing Code, and NFPA 99C, ASME B31.1, NFPA 50, and NFPA 51.
- g. Gas Piping:
  - i. Conformance: Comply with requirements of the gas utility company that will supply gas to be used at the site.
  - ii. Underground piping
    - 1. Steel Pipe, if used, shall be Schedule 40, A120/A53, ASTM A-120, Type F, or ASTM A-53, Type F if 4 inch NPS or smaller. If 5 inch NPS or larger, steel pipe shall be ASTM A53, Type E, Grade B, Schedule 40. All pipes shall be black steel with factory applied plastic coating or factory applied tar and paper wrapper. Joints shall be welded and wrapped with asphaltum type tape. Use backing rings for welding 8-inch and larger pipe. Provide isolation fittings and cathodic protection for each underground piping system.
  - iii. Interior piping shall be Schedule 40, A120/A53, ASTM A-120, Type F, or ASTM A53, Type F, Grade B black steel pipe. Joints in 1-1/2 inch and smaller pipe may be screwed. Fittings, class 150 lb. banded, malleable iron, black. Use of bushings is prohibited. Weld joints in pipe 2 inch and larger. Use backing rings for welding 8 inch and larger pipe.
- h. Piping for Soil, Waste, And Storm Drains
  - i. Exterior storm sewers: (Minimal pipe size shall be 8" for all piping that is not a roof leader) Acceptable materials are type PSM PVC pipe for 4 inch and 6 inch diameters conforming to ASTM D-3034, extra strength ASTM C700 vitrified clay pipe for 4 inch and larger diameters, and reinforced concrete pipe (ASTM C-76 deleting Sections 3.1.2 and 11. regarding design, concrete compression testing and production core and cylinder tests) for 6 inch and larger diameters, and corrugated polyethylene N-12 pipe conforming to ASTM-F405 and AASHSTO M252 for pipe 4" to 36" in diameter.
    - 1. For clay pipe, joints shall conform to ASTM C-425 Compression Joints for Vitrified Clay Bell and Spigot Pipe. For concrete pipe, joints shall conform to ASTM C-443 Type A Rubber Gasket. Also see 22 20 07 (15453).
  - ii. Exterior sanitary sewers: Acceptable materials are type PSM PVC pipe for 4 inch diameters conforming to ASTM D-3034, extra strength vitrified clay pipe for 4 inch and larger diameters and

- service weight cast iron pipe for 4 inch and larger diameters, and PVC SDR-26 pipe for 6" and larger diameters.
- iii. Interior vents, soil, waste and storm drains, except underground: Extra-heavy or service weight centrifugally cast iron soil pipe with lead, rubber gasket or "no hub" joints may be used for 1-1/2-inch diameter and larger pipe. When rubber gaskets are used, specify "Dual-Tight" or "Ty-Seal" with lubricant equal to "Lubrifest". Schedule 40 ASTM A120, type F, galvanized steel pipe, with galvanized cast iron drainage type fittings may be used for 2-1/2-inch diameter and smaller. Type L copper tubing and copper drainage fittings for waste and type M copper tubing for vents may be used for 4-inch diameter and smaller. Provide structural support for large pipe and lateral restraint for all kinetic forces. PVC piping for interior vents, soil, waste and storm drains including using as sleeves shall be prohibited.
  - iv. Interior underground vent, soil, waste and storm drains: Extra-heavy weight centrifugally cast iron soil pipe with lead, rubber gasket or "no hub" joints may be used. When rubber gaskets are used, specify "Dual-Tight" or "Ty-Seal" with lubricant equal to "Lubrifest". Type K copper tubing and copper drainage fittings may be used for 3-inch diameter and smaller.
- i. Copper Connections: Solder joints for copper water lines should be made with no-lead solder in order to minimize the exposure to lead; water coolers must be lead-free.
    - i. Copper solder joints: Copper piping less than 2 inch may be soldered using 95/5 tin/antimony solder. Copper piping 2 inch and larger shall use a 6 percent silver alloy with a 1000°F solidus minimum and comparable to J.W. Harris Co., Dynaflow.
    - ii. Connections between copper and steel piping: Those carrying water shall be made with an approved type dielectric union. Specify that all dielectric unions used have the highest temperature rating. Where it is practical use a dielectric nipple on the equipment.
    - iii. "Pro-Press" fittings are also acceptable.
      - 1. "Pro-Press" fittings shall not be used for gravity drain lines.

## **Section 22 11 00 Facility Water Distribution**

- 1. Water Distribution System
  - a. Sterilization: Specify that new and reworked domestic water piping be sterilized by a firm regularly engaged in the performance of pipe sterilization.
  - b. Unions shall be provided at the following locations:
    - i. Adjacent to and downstream from all valves.
    - ii. At final connections to all items of equipment.
    - iii. At connections to all plumbing fixtures.

- iv. Unions or flanged connections - where required for construction or assembling purposes.
  - c. Water service lines shall not be caulked and leaded into a building wall; tar, rubber, or some other soft material shall be used. Special wall sleeve fittings with soft rubber seals are approved. A swing joint shall be provided on water lines just inside the building, to compensate for pipe movement. Specify that threading of cast iron or ductile iron pipe is prohibited.
  - d. In buildings containing laboratories, water lines to drinking fountains shall be run on separate risers connected to the mains ahead of laboratory equipment lines. Vacuum breakers shall be provided at all laboratory equipment and laboratory water lines.
  - e. Check Valves shall be provided on showers, soap dispensers in custodial closets, automatic washers, and other items or equipment equipped with cold and hot water mixers.
  - f. Provide necessary water hammer arrestors in accordance with ASSE 1010 for sealed wall installations without an access panel. Size and locate arrestors per Plumbing Drainage Institute (PDI) requirements.
  - g. Provide frost proof wall hydrants a maximum of 200 feet apart, at loading docks and at building entrances, with a minimum of one wall hydrant on each exterior wall.
  - h. Maintain a minimum pressure of 35 psi at the plumbing fixtures on top floor.
  - i. Coordinate electrical supply to electronic faucets and flush valves.
  - j. Vacuum breakers and check valves shall be located in non-accessible locations.
2. Domestic Hot Water
- a. Design of Systems
    - i. Domestic hot water systems shall be designed to reasonably assure an expeditious flow of hot water at ALL outlets. When the facility is large (i.e., multistory laboratory building) or the system is large to support heavy flow (i.e., gymnasium showers) with central domestic water heating, the design shall include recirculating line(s) and pump(s). When the total facility requirements are minimal and compact (i.e., fixture count of a small residence), or in the case of an isolated and remote minimal requirement in a large facility, the economics of space requirements and recirculating system must be calculated. An independent residential size water heater, backed up to the fixture(s) location, without recirculating system may be most appropriate. As a rough guide, domestic hot water systems shall dispense hot water after a flow of not over 1-1/2 quarts or within 10 seconds.
    - ii. A Recirculating Line shall be provided for all mains. Except for short runouts, lines shall be a minimum of 3/4 inch for large facilities.

- iii. Maximum Fouling Factor shall be used in sizing domestic hot water heaters. Factory assembled units are recommended; installation should be by the manufacturer or his approved representative.
  - iv. Shielding shall be specified around the packing areas of all circulating pumps.
3. Domestic Water Booster System
- a. Option 1: Use a three pump system. Size one pump for approximately one-third of the total water demand. Each of the other pumps shall be sized for approximately two-thirds of the total demand. The smaller will operate until water demand exceeds the pump's capacity, at which point it will stop and one of the other larger pumps shall start. When the demand exceeds the capacity of this larger pump, the smaller pump will restart and both pumps will operate together. The other large pump will be a standby and alternate with the first large pump. Provide a pneumatic tank and "NO-FLOW" shut-down controls. Provide emergency power. Pumps shall be bronze fitted.
  - b. Option 2: Use a two pump system. Size each pump for 75 percent of the total water demand. Pumps shall alternate. When the demand exceeds the capacity of one pump, both pumps shall operate. Provide a pneumatic tank and "NO-FLOW" shut-down controls. Provide emergency power. Pumps shall be bronze fitted.

## **Section 22 13 00 Facility Sanitary Sewerage**

1. Soil and Waste Systems
- a. General Provisions:
    - i. Applicable Specifications and Codes: Sanitary sewers external to a building shall conform with the City of Ypsilanti or State of Michigan, and to local building codes. When the City of Ypsilanti or Michigan specifications and the code differ, the more demanding requirements shall govern.
  - b. Design of Systems:
    - i. Cleanouts shall be provided on all downspouts before they enter the ground.
    - ii. Floor Drains: In general, floor drains shall be provided in toilet rooms and in equipment and fan rooms. These drains shall not be placed in ducts or plenums, or places of negative air pressure. (This is to avoid drying traps and pulling sewer gas into the air system.) Floor drains with sediment bucket shall be provided in trash rooms serving kitchens. In emergency shower and eyewash areas, floor drains must be discussed with the Physical Plant. Trap primers shall be provided on traps prone to drying out or required by code.
    - iii. Equipment Drains: Specify extra deep traps in locations subject to high pressure or vacuum such as fan housing, etc., to avoid loss of trap seal.

- iv. Drip Lines from pumps, automatic traps, automatic air vents and from equipment shall be located to discharge over adjacent floor drains. Drip lines from pumps shall be connected to stuffing box drip points, not at drip base of pump. A separate drip line from drip base to over adjacent floor drain shall be provided.
  - v. Flashing shall be provided for each vent. Flashing shall not be less than 4 lb. sheet lead and shall extend up and turn down inside top of vent. Specifications shall call attention to the requirement for coordination with the installation of roofing.
  - vi. The Manufacturer's Detailed Instructions for the installation of acid waste and vent lines shall be included in the final specifications submittal.
  - vii. Acid Neutralizing Sumps: Provide as required. Locate sumps for servicing ease.
  - viii. Glass waste piping under slabs or underground is prohibited.
2. Valve Installation
- a. General valve installation requirements are specified in Division 22 Section 22 05 23 "General-Duty Valves for Plumbing Piping."
  - b. Backwater Valves: Install backwater valves in piping subject to sewage backflow.
    - i. Horizontal Piping: Horizontal backwater valves. Use normally closed type, unless otherwise indicated.
    - ii. Floor Drains: Drain outlet backwater valves, unless drain has integral backwater valve.
    - iii. Install backwater valves in accessible locations.
    - iv. Backwater valve are specified in Division 22 Section "Sanitary Waste Piping Specialties."
3. Piping Schedule
- a. PVC schedule 40 DWV may be used in lieu of cast iron for piping above grade in alteration projects only if approved by EMU FPC. Use cast iron in major/new constructions and in all kitchen drainage.
  - b. Aboveground, soil and waste piping shall be any of the following:
    - i. Hubless cast-iron soil pipe and fittings; heavy-duty shielded, stainless-steel couplings; and hubless-coupling joints.
    - ii. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
  - c. Aboveground, vent piping shall be any of the following:
    - i. Hubless cast-iron soil pipe and fittings; heavy-duty shielded, stainless-steel couplings; and hubless-coupling joints.
    - ii. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
  - d. Underground, soil, waste, and vent piping shall be of the following:
    - i. Hubless cast-iron soil pipe and fittings; heavy-duty shielded, stainless-steel couplings; and hubless-coupling joints.
4. Backwater Valves
- a. Horizontal, Cast-Iron Backwater Valves:

- b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - i. Josam Company; Josam Div.
    - ii. MIFAB, Inc.
    - iii. Smith, Jay R. Mfr. Co.; Division of Smith Industries, Inc.
    - iv. Tyler Pipe; Wade Div.
    - v. Watts Drainage Products Inc.
    - vi. Zurn Plumbing Products Group; Specification Drainage Operation.
5. Cleanouts
- a. Cast-Iron Floor Cleanouts:
    - i. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - 1. Josam Company; Josam Div.
      - 2. Sioux Chief Manufacturing Company, Inc.
      - 3. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
      - 4. Tyler Pipe; Wade Div.
      - 5. Watts Drainage Products Inc.
      - 6. Zurn Plumbing Products Group; Specification Drainage Operation.
  - b. Cast-Iron Wall Cleanouts:
    - i. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - 1. Josam Company; Josam Div.
      - 2. MIFAB, Inc.
      - 3. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
      - 4. Tyler Pipe; Wade Div.
      - 5. Watts Drainage Products Inc.
      - 6. Zurn Plumbing Products Group; Specification Drainage Operation.
6. Floor Drains
- a. General Floor Drain:
    - i. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - 1. Josam Company; Josam Div.
      - 2. MIFAB, Inc.
      - 3. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
      - 4. Tyler Pipe; Wade Div.
      - 5. Watts Drainage Products Inc.
      - 6. Zurn Plumbing Products Group; Specification Drainage Operation.
  - b. Shower/Toilet Floor Drains:
    - i. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - 1. Josam Company; Josam Div.
      - 2. MIFAB, Inc.
      - 3. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
      - 4. Tyler Pipe; Wade Div.
      - 5. Watts Drainage Products Inc.



## 6. Zurn Plumbing Products Group; Specification Drainage Operation.

**Section 22 14 00 Facility Storm Drainage**

1. Roof Drainage:
  - a. Coordination: Location and depth of drains shall be carefully coordinated to assure adequate pitch of the drainage area to drain.
  - b. Drains: Roof drains shall be cast iron with removable combined beehive strainer and sediment cup. Roof drains for multistory building or one-story buildings equivalent to at least two stories in height shall be provided with integral expansion joint.
  - c. Flashing: Drains shall be installed with lead sheet weighing not less than 6 pounds per square foot extending a minimum of 12 inches in all directions outward from the clamping ring. Lead flashing shall be placed below the roof insulation, and insulation shall be tapered down to the drain. Specifications shall call attention to the requirement for coordination with the installation of roofing.
2. Area Drainage:
  - a. Open Area Drains: Where drains are subject to clogging with leaves, select drains which will avoid pooling of water.
  - b. Areaway Drains: In areaways, at landings at the foot of exterior stairways, and similar locations, provide angular strainers at the wall and floor intersection, so vertical face acts as an overflow when the horizontal portion of the grating is obstructed.
  - c. Wheelchair Ramps: Where drainage is required at the base of wheelchair ramps, trench drains shall be used with slotted grating designed not to create a hazard to wheelchairs.

**Section 22 20 00 Plumbing Systems**

1. Water Distribution System
  - a. Sterilization: Specify that new and reworked domestic water piping be sterilized by a firm regularly engaged in the performance of pipe sterilization.
  - b. Unions shall be provided at the following locations:
    - i. Adjacent to and downstream from all valves.
    - ii. At final connections to all items of equipment.
    - iii. At connections to all plumbing fixtures.
    - iv. Unions or flanged connections - where required for construction or assembling purposes.
  - c. Water service lines shall not be caulked and leaded into a building wall; tar, rubber, or some other soft material shall be used. Special wall sleeve fittings with soft rubber seals are approved. A swing joint shall be provided on water lines just inside the building, to compensate for pipe movement. Specify that threading of cast iron or ductile iron pipe is prohibited.

- d. In buildings containing laboratories, water lines to drinking fountains shall be run on separate risers connected to the mains ahead of laboratory equipment lines. Vacuum breakers shall be provided at all laboratory equipment and laboratory water lines.
  - e. Check Valves shall be provided on showers, soap dispensers in custodial closets, automatic washers, and other items or equipment equipped with cold and hot water mixers.
  - f. Provide necessary water hammer arrestors in accordance with ASSE 1010 for sealed wall installations without an access panel. Size and locate arrestors per Plumbing Drainage Institute (PDI) requirements.
  - g. Provide frost proof wall hydrants a maximum of 200 feet apart, at loading docks and at building entrances, with a minimum of one wall hydrant on each exterior wall.
  - h. Maintain a minimum pressure of 35 psi at the plumbing fixtures on top floor.
  - i. Coordinate electrical supply to electronic faucets and flush valves.
  - j. Vacuum breakers and check valves shall be located in non-accessible locations.
2. Domestic Hot Water
- a. Design of Systems
    - i. Domestic hot water systems shall be designed to reasonably assure an expeditious flow of hot water at ALL outlets. When the facility is large (i.e., multistory laboratory building) or the system is large to support heavy flow (i.e., gymnasium showers) with central domestic water heating, the design shall include recirculating line(s) and pump(s). When the total facility requirements are minimal and compact (i.e., fixture count of a small residence), or in the case of an isolated and remote minimal requirement in a large facility, the economics of space requirements and recirculating system must be calculated. An independent residential size water heater, backed up to the fixture(s) location, without recirculating system may be most appropriate. As a rough guide, domestic hot water systems shall dispense hot water after a flow of not over 1-1/2 quarts or within 10 seconds.
    - ii. A Recirculating Line shall be provided for all mains. Except for short runouts, lines shall be a minimum of 3/4 inch for large facilities.
    - iii. Maximum Fouling Factor shall be used in sizing domestic hot water heaters. Factory assembled units are recommended; installation should be by the manufacturer or his approved representative.
    - iv. Shielding shall be specified around the packing areas of all circulating pumps.
3. Soil and Waste Systems
- a. General Provisions:

- i. Applicable Specifications and Codes: Sanitary sewers external to a building shall conform with the City of Ypsilanti or State of Michigan, and to local building codes. When the City of Ypsilanti or Michigan specifications and the code differ, the more demanding requirements shall govern.
      - b. Design of Systems:
        - i. Cleanouts shall be provided on all downspouts before they enter the ground.
        - ii. Floor Drains: In general, floor drains shall be provided in toilet rooms and in equipment and fan rooms. These drains shall not be placed in ducts or plenums, or places of negative air pressure. (This is to avoid drying traps and pulling sewer gas into the air system.) Floor drains with sediment bucket shall be provided in trash rooms serving kitchens. In emergency shower and eyewash areas, floor drains must be discussed with the Physical Plant. Trap primers shall be provided on traps prone to drying out or required by code.
        - iii. Equipment Drains: Specify extra deep traps in locations subject to high pressure or vacuum such as fan housing, etc., to avoid loss of trap seal.
        - iv. Drip Lines from pumps, automatic traps, automatic air vents and from equipment shall be located to discharge over adjacent floor drains. Drip lines from pumps shall be connected to stuffing box drip points, not at drip base of pump. A separate drip line from drip base to over adjacent floor drain shall be provided.
        - v. Flashing shall be provided for each vent. Flashing shall not be less than 4 lb. sheet lead and shall extend up and turn down inside top of vent. Specifications shall call attention to the requirement for coordination with the installation of roofing.
        - vi. The Manufacturer's Detailed Instructions for the installation of acid waste and vent lines shall be included in the final specifications submittal.
        - vii. Acid Neutralizing Sumps: Provide as required. Locate sumps for servicing ease.
        - viii. Glass waste piping under slabs or underground is prohibited.
    4. Domestic Water Booster System
      - a. Option 1: Use a three pump system. Size one pump for approximately one-third of the total water demand. Each of the other pumps shall be sized for approximately two-thirds of the total demand. The smaller will operate until water demand exceeds the pump's capacity, at which point it will stop and one of the other larger pumps shall start. When the demand exceeds the capacity of this larger pump, the smaller pump will restart and both pumps will operate together. The other large pump will be a standby and alternate with the first large pump. Provide a pneumatic tank and "NO-FLOW" shut-down controls. Provide emergency power.

- Pumps shall be bronze fitted.
- b. Option 2: Use a two pump system. Size each pump for 75 percent of the total water demand. Pumps shall alternate. When the demand exceeds the capacity of one pump, both pumps shall operate. Provide a pneumatic tank and "NO- FLOW" shut-down controls. Provide emergency power. Pumps shall be bronze fitted.

### **Section 22 40 00 Plumbing Fixtures**

1. Fixtures and Appurtenances: Fixtures shall be of standard types and design and shall be selected on the basis of providing low flow rates of water, either by design or by the installation of flow restrictors. Principal fixture consideration should be given to showerheads and faucets.
2. Details:
  - a. Urinals and Water Closets: Siphon jet or blowout type urinals shall be used except where sound control is a problem. Water closets shall be elongated design with open front seat, color as approved by the Physical Plant. Seats shall be plastic open front without lid.
  - b. Janitors' Sinks shall be precast terrazzo or molded stone (24 inch by 36 inch minimum) on the floor.
  - c. Individual Electric Refrigerated Water Coolers shall be provided in new buildings. Wall hung types are preferred.
  - d. Shower Mixers shall be thermostatic mixing type with integral check valves.
  - e. Built-up Shower Pans shall be detailed in the drawings and specified.
  - f. Traps on Lavatories and Sinks shall be not less than 1-1/4 inch by 1-1/2-inch chrome plated cast brass "P" traps with brass nut.
  - g. Supplies to Lavatory Fittings shall be flexible tube risers with steel handle stops, all chrome plated.
3. Fixture Carriers: Lavatories, urinals, wall hung sinks, electric water coolers, and wall hung water closets shall be supported by chair carriers strongly anchored to withstand abusive eccentric loadings.
  - a. Closet Chair or Carrier shall be selected so that the stud plate is supported by the wall back of the fixture. (It is important that this plate be against the wall to provide a rigid mounting.)
  - b. Carriers shall be firmly anchored to the floor with maximum sized bolts that the feet will accommodate. Remember that people stand and bounce on fixtures so solid anchorage is imperative. Provide a template for bolts through the wall.
  - c. Neoprene gaskets shall be used.
  - d. The stud or nipple on the carrier shall be adjustable without cutting or defacing the wall and still maintain a tight joint.
4. Drinking Water Equipment: Provide wall hung, self-contained, electric, wheelchair accessible, and water coolers. Provide hi-low units in areas where only one unit is provided

**Section 22 70 00 Special Systems**

1. Compressed Air
  - a. Automatic condensate traps shall be provided at all air receiver tanks and low points on compressed air line.
  - b. Copper pipe shall be used where there is likelihood of rust or of dirt in the air.
  - c. Compressors:
    - i. Provide vibration isolation as described elsewhere.
    - ii. Air compressors (10 hp and under) shall be air cooled. Caution shall be exercised in locating compressors, with respect to heat producing equipment and room ambient temperature.
    - iii. Refrigerated coolers shall be used on air supply to building air control systems or equipment. If intake is extended, provide for easy maintenance.
2. Air and Gas Piping Systems:
  - a. Gas Burning Equipment: All gas burning equipment shall comply with the local gas company requirements, the State Code, and the City Code. Where applicable, appliances shall carry the AGA stamp. All such devices shall have approved safety pilots.
  - b. Large gas burning devices (such as boilers, incinerators, ovens, and kilns over 50,000 Btu) shall comply with Factory Mutual or Industrial Risk Insurance recommendations. In buildings of high occupancy, Industrial Risk recommendations shall be followed.
3. Gas Piping:
  - a. Piping shall not be run under buildings or basement floors. Double pipe with a vent shall be used where piping passes through an outside wall of a building or tunnel or under pavement other than normal sidewalk. Piping shall not pass through plenum chambers.
  - b. Interior Piping: An insulating flange shall be furnished and installed at the point of service entrance, to electrically isolate interior and exterior piping.
  - c. Concealed piping shall be welded.
  - d. Regulators: Properly vent to the outside where required by code or for safety.
  - e. Provide solenoid valve in the gas supply to the kitchen area with an emergency shut-off located in the area. Coordinate with the kitchen equipment drawings.

**Section 22 60 00 Gas and Vacuum Systems for Laboratory and Healthcare Facilities**

1. Design laboratory compressed air, laboratory vacuum, natural gas and miscellaneous laboratory cylinder gas systems in accordance with current editions of NFPA 54 and 99, and the following:
  - a. Central Supply Systems:
    - i. Provide minimum 100 psi laboratory air at the compressor discharge. Run 100 psi air to a storage room (or other non-working or unfinished space) in the laboratory area being served. Valve and

- cap the 100 psi air line for future connection. Tee off the 100 psi line and locate a pressure regulating valve to reduce the air pressure to 50 psi. Run 50 psi air to all outlets in laboratory hoods and benches.
- ii. If laboratory equipment being purchased is known, and items have requirements for higher air pressures, provide additional tee, regulator, and piping to that equipment at the required pressure.
  - iii. Natural gas, and manifolded laboratory gas system pressures shall be determined on a project basis.
  - iv. Design laboratory vacuum systems to deliver 15 inches at the point of use.
  - v. Place a source shut-off valve for each laboratory gas and vacuum system at the immediate outlet or inlet, in the case of vacuum of the source of supply, so that the entire supply source, including all accessory equipment, can be isolated from the entire pipeline system.
  - vi. In facilities where manifolded laboratory gases occur, ensure that adequately sized and properly constructed storage space is provided for the gas cylinders. Primary and reserve banks are required for cylinder gas sources.
  - vii. Laboratory air compressors and vacuum pumps shall serve the laboratory air and vacuum systems only.
  - viii. Locate laboratory air compressors and vacuum pumps in a clean, relatively cool environment [i.e., not with steam equipment, exceeding 100 degrees F ambient temperature.] Locate equipment in an area where it can be monitored regularly.
  - ix. Laboratory air compressors and vacuum pumps shall be multiplexed with single receivers. Compressors and pumps shall be sized such that 100 percent of the design load is carried with the largest single unit out of service. Provide three-valve bypass at receiver.
  - x. Design air dryers, filters and pressure regulators for the laboratory air system in duplex, each sized for 100 percent of the load using duplex twin tower desiccant dryers.
  - xi. Locate the laboratory air compressor system intake outdoors above roof level, at least 25 feet may be more depending upon prevailing wind direction and velocity from any building opening or other intake, and where no contamination from engine exhausts, fuel storage vents, vacuum system discharges, particulate matter or odor of any type is anticipated. Air that is already filtered for ventilation system use is an acceptable source for laboratory air compressors. Combined intakes must be sized for no restriction while flowing with the maximum intake possible, and provided with an isolation valve at the header for each compressor served.

- xii. Combine discharge from each laboratory vacuum pump into one discharge pipe, sized for no restriction while flowing with the maximum discharge possible, and provide an isolation valve at the header for each pump served. Exhaust discharge at the highest point of the building, above and at least 25 feet horizontally (may be more depending upon prevailing wind direction and velocity) from any door, window, louvered or ventilating opening of the building.
2. Piping Systems:
- a. Design natural gas piping systems in accordance with NFPA 54. Design other pressure piping systems not to exceed 5 psi loss from source to point of use. Design vacuum piping systems not to exceed 3 inches Hg from source to point of use.
  - b. Provide main line supply line with a shut-off valve. Locate valve as to be accessible by authorized personnel only and be located downstream of the source valve and outside of the source room, enclosure, or where the main valve enters the building. Identify this valve. A main line valve is not required when the source shut-off valve is accessible within the building.
  - c. Each branch and riser supplied from the main line shall have an in-line shut-off valve adjacent to the main. Each branch supplied from a riser shall have an in-line shut-off valve adjacent to the riser. Conceal in-line shut-off valves (e.g. above ceiling with ceiling tag, or in a locked equipment room). Comply with applicable codes and standards for concealed valves of flammable gases.
  - d. Include a zone valve in a cabinet with other laboratory gas zone valves for branches serving laboratory gas outlets. Located separate natural gas zone valve cabinets adjacent to other laboratory gas zone valve cabinets. Provide additional service valves above ceiling to subdivide areas for maintenance.
  - e. Laboratory gas outlets and vacuum inlets shall be standard needle valves.
  - f. Provide emergency natural gas solenoid valve for each laboratory area. Locate emergency shut-off switch adjacent to exit.

### **End of Division 22 – Plumbing**