PART 1 GENERAL

1.1 DESCRIPTION

A. Provide pipe, pipe fittings, piping specialties, pumps and related items required for complete piping system.

B. Related Work: The requirements of Section 22 0500, Common Plumbing Materials and Methods, also apply to this section.

1.2 QUALITY ASSURANCE

A. General: ASTM, and ANSI Standards are indicated. In addition, special standards are referenced where neither ASTM nor ANSI Standards are applicable.

B. Labeling: All piping shall be continuously and legibly labeled on each length as required by codes and standards and including as a minimum, country of origin, manufacturer's identification marking, wall thickness designation, and applicable standards and approvals. Fittings shall be labeled as required by the referenced standard. Tubular fixture traps shall be stamped with manufacturer's mark and material thickness.

C. Potable Water Valves: Potable water piping materials not limited to faucets, mixing valves, or pressure reducing valves. Valves shall meet NSF Standard 61, Section 9, for drinking water faucets and shall be brass construction. Brass components which contact water within the faucet shall be from brass which contains no more than 3 percent lead by dry weight.

D. Concealed Plastic Piping: No concealed plastic piping inside the building unless approved by Code or Governing Authorities.

E. Definitions: Where piping fluid is not indicated in the following paragraphs, provide similar piping materials for similar fluids (i.e., "make-up water" = "domestic water"; "wet stand pipe" = "fire sprinkler pipe"; "drainage piping" = "sanitary/storm sewer piping").

F. Plumbing System Disinfection shall be performed by an experienced, qualified, chemical treatment agency. Mt. Hood Chemical, Chemcoa, or approved alternate.

1.3 STORAGE AND HANDLING

A. Provide factory-applied end caps on each length of pipe and tube. Maintain end caps through shipping, storage and handling as required to prevent pipe-end damage and eliminate dirt and moisture from inside of pipe and tube. Protect flanges and fittings from moisture and dirt by inside storage and enclosure, or by packaging with durable, waterproof wrapping.

1.4 SUBMITTALS

A. Submit catalog data for each product specified.

PART 2 PRODUCTS

2.1 PIPING MATERIALS

A. Copper Pipe and Tube:
   1. Application:
      a. Domestic water

b. Priming lines
2. Pipe: ASTM B88.
a. Above Ground Domestic Water: Type L hard temper copper with soldered joints.
b. Underground Domestic Water and Priming Lines: Type L soft annealed with no joints or type K hard tempered copper with silver soldered joints.
3. Fittings: Wrought copper solder-joint fittings, ANSI B16.22.

B. Cast Iron DWV Pipe:
1. Application: 1-1/2"" and larger.
a. Sanitary waste
b. Plumbing vent
c. Rain drain
2. Pipe: Hubless cast iron soil pipe, CISPI 301-05/ASTM A 888-05.
3. Fittings: Hubless cast iron fittings: CISPI 301-05/ASTM A 888-05.
4. Couplings:
a. Light Duty: Standard couplings meeting CISPI 310.
b. Medium Duty: No-hub couplings meeting CISPI 310 and incorporating ASTM C 564 gasket, type 304 SS corrugated shield and type 304 SS clamping bands. Two clamping bands on 1-1/2” thru 4” pipe and four bands on 6” thru 10” pipe.
c. Heavy Duty: No-hub couplings meeting ASTM C 1540, and FM 1680. ASTM C 564 neoprene gasket, type 304 SS corrugated shield and type 304 SS clamping bands. Four bands on 1-1/2” thru 4” pipe and 6 bands on 5” thru 10” pipe.
d. Couplings to Dissimilar Pipe in Concealed Locations: Fernco "LowFlex" or approved substitute.
5. Manufacturers: Cast iron pipe and fittings – AB&I, Charlotte Pipe, Tyler Pipe, or approved. All pipe shall be labeled by the manufacturer.

C. Plastic Pipe – Drain, Waste, Vent (DWV):
1. Application: Three-story or less structures and where allowed by Code only.
a. Sanitary waste (below grade only)
b. Plumbing vent
c. Rain drain (below grade only)
2. Pipe:
a. Acrylonitrile-butadiene-styrene (ABS) (ASTM D3965) plastic drain, waste and vent piping (ASTM F628) and fittings (ASTM D2661) (DWV).
b. Poly(vinyl chloride) (ASTM D1784) (PVC) plastic drain, waste and vent pipe (ASTM D2665 and D1785) and fittings (ASTM D2665) (DWV).
3. Fittings: Provide fittings of the type indicated, matching piping manufacture. Where not otherwise indicated, provide socket style, solvent weld fittings produced and recommended for the service indicated by the piping manufacturer.

D. Cast Iron Pressure Pipe:
1. Application: 4" and larger.
a. Water
b. Pressure sewer
2. Pipe: Ductile iron coated outside with bitumastic enamel, ANSI A21.51.
3. Fittings: Gray or ductile iron bolted stuffing box mechanical joint or rubber ring joints, ANSI A21.1. Rubber gaskets, lubricants, bolts, and nuts, ANSI A21.11.

E. Plastic Pipe:
1. Application: Below ground water, 4" and larger, 5' outside the building line.
2. Pipe: Polyvinyl chloride pipe and fittings, Class 200, AWWA C900.
3. Fittings: Provide fittings of the type indicated, matching piping manufacturer. Where not otherwise indicated, provide fittings produced and recommended for the service indicated by the piping manufacturer.

F. Plastic Pipe:
   1. Application: Where approved by Code.
      a. Cooling coil condensate drain
   2. Pipe:
      a. Polyvinyl Chloride and Chlorinated Polyvinyl Chloride Plastic Pipe for Water Service: SDR-PR pipe, ASTM D2241; Schedules 40, 80 and 120, ASTM D1785.
   3. Fittings: Provide fittings of the type indicated, matching piping manufacturer. Where not otherwise indicated, provide socket style, solvent weld fittings produced and recommended by the piping manufacturer for the service indicated.

G. Plastic Pipe:
   1. Application: Where approved by Code.
      a. Domestic water
      b. Distilled and deionized water
   2. Pipe:
      a. Cross-linked polyethylene (PEX-a) tubing for Water Service: ASTM F877; SDR 9. NSF-pw and NSF 61.
   3. Fittings: Cold expansion (ASTM F1960) style fittings of the type indicated, matching piping manufacturer. Where not otherwise indicated, provide fittings produced and recommended by the piping manufacturer for the service indicated.

2.2 MISCELLANEOUS PIPING MATERIALS

A. Insulating (Dielectric) Fittings: Provide standard products recommended by the manufacturer for use in the service indicated, and which effectively isolate ferrous from non-ferrous piping (electrical conductance), prevent galvanic action, and reduce corrosion. Victaulic "Clear Flow."

B. Soldering and Brazing Materials: Provide soldering materials as determined by the installer to comply with installation requirements.
   1. Tin-Antimony Solder: ASTM B32, Grade 95TA.
   2. Lead-Free Solder: ASTM B32, Grade HB. Harris "Bridgit" approved.
   3. Silver Solder: ASTM B32, Grade 96.5TS.
   4. Flux: Water soluble paste flux.
   5. Brazing filler rod: BCuP rod to suit conditions.

C. Gaskets for Flanged Joints: ANSI B16.21; full-faced for cast-iron flanges; raised-face for steel flanges. Pressure and temperature rating required for the service indicated.

D. Sleeve Seal: Rubber-link pipe wall and casing closure. Thunderline Link-Seal. For fire rated wall, floor or ceiling penetrations, 3-M "CP-25" caulk, "No. 303" putty and/or "PSS 7904" sealing system.

E. Strainers: "Y-pattern," iron or bronze body rated for pressures indicated with blow-off connection and 20 mesh stainless steel screen.

F. Tracer Wire: 14 gauge, single strand, copper wire with blue insulation for water, green for sanitary and storm sewers, and yellow for gas. 3M "DBY" direct bury splice kit required at all splices.

2.3 PIPING SPECIALTIES

A. Cleanouts:
   1. Manufacturer: J.R. Smith, Zurn, Wade, Watts, Josam, Mifab, or approved substitute.
   2. Types:
      a. Tile Floor Cleanouts: Smith 4053-U with square heavy-duty nickel bronze top, bronze plug, and vandalproof screws. Adjustable top where cast into floor slab.

b. Carpeted Floor Cleanout: Smith 4023-U-X with round heavy-duty nickel bronze top, bronze plug, carpet clamping device, and vandalproof screws. Adjustable top where cast into floor slab.
c. Concrete Floor Cleanout: Smith 4023 with round heavy-duty nickel bronze top. Adjustable top where cast into floor slab.
d. Wall Cleanouts: Smith 4472-U, bronze ferrule with raised head bronze plug, stainless steel shallow cover and vandalproof screws.
e. Outside Area Walks and Drives: Smith 4253-U-G with galvanized cast iron body, top secured with vandalproof screws, and bronze plug. Install in 18” x 18” x 6” deep concrete pad flush with grade.

B. Drains:
1. Zurn, Jay R. Smith, Josam, Watts, Wade and Mifab. Numbers scheduled on drawings represent minimum acceptable standard for locations involved.
2. Cast iron construction with acid resistant coating, anchor flange, and other options as indicated by model number. PVC drains where specifically noted.
3. Install 4 pound sheet lead flashing, extending not less than 10" from and clamped to all drains not completely cast-in-place in a homogeneous material.

C. Flashing: Minimum 4# sheet lead; to extend horizontally 10” from edge of vent penetrations or rain drain body and vertically 12” minimum up from roof turned over and down into hub of vent or finished with bronze cap providing counterflashing for screwed pipe.

D. Shock Arrester: Precharged bellows or sealed piston type manufactured to meet PDI WH-201 and ASSE 1010 Standards. Size in accordance with PDI procedures. J. R. Smith, PPP, Sioux Chief, Wade, Zurn, Watts, Josam, or approved substitute.

E. Priming Valves: Smith 2699, Josam 88250, Wade W8800T, Zurn Z1022, Watts MS810 or equivalent Precision Plumbing, Mifab. Locate in closets, under counters or in walls behind access panels as specified in Section 22 0500. Use copper specified previously for all underground priming lines.

F. Traps: Except chrome plated fixture traps. Recessed drainage pattern for threaded pipe and same grade as pipe for cast iron and plastic pipe; with cleanout plugs in trap body in all above grade locations.

G. Pressure Reducing Valve: Single seat type with renewable stainless steel seat and valve. Size and capacity as shown on Drawings. Bronze bodies with screwed connections on valves 2-1/2” and smaller and flanged steel bodies on valves 3” and larger. Install each PRV with strainer on inlet or internal strainer. Leslie, Watts, Cash-Acme, Zurn-Wilkins, or approved substitute.

H. Backflow Preventer: Where indicated on the Drawings, install a reduced pressure backflow preventer complete with strainer on inlet, shutoff valves, two separate check valves, differential relief valve, and test cocks. USC Foundation for Cross Connection Control, State Health Officials, and serving utility approved. Bronze bodies on units 2” and smaller, and cast iron bodies with bronze trim on units 2-1/2” and larger.

I. Backflow Preventer: Where indicated on the Drawings, install a double check backflow preventer complete with strainer on inlet, shutoff valves, two separate check valves, and test cocks. USC Foundation for Cross Connection Control, State Health Officials, and serving utility approved. Bronze bodies on units 2” and smaller, and cast iron bodies with bronze trim on units 2-1/2” and larger.

J. Master Mixing Valve: All brass or bronze body with stainless steel parts, thermostatic master control element to fail safe upon cold water or control element failure. Provide with external union angle check stops, strainers, volume control, shutoff valves, dial thermometer. Valve location, arrangement and capacity as shown on plans. Leonard, Lawler, Powers, Symmons, or approved substitute.

K. Domestic Water Balancing Valve: Griswold domestic constant flow regulator.

L. Building Shut Off Valve Box: 10” round concrete enclosure with cast iron traffic weight cover. Brooks 3RT or approved substitute.

2.4 PUMPS

A. Domestic Hot Water Circulator: Bronze body, bronze fitted, in-line circulator with sleeve bearing. Bell & Gossett or equivalent Grundfos, Thrush, Taco, or Armstrong.

B. Elevator Sump Pump: Submersible, 5 gpm at 20 ft. head, minimum 1/3 horsepower sump pump with integral float switch. Myers SSM33 or equivalent Paco, Hydronix, Zoeller, Viking, or approved.

2.5 BACKFILL MATERIALS

A. Subbase Materials: A graded mixture of gravel, sand, crushed stone or crushed slag.

B. Finely-Graded Subbase Material: Well graded sand, gravel, crushed stone or crushed slag, with 100% passing a 3/8" sieve.

C. Backfill Material: Soil material suitable for compacting to the required densities, and complying with AASHTO designation M145, Group A-1, A-2-4, A-2-5. or A-3.

D. Drain Field Fill Material: Washed and uniformly graded gravel crushed stone or crushed slag, with 100% passing a 1-1/2" sieve and not more than 5% passing a No. 4 sieve.

E. Stabilization Fabric: Nonwoven stabilization and drainage fabric. Mirafi 140S or 140M.

PART 3 EXECUTION

3.1 PIPE INSTALLATION

A. General: Install pipe, tube and fittings in accordance with recognized industry practices and plumbing code standards. Install each run accurately aligned with a minimum of joints and couplings, but with adequate and accessible unions and flanges for disassembly, maintenance and/or replacement of valves and equipment. Reduce sizes (where indicated) by use of reducing fittings.

B. Piping Runs: Route piping close to and parallel with walls, overhead construction, columns and other structural and permanent-enclosure elements of the building. Install piping plumb and level except where pitched for drainage. If not otherwise indicated, run piping in the shortest route which does not obstruct usable space or block access for servicing the building or equipment and avoid diagonal runs. Wherever possible in finished and occupied spaces, conceal piping from view. Do not encase horizontal runs in solid (concrete or CMU) partitions.

C. Piping: Install for services as specified in Part 2. The following are special requirements:

1. Underground Drainage Pipe: Install cast iron soil pipe for the following conditions. When specified in Part 2 of this Section and where allowed by Code, plastic piping may be installed in lieu of cast iron piping.
   a. Under the building to 5' outside the building structure.
   b. 5' each way from a potable water line crossing.
   c. First section (minimum 5') from any connection to underground structures such as catch basins, manholes, disposal well or tank, etc.
   d. Through all fill areas where pipe cannot be rested on undisturbed earth.
   e. Where the top of the pipe is less than 12 inches below finish grade.
   f. At contractor's option in lieu of concrete or clay sewer pipe.

2. Acid Waste Piping: Install acid resisting piping and corresponding fittings in accordance with the manufacturer's recommendations. Use acid resisting fittings in connecting to standard waste lines. Install acid vent-thru-roof separately per Code. Install steel sleeves at all fire-rated wall penetrations as approved.
3. Demineralized, Deionized and/or Distilled Water Piping: GSR polypropylene piping with "Fuseal" joints or Nalgene polyethylene piping with "polyfusion" joints. Piping and joints installed in accordance with manufacturer's recommendations. Install steel sleeves at all fire rated wall penetrations as approved.
4. Existing Domestic Water Piping: Copper piping as specified in Part 2 except where existing domestic water piping to be connected to is galvanized steel, new galvanized steel piping for short branches and rough-ins may be installed.

D. Tracer Wire: Install tracer wire as close to underground non-metallic water, sanitary and storm sewers and gas pipe in the trench as possible. Tracer wire shall be accessible at grade via all services, valve and meter boxes, curb cocks, cleanouts at the building, manholes (inside the cover near the top), etc. Locate all points on the record as-installed drawings. Splice into utility tracer system where available. Comply with code requirements.

3.2 PIPING JOINTS

A. General: Provide joints of the type indicated in each piping system, and where piping and joint as manufactured form a system, utilize only that manufacturer's material.

B. Cast Iron "No-Hub": All joints in accordance with the Cast Iron Soil Pipe Institute (CISPI) Designation No. 310-97 "Installation Procedures for Hubless Cast Iron Soil Pipe and Fittings For Sanitary and Storm Drain, Waste and Vent Piping Applications." Horizontal runs of 5" and greater shall be braced as indicated in Figure 4 for "rodding" restraints. Application of couplings as follows:
   1. Light Duty Couplings: All vent piping and all drainage and waste piping above grade and serving the uppermost floor of the structure.
   2. Medium Duty Couplings: All aboveground waste and drainage piping unless indicated otherwise.
   3. Heavy Duty Couplings:
      a. All underground installations.
      b. All rain drain leader joints located more than 20 feet below the roof drain.
      c. Above all patient critical care areas, operating rooms, delivery rooms, nurseries, and food storage, preparation, and serving areas in health care facilities.

C. Ferrous Threaded Piping: Thread pipe in accordance with ASME B1.20.1; cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Apply pipe joint compound or pipe joint tape (Teflon) where recommended by pipe/fitting manufacturer, on male threads at each joint and tighten joint to leave no more than three threads exposed.

D. Solder Copper Tube and Fitting Joints: In accordance ANSI B 828 with recognized industry practice. Cut tube ends squarely, ream to full inside diameter, and clean outside of tube ends and inside of fittings. Apply solder flux to joint areas of both tubes and fittings. Insert tube full depth into fitting, and solder in a manner which will draw solder full depth and circumference of joint. Wipe excess solder from joint before it hardens. "T-Drill" field formed tees may be utilized where the main is at least two pipe sizes larger than the branch.

E. Braze Copper Tube and Fitting Joints: Where indicated. Pass a slow stream of dry nitrogen gas through the tubing at all times while brazing to eliminate formation of copper oxide.

F. Flanged Joints: Match flanges within piping system, and at connections with valves and equipment. Clean flange faces and install gaskets. Tighten bolts to provide uniform compression of gasket.

G. Concrete Sewer Pipe Joints: Comply with applicable provisions of "Concrete Pipe Field Manual" by the American Concrete Pipe Assoc.

H. Plastic Pipe/Tube Joints: Comply with manufacturer's instructions and recommendations, and with applicable industry standards:
   1. Heat Joining of Thermoplastic Pipe: ASTM D-2657.
   2. Making Solvent-Cemented Joints: ASTM D-2865 and ASTM F-402.

I. Glass Pipe Joints: Comply with manufacturer's instructions and recommendations.

J. Grooved Pipe Joints: Comply with fitting manufacturer's instructions for making grooves in pipe ends. Remove burrs and ream pipe ends. Assemble joints in accordance with manufacturer's instructions. Visually inspect the assembled joint to ensure proper gasket seating.

K. Insulating (Dielectric) Fittings: Comply with manufacturer's instructions for installing unions or fittings. Install in a manner which will prevent galvanic action and stop corrosion where the "joining of ferrous and non-ferrous piping" is indicated.

L. Changes in Direction: Use fittings for all changes in direction. Run lines parallel with building surfaces.

M. Line Grades:
   1. Drainage Lines: Run at maximum possible grade and in no case less than 1/4" per foot within building.
   2. Vents: Pitch for drainage 1/4" per 10'.
   3. Water: Pitch to low points and install hose bib drains. 3' minimum depth of ground cover for all lines outside building unless otherwise noted.

N. Unions and Flanges: At all equipment to permit dismantling and elsewhere as consistent with good installation practice.

O. Expansion: Provide loops, swing joints, anchors, runouts and spring pieces to prevent damage to piping or equipment.

3.3 CLEANOUTS

A. Where required by code, at each change of sewer direction 45 degrees or greater and more than 10’ long, at end of each branch or main and spaced not greater than 100’ apart, as required by code and/or as shown on Drawings.

3.4 MISCELLANEOUS PIPING EQUIPMENT

A. Floor, Wall and Ceiling Plates: Chrome plated pressed steel or brass screw locked split plates on all pipe penetrations in finished spaces.

B. Strainers: Install in a manner to permit access for cleaning and screen removal and with blow-off valve.

C. Sleeves: At all penetrations of concrete or masonry construction. PVC, 24 gauge galvanized steel or Schedule 40 galvanized steel pipe. Use steel pipe sleeves through beams, footings, girders or columns and for all penetrations of walls or floors below grade. Where floor finish is ceramic tile, terrazzo, or similar material extend standard steel pipe sleeves 1-1/2" above finished floor. Fabricate sleeves 1" diameter larger than pipe or insulation. PVC and sheet metal sleeves at non-structural penetrations only.

D. Sleeve Caulking: Caulk below grade pipe with rubber link seal. Grout above grade pipe with cement mortar or approved waterproof mastic. All caulking or grouting shall extend full depth of sleeve. Utilize rubber sealing links in lieu of caulking. Install UL sealing caulk, putty and/or system at all penetrations of fire rated walls, floors and ceiling.

E. Shock Arrestors: Install at end of mains, in a battery of three or more flush valve-operated fixtures water header, ahead of quick closing and solenoid operated valves. Size per PDI recommendations where size is not indicated. Provide access panels.

F. Trap Priming: Traps serving floor drains, floor sinks, catch basins, and similar fixtures shall be primed in accordance with Code requirements.

3.5 EXCAVATING

A. General: Do not excavate for mechanical work until the work is ready to proceed without delay, to minimize the total time lapse from excavation to completion of backfilling. Comply with all applicable Federal and state safety regulations and local erosion control requirements.

B. Width: Excavate for piping with 6" to 9" clearance on both sides of pipe, except where otherwise shown or required for proper installation of pipe joints, fittings, valves and other work. Excavate for other work to provide minimum practical but adequate working clearances.

C. Depth for Direct Support: For work to be supported directly on undisturbed soil, do not excavate beyond indicated depths, and hand-excavate the bottom cut to accurate elevations. Support the following work on undisturbed soil at the bottom of the excavations:
   1. Piping of 5" and less pipe/tube size.
   2. Cast-in-place concrete.

D. Depth for Subbase Support: For large piping (6" pipe size and larger), tanks and where indicated for other mechanical work, excavate for installation of subbase material in the depth indicated, or, if not otherwise indicated, 6" below bottom of work to be supported.

E. Depth for Exterior Piping: Excavate for exterior water-bearing piping (water and drainage) so that the top of piping will not be less than 3' vertical distance below finished grade.

F. Depth for Unsatisfactory Soil Conditions: Where unsatisfactory soil condition at the bottom of excavation exists, excavate additional depth as directed to reach satisfactory soil-bearing condition. Backfill with subbase material, compacted as directed, to indicated excavation depth.

G. Rock and Boulder Removal: Refer to Division 1 for procedure on additional work, including additional excavating and backfilling, rock removal, etc.

H. Protection of Trees: Excavate near large trees (within the drip line) by hand, and protect the root system from damage or dryout to the greatest extent possible. Maintain moist condition for root system and cover exposed roots with burlap. Paint root cuts of 1" diameter and larger with asphaltic tree paint.

I. Excavated Materials: Store excavated material (temporarily) near the excavation, in a manner which will not interfere with or damage the excavation or other work. Do not store under trees (within the drip line). Retain excavated material which complies with the requirements for backfill material. Dispose of excavated material which is either in excess of quantity needed for backfilling or does not comply with requirements for backfill material.

3.6 BASE PREPARATION

A. Subbase Installation: Where indicated, install subbase material to receive mechanical work, and compact by tamping to form a firm base for the work. For 4" and larger piping, horizontal cylindrical tanks and similar work, shape the subbase to fit the bottom 90 degrees of the cylinder, for uniform continuous support. Provide finely-graded subbase material for wrapped, coated and plastic pipe and tank. Shape subbases and bottoms of excavation with recesses to receive pipe bells, flanged connections, valves and similar enlargements in the piping systems and set bottom of trench at proper pitch and correct elevations with subbase material.

B. Concrete Encasement: Where piping under roadways is less than 2'-6" below surface of roadway, provide 4" base slab of concrete to support piping. After piping is installed and tested, provide 4" thick encasement (sides and top) of concrete before backfilling. Provide Class 2500 concrete for encasement and slab.

C. Previous Excavations: Where piping crosses over an area more than 5' wide which has been previously excavated to a greater depth than required for the piping installation, provide suitable subsidence-proof support for the piping. Comply with the details shown, or where not otherwise shown, provide the following support system:
   1. Excavate to undisturbed soil, in a width equal to the pipe diameter plus 2'. Install 8" courses of subbase material, each compacted to 95% of maximum density, as required to fill excavation and support piping.

3.7 BACKFILLING

A. Do not backfill until installed mechanical work has been tested and accepted wherever testing is indicated. Install drainage fill where indicated, and tamp to a uniform firm density. Backfill with finely-graded subbase material to 6" above wrapped, coated and plastic piping and tanks, and to center line of other tanks (where recommended by tank manufacturer, use "pea gravel" backfill). Condition backfill material by either drying or adding water uniformly, to whatever extent may be necessary to facilitate compaction to the required densities. Do not backfill with frozen materials.

3.8 CLEANING

A. General: Clean all dirt and construction dust and debris from all mechanical piping systems and leave in a new condition. Touch up paint where necessary.

B Disinfection of Domestic Water Piping System:
   1. Prior to starting work, verify system is complete and clean.
   2. Open all drains and fixtures valves in the building starting with the valve nearest the water service line and permit the water to run clear for 10 minutes to eliminate grease, cuttings, flux, and foreign matter.

3. Inject disinfectant at beginning of water system to be disinfected. Introduce free chlorine in liquid form, throughout system to obtain concentration required by local Public Health Department regulations or 50 to 80 mg/L residual.
5. Bleed water from all potable water outlets to ensure distribution and test for disinfectant residual at minimum 15 percent of outlets.
6. Maintain disinfectant in system for 24 hours.
7. If final disinfectant residual tests less than 25 mg/L, repeat treatment.
8. Flush disinfectant from system until residual is equal to that of incoming water or 1.0 mg/L.
9. Take samples no sooner than 24 hours after flushing, from 10 percent of outlets and from water entry, and analyze in accordance with AWWA C601. If any sample fails the analysis, repeat the procedure.
10. Include a copy of the bacteriological analysis in the Operating and Maintenance manuals.

C. Sanitary and Storm Drainage System:
1. Remove construction debris from cleanouts, drains, strainers, baskets, traps, etc., and leave same accessible and operable. Place plugs in the end of uncompleted piping at the end of the day or whenever work stops.
2. Before final acceptance of completed sewer system, flush and clean the entire system with water. Trap and remove solid material obtained from flushing and cleaning from the new system. Do not allow debris to enter the existing sewer system.

D. Deionized Water Piping: Remove all foreign material from piping and flush with clean water. Sanitize and clean in accordance with procedure recommended by deionized water equipment manufacturer. After system is ready to be operated, test water purity and certify that water quality is within allowable limits.

3.9 TEST

A. General:
1. Minimum duration of two hours or longer, as directed for all tests. Furnish report of test observation signed by qualified inspector. Make all tests before applying insulation, backfilling, or otherwise concealing piping or connecting fixtures or equipment. Where part of the system must be tested to avoid concealment before the entire system is complete, test that portion separately, same as for entire system.
2. Provide all necessary temporary equipment for testing, including pump and gauges. Remove control devices before testing and do not use piping system valves to isolate sections where test pressure exceeds valve pressure rating. Fill each section with water and pressurize for the indicated pressure and time.
3. Observe each test section for leakage at end of test period. Test fails if leakage is observed or if pressure drop exceeds 5% of test pressure.

B. Repair:
1. Repair piping system sections which fail the required piping test by disassembly and re-installation, using new materials to the extent required to overcome leakage. Do not use chemical stop-leak compounds, solder, mastics, or other temporary repair methods.
2. Drain test water from piping systems after testing and repair work has been completed.

C. Sewer: Furnish all facilities and personnel for conducting the test. Test in accordance with the requirements of the State Plumbing Inspector and local authorities.

D. Plumbing Waste and Vent Piping: Hydrostatic test by filling to highest point, but not less than 10' water column on major horizontal portion.

E. Water Piping: Hydrostatic pressure of 100 psig without loss for four hours.

F. Tanks and Equipment: Hydrostatic pressure to 1.5 times operating pressure but do not exceed maximum rated pressure.

G. Deionized (PVDF) Piping:
   1. Test Medium: Water only. No compressed air or gases.
   2. Initial Low Pressure Test: Maximum 50 psig for four hours with no loss.
   3. High Pressure Test: Maximum of 150 percent of the system operating pressure or the piping/fitting pressure ratings, whichever is lower. Test a minimum of 12 hours at the above pressure. Observe safety precautions indicated by the manufacturer.
   4. Repair of Leaks: Re-fuse leaky joints in accordance with the manufacturer's recommendations. Replace defective sections of piping.

3.10 SUPERVISION AND START-UP

A. Adjust flush valves, pressure reducing valves, mixing valves, water heater thermostats, and similar equipment.

END OF SECTION