SECTION 40 20 00

WATER AND WASTE SYSTEMS FOR LABORATORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes guidelines for the development of water and waste systems for laboratories. Laboratory waste and water systems are designed to serve specific program requirements independent of general building plumbing and piping systems. This section should be used in conjunction with the Facilities Design Guide sections on plumbing waste and vent piping, and domestic water supply piping. This section provides guidelines for the following systems:

1. Industrial (non-potable) water
2. Process cooling water
3. Research grade water
4. Laboratory waste and vent systems

B. Related Sections:

1. Section 22 05 00 General Requirements for Plumbing
2. Section 31 23 00 – Excavation and Fill: Execution requirements for pipe trenches and backfill specified by this section.
3. Section 26 05 83 – Equipment Wiring Connections: Execution requirements for electric connections specified by this section.
4. <<Add chilled water spec reference for PCW>>

1.2 REFERENCES

A. ASTM D1193 Standard for Reagent Grade Water

B. ANSI B40.1 - Gauges, Pressure and Vacuum, Indicating Dial Type-Elastic Element.

C. ASME B16.26 (American Society of Mechanical Engineers) - Cast Bronze Fittings for Flared Copper Tubes.

D. ASME B31.9 (American Society of Mechanical Engineers) - Building Services Piping.

E. ASTM B32 - Solder Metal.

F. ASTM B88 - Seamless Copper Water Tube (ASTM B88M - Seamless Copper Water Tube [Metric]).

G. ASTM D2683 - Socket-Type Polyethylene Fillings for Outside Diameter-Controlled Polyethylene Pipe.
H. MSS SP-80 (Manufacturers Standardization Society of the Valve and Fittings Industry) - Bronze Gate, Globe, Angle and Check Valves.

I. MSS SP-110 (Manufacturers Standardization Society of the Valve and Fittings Industry)

J. Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

K. AWS A5.8 (American Welding Society) - Brazing Filler Metal.

L. FM (Factory Mutual System) - Approval Guide.

M. FS WW-V-35 - Valve Ball.

N. FS WW-V-54 - Valve, Gate, Bronze (125, 150 and 200 Pound, Screwed, Flanged, Solder End, For Land Use).

O. MIL-R-36557 - Regulator, Pressure, Medical Gas Administration Apparatus.

P. MIL-V-82026 - Valves, Diaphragm, Stop.

Q. MSS SP-58 (Manufacturers Standardization Society of the Valve and Fittings Industry) - Pipe Hangers and Supports - Materials, Design and Manufacture.

R. MSS SP-69 - Pipe Hangers and Supports - Selection and Application.

S. MSS SP-80 (Manufacturers Standardization Society of the Valve and Fittings Industry) - Bronze Gate, Globe, Angle and Check Valves.

1.3 SUBMITTALS

A. General:

1. In the absence of specific requirements in the design contract the following submission requirements shall be followed. Confirm the submission requirements with Stanford University Project Manager.

2. Design drawings, data and calculations at various stages of completion shall be submitted for each phase of the University's plan review process. The specific submission requirements for each phase are outlined below.

B. 100% Schematic Design Submissions:

1. Selection of types of laboratory waste and water piping systems.

2. Preliminary system cost estimate in terms of unit cost (dollars per square foot gross building floor space, dollars per system or component, or similar).

3. Location of major laboratory waste and water piping equipment.

4. Schematic diagrams of laboratory waste and water piping systems.

C. 100% Design Development Submissions:

1. Location of all laboratory waste and water piping equipment.
2. Routing plans for all piping mains.
3. Major riser diagrams.
4. Preliminary design calculations, including selection of major equipment
5. Preliminary cost estimate for all systems.
7. Outline specifications.

D. 50% Construction Documents Submissions:

1. 50% complete laboratory waste and water piping plans, sections, and details.
2. Final selection of equipment and systems options considered under Design Development Phase.
3. Design calculations.
4. Revised system cost estimate based on 50% design documents.
5. 50% complete specifications.

E. 95% Construction Documents Submissions:

1. 95% complete design drawings.
2. 100% design calculations.
3. Revised system cost estimate based on 90% design documents.
4. 95% complete specifications.

F. 100% Construction Documents Submissions:

1. Final contract drawings and specifications.
2. Final cost estimate.

G. Contract Closeout:

1. As-Built Drawings: All changes to Contract Drawings and Specifications, including schedules, control diagrams, etc., shall be incorporated into As-Built Drawings in accordance with Section 01 33 00: Submittal Requirements.
2. Operations and Maintenance Manuals shall include complete laboratory waste and water piping systems operating and service descriptions written by the Consulting Engineer. The descriptions shall supplement any operating instructions provided as part of vendor-furnished equipment. Refer to Section 01 33 00: Submittal Requirements.

H.

I. Construction Submittals:

1. Product Data: Provide manufacturers catalog literature with capacity, weight, and electrical characteristics and connection requirements.
2. Design Data: Provide manufacturer’s data sheets for all products to be used.
3. Test Reports: Provide independent testing agency report showing that systems are complete, zone valves installed, alarm systems functional, and pressure and cross connections tests performed.
4. Manufacturer's Installation Instructions: Submit hoisting and setting requirements, starting procedures.
5. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
6. Manufacturer's Field Reports: Indicate systems are complete, zone valves installed, and alarm systems functional.

1.4 CLOSEOUT SUBMITTALS

A. Section 01 77 00 – Closeout Procedures: provide the following in addition to the requirements of.
   1. Project Record Documents: Record actual locations of equipment piping, valves, outlets and components.
   2. Operation and Maintenance Data: Submit assembly views, lubrication instructions, replacement part numbers and availability.

1.5 QUALITY ASSURANCE

A. Maintain one copy of each document on site.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store and protect equipment.

B. Accept equipment on site in factory fabricated containers with shipping skids and plastic pipe end protectors in place. Inspect for damage.

C. Protect piping and equipment from weather and construction traffic. Maintain factory packaging and caps in place until installation.

D. All research grade water piping and fittings shall be delivered in factory sealed bags and stored indoors and out of the weather. End caps shall be installed at end of work on any section to minimize the introduction of dirt into the piping.
PART 2 - PRODUCTS

2.1 INDUSTRIAL WATER

A. Industrial water shall be provided from the building domestic water system. Industrial water shall be isolated from the domestic water system with reduced pressure zone backflow devices.

B. Industrial water shall be installed to the same criteria as domestic water systems. Industrial water piping shall be clearly labeled as such. Refer to 22 11 16 Domestic Water Piping.

2.2 PROCESS COOLING WATER

A. Process cooling water shall be installed to the same criteria as small diameter chilled water systems. Process cooling water shall be clearly labeled as such. Refer to 23 20 00 HVAC Piping and 23 21 16 Hydronic Piping Specialties.

B. Valves:
   2. Hand valve: GF or GSR, PVC true union ball valve, type 1, grade 1, Teflon ball seal, EPDM “0” ring seals, solvent weld socket ends.
   3. Check valve: stainless steel spring check.

2.3 RESEARCH GRADE WATER SYSTEM DESIGN:

A. The Architect, in association with the University Project Engineer, shall meet with the laboratory user to determine which type/grade of ASTM water is to be used.

B. The Stanford Project Engineer shall provide the definition of the ASTM Type I, II, III grade water for wet chemistry and biology laboratories. Electronics laboratory research grade water requirements shall be defined differently. All research grade water systems shall be tied into the EMCS to alarm on low tank water level condition, low water quality, and on "no flow" condition.

C. In the absence of a specification for the water quality the design shall provide ASTM Type II Reagent Grade Water as defined by ASTM D1193 Standard for Reagent Grade Water.

D. ASTM Types I, II, and III water design requirements:
   1. Type II: The makeup pretreatment shall consist of: prefilter, water softener, activated carbon absorption and a five (5) micron filter. Treatment shall consist of a Reverse Osmosis (RO) unit, deionized mixed bed units, ultraviolet light and a 0.2 micron final filter.
   2. Type III: The makeup pretreatment shall consist of prefilter, water softener, activated carbon absorption, and a five (5) micron filter. Treatment shall consist
of a Reverse Osmosis (RO) unit, provisions for installing deionized mixed bed units for future requirements, ultraviolet light and a 0.2 micron final filter.

3. Type I: The makeup pretreatment shall consist of prefilter, water softeners, activated carbon absorption and a five (5) micron filter. Treatment shall consist of a Reverse Osmosis (RO) unit, deionized mixed bed units, ultraviolet light and a 0.2 micron filter. Final treatment of Type I water will be done at point of use by means of a polishing system selected by the Project Engineer for the specific use in the laboratory.

E. Piping shall be socket fused polypropylene. Valves shall be diaphragm type. Pumps shall be stainless steel where pump materials contact water.

F. The makeup system shall feed into a holding tank. The distribution system shall feed from the holding tank(s) and distribute and return water throughout the building. Modularity in design is encouraged for system isolation. System shall be designed so as to provide valving, venting, and drains for cleaning. There shall be no dead legs greater than five (5) pipe diameters in length. Velocity through the pipe shall be five to seven feet per second (5-7 FPS).

G. A mixed bed deionized unit, ultraviolet light and a 0.2 micron filter shall be in the distribution loop.

H. System Capacity

1. Makeup system
   a. The pretreatment and purification systems are also known as the makeup system. The system shall be sized so as to run as continuously as possible to prevent bacteria buildup. This also allows the system to be downsized, thereby reducing first time cost. Expandability for future requirements shall be considered.
   b. The makeup system capacity shall be sized according to the following:

   \[ C = \frac{RD}{24} \]

   c. Where "C" is capacity in gallons per hour. "R" is building daily water requirement, usually consisting of a small percentage (approximately 20%) for laboratory use. Any special equipment requiring research grade water would, of course, be added to this requirement. "D" is diversity and is based on empirical knowledge of existing buildings.

2. Storage Tank: The storage tank shall be sized to allow for peak system usage. While the makeup system may be producing water over a twenty-four (24) hour day, the actual usage generally will be over a ten (10) hour period.
   a. The equation below is for sizing storage tanks.

   \[ S = C(24-T) \]
b. Where: S is tank size in gallons; C is makeup system capacity in gallons per hour; T is hours per day system is being used.

I. Testing: The quality of the water shall be tested for compliance with design criteria as part of the installation contract by an approved testing agency. System shall be tested upon start-up, at one month, and four times at three (3) month intervals thereafter.

2.4 RESEARCH GRADE WATER PIPING

A. Supply and return piping shall be in piping appropriate for the water quality.

B. Standard piping shall be unpigmented schedule 80 polypropylene with fusion welded joints.

C. Ultra-high purity water piping shall use SYGEF virgin PVDF pipe with socket fusion joints and fittings. Systems requiring the highest purity water shall use bead and crevice free (BCF) joints.

D. Valves: All valves must be pre-cleaned and non-lubricated. The use of Teflon paste, Permatex, Vaseline and other lubricants are expressly forbidden.
   1. Shut-off valves: true union ball valves for sizes ½” thru 2”. Butterfly valve for 2½” and larger. Material same as piping.
   2. Check valve: stainless steel spring check
   3. Back pressure: Jordan stainless steel type MARK-50, 2-20 psig spring range

2.5 LABORATORY WASTE AND VENT

A. Laboratory waste and vent piping should be schedule 40 polypropylene pipe with schedule 40 DMV fusion weld fittings. Mechanical joints are acceptable for piping above lab floor and for vent lines.
   1. Manufacturers: Fuseal, Enfield, Harvel

B. Special applications may require the use of chemical waste drain lines. Glass waste piping may be used for these applications if appropriate. Installation and design should comply with the manufacturer’s requirements, joints should be mechanical joints.
   1. Manufacturers: Schott, Kimax, or equal.

PART 3 - EXECUTION

3.1 CLEANING

A. General Cleaning Requirements: All pipe, fittings, valves, and system-related materials shall be cleaned before use.
B. Cleaning Area for Specialty Piping Construction: There shall be separate cleaning and clean storage areas.

C. Location: Area shall be clean, dry and dust free. It shall be well lighted and with adequate ventilation to eliminate any hazards from cleaning solutions.

D. Storage: There shall be three storage areas: uncleaned approved material, work in process, and clean, work-ready material.

E. Division: All work-ready material shall be stored separately and shall not be allowed to be in contact with the floor, ground, or unclean resting sites.

F. Dating: All work ready material shall be dated and initialed by the cleaning technician.

G. Supplies: All chemicals and supplies shall be stored in a safe, ventilated area and protected from contamination.

H. Used Chemicals: All used chemicals shall be stored in closed drums, held for disposal. Fresh chemicals shall be used daily. No recycled chemicals shall be used.

I. Industrial Water System:
   1. After completing domestic water supply systems, these systems shall be disinfected in accordance with requirements of U.S. Public Health Department. Fifty (50) parts per million (PPM) of chlorine with eight (8) hour retention shall be used and flushed to leave a residual no greater than supply source. Written certification of disinfection completion shall be submitted to the Project Manager.
   2. Test piping as described above before disinfecting.

3.2 RESEARCH GRADE PIPING INSTALLATION, TESTING AND START-UP

A. General:

   1. This article establishes requirements for the installation of polypropylene and PVDF piping for research grade water systems per ASTM D1785, ASTM D2146 or ASTM D2837-85, SDR-11, Thermoplastic Piping Specification.
   2. All installation fitters who fabricate and install polypropylene piping systems shall be requalified by making at least three typical pipe joints into a test spool piece that withstands a test pressure that conforms to the manufacturer's design test recommendations. This will include at least one gasketed joint and is intended to meet the Code qualification of nonmetallic pipe joiners. The Contractor shall arrange the qualifying test with the representative present.
   3. All materials and workmanship of this system shall be subject to inspection and examination by the Project Manager's representative at any place where fabrication and/or erection are carried on.
   4. All research grade piping distribution systems shall be pressure and leak tested by the Contractor and approved by the Project Manager's representative prior to
the final analytical test. All research grade piping test medium shall be research
grade water.
5. Polypropylene piping shall be supported on continuous trough supports, with
hanger spacing and rod sizes same as specified for metallic piping. Troughs shall
be galvanized steel V or U shape, or semi-circular shape. V or U shape troughs
shall have blocking at hangers to prevent rotation. Troughs shall be sized for a
maximum deflection of 1/360th of span under actual loads, with "S" equal to
25,000 psi, and "E" equal to 29,000 psi.

B. Pipe Installation Procedures:

1. Polypropylene piping systems shall be installed in strict accordance with pipe
manufacturer's recommendations, including preparation of pipe and fittings,
selection of latest approved tooling and equipment.
2. All provisions of this specification shall be followed. No substitutions of items
or alterations in the procedures are allowed unless authorized in writing by the
Project Manager's representative. A thorough visual inspection of the completed
pipe system by the Contractor and Project Manager's representative is required.
3. The pipe and fittings shall be carefully unloaded by hand, or using slings made
of nonmetallic (e.g., nylon) material. Pipe shall be stored indoors on sleepers.
Fittings shall be stored indoors in sealed containers. A qualified fitter shall
supervise unloading and visually inspect the piping for evidence of abuse or
damage such as cracks or gouges. Damaged pipe shall be rejected and not used.
4. All capped pipe and boxed fittings and prefabricated spools shall be carefully
handled to avoid damage.
5. Pipe shall be cut with pipe cutter, beveled and deburred. Joining surfaces of
fitting socket and pipe shall be thoroughly cleaned using absorbent clean room
cotton cloth wipes and semiconductor grade anhydrous isopropyl alcohol. New
clean room cotton wipe shall be used each time.
6. Pipe shall be cut accurately to job measurements and installed per manufacturer's
recommendations without springing or forcing, true to line and grade per design
specifications.
7. All joints shall be made up in a dry, clean environment according to the
manufacturer's instructions.
8. Piping shall be joined by a heat fusion method. Fittings shall be socket type. The
pipe end and fitting socket shall be heated to fusion joint temperature per
Manufacturer's specifications.
9. The depth of penetration of the pipe into the socket is to be as defined in
manufacturer's instructions. The pipe system selected will determine the size of
outside bead.
10. Valves shall be located with stems above horizontal plane of pipe and in
accessible locations with adequate clearance around hand wheels or levers for
easy operation.
11. All valved stubs for future connections shall be piped within six (6) pipe
diameters on main run.
12. Special care shall be taken during installation to keep piping system clean. All
open ends shall be capped with teflon tape.
C. Piping Distribution Cleaning:

1. Cleaning procedure will require the following materials and equipment:
   a. Alconox detergent and thirty percent (30%) hydrogen peroxide cleaning agents.
   b. Circulating pump.
   c. Acid resistant tanks of sufficient size to fill all lines.
   d. One percent (1%) potassium permanganate testing solution.
   e. Balsbough resistivity meter.

2. Procedure:
   a. Flush piping system with research grade Type III water to remove all foreign substances.
   b. Connect piping systems to be cleaned to the pump and tank. Fill the tank with research grade Type III water and add Alconox twenty-five (25) grams/gallon.
   c. Circulate solution through all research grade piping for six (6) hours, bleeding 0.5 gallons from each valve at two (2) hour intervals.
   d. Drain system and refill with research grade Type III water and test resistivity. Repeat procedure until the return side of each loop conforms to the NCCLS Type III water specifications.
   e. Add hydrogen peroxide (1 gallon per 5 gallons of system volume) and repeat Procedures 2.c and 2.d above.
   f. Flush system with fresh research grade Type III water and test all discharge points with potassium permanganate. Continue flushing until test shows negative. (A positive test will show color change from violet to brown.)
   g. Drain and fill system including filter housings, pumps, and storage tanks with fresh research grade water and proceed to operate entire system.
   h. Check water quality and continue flushing with fresh research grade water until the return side of each loop conforms to the NCCLS water type of this piping system.

3. System Start-up:
   a. Prior to start-up, all subsystems shall be checked to ensure they are ready, including but not limited to the following: proper equipment rotation, proper wiring, auxiliary connections, lubrication, venting controls, all filters installed and properly set relief and safety valves.
b. All systems shall be started and operated. The services of factory trained technicians shall be provided for start-up of major equipment and systems, including but not limited to temperature controls and pump sets. All balancing valves, flow and pressure regulators, and any other adjustable equipment shall be adjusted for optimum performance and to suit job conditions.

<table>
<thead>
<tr>
<th>System</th>
<th>Testing Pressure</th>
<th>Testing Media</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research Grade Water</td>
<td>150 PSIG</td>
<td>DI Water *</td>
<td>4 hours</td>
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*Domestic water may be used for preliminary testing before cleaning of research grade water systems in accordance with the procedures set forth in this section.

END OF SECTION