

DIVISION 22 – PLUMBING

See Part II for additional information regarding Energy Efficiency, etc.

DESIGN CRITERIA

Employ strategies that in aggregate use 20 percent less water than the water use baseline calculated for the building (not including irrigation) after meeting the Energy Policy Act of 1992 fixture performance requirements.

SYSTEMS DEFINITION

Campus is served by three water distribution systems; potable, non-potable and agricultural water. The potable water is identified as the Campus Domestic Water Distribution System. This system serves the building domestic water, building industrial water and Campus fire water.

AGRICULTURAL WATER

The Agricultural Water Distribution system is designated as AG Water. This system is non-potable and has a dedicated piping distribution system serving the West Campus agricultural fields.

UTILITY WATER

The non-potable water supply system is designated as the Utility Water Distribution System and is primarily use for landscape irrigation. This system has a dedicated piping distribution system serving the main Campus only.

BUILDING DOMESTIC WATER

This system is used to provide for consumption and sanitary needs, industrial water needs, make-up water for mechanical system, and process water needs (i.e. DI, RO, etc.).

The service at the building shall provide the following:

1. A reduced pressure backflow prevention device (RPBP).
2. An accessible main strainer with "blow down" capabilities to prevent well water sediment from reaching building's water supply and fixtures. Strainer shall be #20 mesh (1/32-inch).
3. After the backflow device a water conditioning device; using a modulating frequency wave form shall be installed. Scale Blaster, or equal, no known equal. . Depending on the size of the system, it is possible more than one device may be needed particularly at hot water heat exchangers where scale tends to build up. The conditioning system type shall be discussed with the University's Representative early in the design process before implementing a technology.
4. A domestic water booster pump, if project exceeds 3 stories. Water pressure calculations should be performed for the project to determine the need for a booster pump. Water booster pumps shall be controlled with VFDs in lieu of hydraulic controls.
5. Incoming domestic water shall be plumbed with injector fittings for water system chlorination testing.

BUILDING INDUSTRIAL WATER

A building’s industrial water system is a branch of domestic water system and serves mainly laboratory spaces and fixtures. Industrial water is generated by installing reduced pressure backflow prevention (RPBP) devices at a tee, downstream of the building domestic water RPBP. This industrial water RPBP device is intended to protect the building occupants from labs and other research areas or mechanical spaces. Note, additional water conditioning as described above may be required after the RPBP.

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| COMMON REQUIREMENTS | 22 05 13 |
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COMMON WORK FOR PLUMBING

1. Piping shall not be installed in, pass through, or enter the telecommunications room, except as needed to serve the room itself.
2. See Section 23 05 13 in Division 23 for motor requirements.
3. Section Zone Valves: Union ball valves.
4. Pressure Gauges: Pressure or vacuum type as required.
5. Gas Outlets: See Vacuum System requirements above.
6. Fuel Gas: Lubricated plug cock.
7. For maintenance and access requirements, refer to Part II Design Requirements, 'Access'.

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| METERS & GAGES FOR PLUMBING PIPING | 22 05 19 |
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Refer to the University’s Standard Specification, Section 33 12 33, Water Utility Metering, for metering requirements.

The following meters are typically not required but may be requested on specific projects.

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| <p>Utility Water Meter (IF REQ'D) Size 3/4-inch- 2-inches</p> | <p>Sensus SR1 Series (to match existing)</p> | <p>Positive Displacement Meter with an Impulse Contactor Transmitting Register 10 gallons/contact http://www.sensus.com</p> | <p>* Repeater Totalizer. ACT-PAK Model 7112-1 with non-resettable totalizer. Totalizer to read in 10 gallon increments.</p> | <p>Design Engineer to size meter based on building maximum flow. 1 1/2-inches & 2-inches meters shall be flanged. Connect the impulse contactor to the remote totalizer (if provided) or the power monitor. Install a 3/4-inch conduit from the impulse contactor or remote totalizer (if provided) to a J-box within 5 feet of the electric panel housing the electric power monitor. Connect to power monitor for SCADA interface per connection diagram.</p> |
| <p>Utility Water Meter (IF REQUIRED) Size 3-inches – 8-inches</p> | <p>Sensus SRH Series (to match existing)</p> | <p>Compound Meter with an Impulse Contactor Transmitting Register 10 gallons/contact http://www.sensus.com</p> | <p>* Repeater Totalizer. ACT-PAK Model 7112-1 with non-resettable totalizer. Totalizer to read in 10 gallon increments.</p> | <p>Design Engineer to size meter based on building maximum flow. Provide & install a Sensus AWWA type Bronze strainer and valved meter by-pass assembly. Connect the impulse contactor to the remote totalizer (if provided) or the power monitor. Install a 3/4-inch conduit from the impulse contactor or remote totalizer (if provided) to a J-box within 5 feet of the electric panel housing the electric power monitor. Connect to power monitor for SCADA interface per connection diagram.</p> |
| <p>DI Water (IF REQ'D)</p> | <p>Badger AMCO Or Equal</p> | <p>Thermoplastic Disc Meter, Model 25 or Model 40 Positive Displacement Meter Model C700</p> | | <p>Meter shall be located in the same space as DI equipment. If the facility is connected to campus DI system, a lockable valved bypass assembly shall be installed. For facilities that have RO units installed as part of the DI water treatment system, the meter shall be installed downstream of the RO unit.</p> |
| <p>Waste Water (Sewer) & Storm Drainage Lift Station Discharge</p> | <p>Rosemount, ABB, Sparling TigerMag Or Equal</p> | | | |

1. Repeater Totalizer is required only when meter cannot be easily read directly, as determined by the University's Representative.

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| HANGERS AND SUPPORTS FOR PLUMBING PIPING & EQUIPMENT | 22 05 29 |
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LIFTING EYE AT SUMPS AND PITS

Provide a lifting eye or insert in structure over any pump pit or sump located in a building to aid in future removal of equipment.

ISOLATORS

Provide pipe isolator at all hangers for non-insulated lines.

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| FACILITY DRAINAGE PIPING CLEANOUTS | 22 05 76 |
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Make all cleanouts accessible. If cleanouts are installed in an accessible ceiling space, the cleanout shall be extended through the floor above. Use graphite on all cleanouts with all threads being thoroughly greased after acceptable pressure test.

TYPES

1. Exposed: Cast iron plug.
2. In Wall: Cast-iron body, stainless steel cover.
3. In Floor or Grade: Adjustable, cast-iron body, ABS thread plug.

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| PLUMBING INSULATION | 22 07 00 |
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Insulate:

Roof and overflow drain piping inside the building; Water piping, 4-inches and smaller, exposed to the weather, including interior spaces subject to outside temperatures; Domestic hot water piping; Industrial hot water piping.

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| COMMISSIONING OF PLUMBING | 22 08 00 |
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GENERAL

Commission the plumbing system in accordance with the University's Standard Specification Section 22 08 00 Commissioning of Plumbing System.

DISINFECTION OF WATER SYSTEMS

Disinfect all domestic hot and cold water systems in accordance with the University's Standard Specification Section 33 13 00 Disinfection of Water Utility Distribution Systems.

TESTS AND ADJUSTMENTS

Test only new piping. Final connection between new and existing piping shall be tested at normal system operating pressures. Make no test against a service valve or meter. Isolate from the system all existing piping systems and new or existing equipment which may be damaged by test pressure.

No loss in pressure or visible leaks shall show after 4 hours at the pressures indicated:

| <u>System Tested</u> | <u>Test Pressure PSI</u> | <u>Test with Sanitary & Lab</u> |
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| Sanitary and Lab, Waste, Drain, Vent | 10 ft. head | Water |

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| Compressed Air | 150 PSI | Air & Soap |
| Deionized Water | 100 PSI | Deionized Water |
| Industrial and Domestic Hot & Cold Water | 150 PSI* | Water |
| Gas | 100 PSI | Air & Soap |
| Vacuum | 27 inch vac. | Air & Soap |

*or 1.5 times the operational pressure, whichever is higher

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| FACILITY WATER DISTRIBUTION | 22 11 00 |
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The building plumbing systems shall have appropriate shut off valve zoning to allow for ease of maintenance with minimal shutdown impact to building occupants. Shut off valves shall be provided on each system to isolate each toilet room.

PIPING

Domestic Cold Water

Underground: Type K copper tubing, hard temper, cold drawn.

Above Ground: Type L copper tubing, hard temper, cold drawn.

Domestic Hot Water

Underground: Pipe shall be type K copper with brazed joints in in powder insulating fill material, Gilsulate 500 XR, or equal.

Above Ground: Type L copper tubing, hard temper, cold drawn.

JOINTS

Copper Tubing: All above grade piping, 1-1/4 inch and larger, and all below grade piping, regardless of size, shall be brazed with silver solder 1000 degrees F.

FITTINGS

Copper tubing: Wrought copper or cast brass solder sweat type.

UNIONS AND FLANGES

Unions and flanges shall be provided at the inlet and outlet of all apparatus and equipment, at all valves, and elsewhere as required to facilitate removal of valves and equipment. Flexible lines shall not be used. When connecting dissimilar metals, use brass nipples. Do not use devices with plastic components in contact with the flow stream.

Two inches and smaller ground joint shall be cast bronze unions. Two and one half inches and larger shall be 150-pound flange, cast brass.

WATER HAMMER ARRESTORS

Air chambers 18 inches long and 1 pipe size larger than rough-in shall be installed at branches to plumbing fixtures. At solenoid valves and make-up valves, provide diaphragm type shock absorber, sized and located in accordance with Plumbing and Drainage Institute Manual WH-201. Provide access panels for arresters.

VALVES

Specify threaded or flanged, two piece, bronze body, full port, ball valves, with stainless steel ball and stem, for isolation/shut off valves. Valves shall be located in open, readily accessible areas, and laboratory utilities valves located in open, hallway outside each laboratory. Valves that are concealed are to be accessible via clearly marked access panels no less than 24 by 24 inches square when valves and piping are concealed above or behind new or existing finished surfaces.

Pressure Reducing Valve: All bronze, Teflon disc and diaphragm for hot water service.

Bench Valves: Ball type with tapered sockets with ball and seat compatible with piping material.

BY-PASS LOOPS

Provide valved by-pass loops at all major pieces of equipment.

HOSE BIBBS

Exterior Hose Bibbs: Shall be served by industrial or utility water services (not domestic). Provide at 100 feet maximum spacing along exterior walls. Vacuum breaker, loose key handle, 3/4-inch hose outlet, CP rough bronze, vandal proof.

Interior Hose Bibbs: Vacuum breaker, loose key handle, 3/4-inch hose outlet, chrome plated brass, vandal proof.

BACKFLOW PREVENTORS

Reduced pressure type, with drain pan and piped to nearest floor drain. Refer to list of backflow prevention assemblies published by University of Southern California - Foundation for Cross-Connection Control & Hydraulic Research (USC-FCCCHR). Where required by University representative (laboratory, housing, food service buildings, etc.), provide backflow preventers. Review sizing of parallel dual backflow preventers with University's Representative.

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| FACILITY SANITARY SEWERAGE | 22 13 00 |
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PIPING

Underground: Service weight cast iron no-hub or hub & spigot joined with compression gaskets.

Above ground:

1. >2 inch service weight cast iron no-hub with stainless steel and neoprene coupling.
2. <2 inch service weight cast iron no-hub with stainless steel and neoprene couplings, or schedule 40 galvanized steel pipe joined with Durham type threaded drainage fittings.

No reducing couplings allowed. Sewer lines at toilet room vanities shall be designed properly with sweeps rather than "Ts" to allow for snaking when blockage occurs.

All toilet rooms, laundry rooms and first floor trash rooms shall have floor drains.

FACILITY STORM DRAINAGE**22 14 00**

Roof and overflow drains shall be piped independently to outside. Overflow drain piping shall be day-lighted through exterior wall, minimum 18-inches above grade.

PIPING:

Same as above Section 22 13 00 - Facility Sanitary Sewerage.

DRAINS

1. Area Drain: Cast iron top.
2. Roof Drain: Cast iron with flange, flashing ring, gravel stop, underdeck clamp, extension, sump receiver, dome strainer, vandal proof.
3. Overflow Drain: same as roof drain plus standpipe.
4. Floor Drain: Cast iron body, N.B. top, with sediment bucket.

COMMERCIAL PLUMBING FIXTURES**22 42 00**

Bottle Filling Stations: Provide at least one per building, located at the ground floor. Individual bottle filling stations shall be installed at an accessible height. The unit shall be lead-free; contain bayonet style, non-proprietary, built-in filtration system; and shall include antimicrobial protection. Basin shall be designed to minimize splashing and standing water. Refrigerated units to be provided if installed above the second floor or if piping passes through an unconditioned basement. Verify refrigeration requirements with the University's Representative.

If drinking fountains are to be installed, provide a combined fountain/bottle filling station unit such as Elkay EZH20 System Cooler/Bottle Filling Station, Oasis Universal Barrier-Free VersaCooler II with VersaFiller, or equal.

Water Closet: Wall hung, vitreous china, siphon jet action, Maximum Performance (MaP) tested by IAPMO to exceed 500g capacity. Provide white, open front seat, less cover. Cast iron floor mounted carrier. Dual level water-conserving flush valve (1.1 and 1.6 gal/flush).

Urinal, Accessible: Wall hung, vitreous china. Provide cast iron floor mounted carrier, ultra low flow (0.125 gal/flush). Cartridge free, liquid type waterless urinal, Kohler or equal. University's Representative shall consult with Engineering, Facilities Custodial and Plumbing offices prior to approval.

Lavatory: Wall hung, vitreous china, 20 inch by 18 inch. Sanitary waste traps for equipment shall be "P" type, 17 gauge, cast brass, slip joint nuts, cast brass escutcheons, and cleanout plug. Visible traps should be chrome plated unless the project requires special finishes.

Sink (Counter Mounted): 18 gauge, type 304 stainless steel sink counter mounted, single bowl, 19 inch by 18 inch by 10 inches deep stainless steel. Deck mounted low flow faucet, lever handle, gooseneck, rigid spout plain outlet. 17 gauge chrome plated 1-1/2 inch by 1-1/2 inch trap.

Drain: 1-1/2 inch tailpiece, grid strainer. Where domestic water is untreated or unconditioned, use manual low flow fixtures.

Laboratory Faucets: Self-closing, deck-mounted, gooseneck spout with replaceable stainless steel seat. Faucet shall be fully assembled and factory tested prior to shipment. Water Saver, Chicago, or equal.

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| EMERGENCY PLUMBING FIXTURES | 22 45 00 |
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Emergency eye or eye/facewash equipment shall be provided in all work areas where, during routine operations or foreseeable emergencies, the eyes of an employee may come in contact with a substance which can cause corrosion, severe irritation or permanent tissue damage or which is toxic by absorption. This equipment shall meet the performance and installation requirements of American National Standards Institute (ANSI) Z358.1 1998. UCDEH&S shall make final determination on selection of equipment to ensure the equipment meets this standard.

LOCATION OF EQUIPMENT

All campus laboratories that use substances described above shall have at least one emergency eye or eye/facewash located within the laboratory and as close as possible to the hazard.

A combination eyewash/emergency shower shall be located within a research laboratory using hazardous chemicals as described above; or a combination eyewash/emergency shower may be located outside the laboratory provided an eyewash is located in the laboratory. The combination unit shall be located so that travel distance is no more than 10 seconds or 100 feet with no obstructions and only one door to pass through to reach the unit.

Hand held drench hoses are not considered eyewash units. They may be used in addition to equipment, which is described as meeting the ANSI standard above. In some cases, a sink-mounted eyewash and a drench hose may be installed in lieu of a combination eyewash/safety shower. Consult UCD EH&S for review and approval of this configuration.

EMERGENCY EYE WASH AND SHOWERS

The units shall be:

1. Supplied by domestic water.
2. Readily visible and accessible to the laboratory or work site. The unit should be located as close to the hazard as possible and cannot be blocked by building structures, cabinets, supplies or equipment.
3. Provided with an activation device, such as stay open ball valve, that allows the user full movement of both hands after the valve is turned on.
4. Identified with a highly visible sign.
5. Drain shall be plumbed to sanitary sewer.
6. Located so as not to pose an electrical shock hazard. No electrical outlets within 6 feet unless GFI protected.
7. Indoor units are not required to deliver tempered water. Units installed outdoors or in adverse climates may need to be tempered. The need for tempered water shall be

reviewed by University of California Davis Environmental Health & Safety (UCDEH&S) during the design phase. Consult the University's Representative.

EMERGENCY EYE WASH

Emergency eye or eye/face wash units are Haws 7611 or Guardian G1805 (laboratory unit – install at sink), Haws 7000BT or Guardian G1750PT (Barrier Free), Haws 7656WC or Guardian GBF 1735DP (recessed), or equal. In addition to the requirements above, the units shall be:

1. Regulated to provide a spray force of three to six gallons per minute at 30 psi.
2. Mounted such that the water nozzles are 33 inches to 45 inches from the floor level; height should comply with Americans with Disabilities Act of 1990 (ADA) requirements.
3. Mounted so that spray nozzles, when activated, are no more than 18 inches from the counter front when located above work counters or benches.
4. Drain shall be plumbed to sanitary sewer.

EMERGENCY SHOWERS

The unit shall be installed and located so both the shower and eyewash can be used at the same time by one person. Eyewash/emergency shower units are Haws 8346 or Guardian G1909 HFC (GBF1909 Barrier Free), Haws 8355WC (recessed), Guardian GBF2150 (recessed), or equal. Eyewash component shall meet the requirements for Emergency Eye Wash above. In addition to the requirements above, the units shall be:

1. Adequately supplied with potable water to meet the requirements of each component. The shower shall be able to deliver a minimum of 30 gallons per minute. The diameter of the water pattern of the shower measured 60 inches above the surface on which the user stands shall be a minimum of 20 inches. The center of the spray pattern shall be located at least 16 inches from any obstruction.
2. Supplied by a minimum pipe size of 1 inch.
3. Installed so that the shower head is not less than 82 inches nor more than 96 inches from the surface on which the user stands.
4. Shower component activated yearly to verify proper operation.

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| COMPRESSED AIR SYSTEMS FOR LABORATORY FACILITIES | 22 61 00 |
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GENERAL

Identify the design and installation requirements for compressed air quality, pressure and flow to meet project specific requirements.

Provide lead/lag compressors for systems requiring 10 HP compressors or larger, i.e. split one 10 HP compressor into two 5 HP lead/lag compressors.

Provide inter-cooled and after cooled, 2 stage compressors/pumps for all 5 HP systems and larger. Once through cooling water systems are prohibited.

Points of connection to existing copper air piping in existing buildings shall be crimped or compression type fitting. Soldering is not permitted.

PIPING

Above Ground: Type L copper tubing, hard drawn.

Below Ground: Type K copper tubing, hard temper, cold drawn with brazed joints.

JOINTS

Silver brazing alloy, melting point above 1000 degrees F, 15 percent silver, 80 percent copper 5 percent phosphorous.

FITTINGS

Wrought copper or brass, solder sweat type. Couplings shall be of the staked stop type.

VALVES

Ball valves

LAB AIR OUTLETS: Line size, Ball valve or needle valves to match project requirements.

Refer to CSDG Section 22 63 00 for Ultra Pure system requirements.

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| VACUUM SYSTEMS FOR LABORATORY FACILITIES | 22 62 00 |
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GENERAL

Identify the design and installation requirements for vacuum, pressure and flow to meet project specific requirements.

PIPING, JOINTS, FITTINGS, VALVES and LAB AIR OUTLETS

See Compressed Air System requirements above.

VACUUM PUMP

Furnish air-cooled duplex vacuum unit, Ingersoll-Rand, Worthington, or equal. Unit to come complete with base mounted pumps, American Society of Mechanical Engineers Association (ASME) tank with sight glass, drain, flexible connection, scrubber, check valves, relief valves, control panel including fused disconnect, vacuum switches and gauges, motors, starters, electrical alternator. NEMA rating shall be specified based on the location of equipment.

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| GAS SYSTEMS FOR LABORATORY FACILITIES | 22 63 00 |
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SPECIALTY GASES

This section applies to laboratories that require Ultra Pure piping system for special gases including compressed air, nitrogen, oxygen, CO₂, Argon, etc.

Identify the design and installation requirements for quality, pressure and flow for all specialty gasses to meet project specific requirements.

Comply with NFPA 99 requirements for Gas and Vacuum Systems. Although this standard applies to Health Care systems, the requirements noted in this standard shall be applied for special lab air system.

Nitrogen and Argon: Plug Shutoff Valve; Circle Seal 9259 with Buna-N O-ring, or equal (no known equal).

INSTALLATION

GENERAL

Screwed Connections: Wherever possible, screwed joints made in attaching valves, or other permanently connected equipment shall be silver brazed after assembly using precautions to avoid overheating the valve or equipment. Where conditions do not permit this method of assembly, the connection joints shall be tinned or sweated with solder. No joint compound shall be used.

Grounding: All oxygen, nitrous oxide and vacuum lines shall be grounded to the water supply system to reduce the possibility of static electric charges.

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| LABORATORY CHEMICAL WASTE AND VENT PIPING | 22 66 00 |
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PIPING

All piping shall be Schedule 40 flame retardant polypropylene pipe and fittings joined with fusion coil joints, Enfield "Enfusion" or equal, except piping around the benches and equipment shall have mechanical joint fittings by Enfield, "Labline" or equal. Compression fittings are not allowed.

Above ground accessible: Schedule 40 flame retardant polypropylene pipe and fittings joined with grooved pipe mechanical joint fittings by Enfield "Labline" or equal. Compression fitting is not acceptable. All acid waste piping around benches and equipment shall have mechanical joint fittings. Chemically resistant glass drain line piping may be used for repair of material in existing buildings only.

TRAPS

Universal, 1-1/2 inch Polypropylene clear base, Enfield W5115, Harrington or equal. Acid waste traps for equipment shall be Nalgene 96025-1500, Sloane, or equal, drum trap with drain connection adapter and union connection. Sanitary waste traps for equipment shall be "P" type, 17 gauge, cast brass, slip joint nuts, cast brass escutcheons, and cleanout plug. Visible traps should be chrome plated unless the project requires special finishes.

SUPPORTS

Horizontal polypropylene piping shall have a continuous 16-gauge galvanized sheet metal trough support or maximum 2 foot support spacing system.

FIXTURES

Funnel Sink: Cast iron, with trap and 6 inch diameter inlet.

Cup Sink: Polyethylene, oval with integral waste fitting, 1-1/2 inch with polypropylene trap.

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| PROCESSED WATER SYSTEMS FOR LABORATORY FACILITIES | 22 67 00 |
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SYSTEM DESIGN

When program needs for new campus facilities require specially treated water supplies (e.g., deionized water for laboratory needs), these needs shall be met by providing on-site treatment systems. Such systems may include carbon filters, water softeners, reverse osmosis units, ion exchange systems, and ultraviolet light disinfection systems with ultra filtration. Review with University representative the project specific requirements for water quality, quantity, pressure and flow to identify the design and installation requirements.

Life-cycle costing shall be used to select system components (e.g., the use of resin beds vs. reverse osmosis units). Consideration should also be given during design for future needs in the facility and/or adjacent areas to allow for future expansion of local water treatment devices to meet higher flow and/or water quality requirements. Leased systems shall not be used to meet new facility needs.

If Reverse Osmosis system is used, it shall have a regenerating type of softener with backwashing carbon filters in lieu of exchange bottles.

Deionized water systems shall be designed to provide for a minimum 1 megohm system unless otherwise required by the University representative. The system shall be recirculating.

PIPING, JOINTS, FITTINGS AND UNIONS

Pipe, fitting, unions and control valves manufactured of polyvinyl chloride PVC, Gray Standard Schedule 80 manufactured specifically for deionized water service. Metric sizes are not acceptable. Pipe shall be sterilized and capped prior to shipment. Fittings, unions and valves shall be sterilized and individually packaged after production. Joining shall be by socket weld, procedure as recommended by pipe manufacturer. No threaded joint or flexible connection shall be permitted.

VALVES

Control and Bench Valves: Ball type with tapered sockets with ball and seat compatible with piping materials. Use aluminum coupler to connect to bench valve.

Bench outlets: Self-closing, hot tin lined, deck-mounted, gooseneck spout with replaceable stainless steel seat. Faucet shall be fully assembled and factory tested prior to shipment. Water Saver Pure Water Faucet, Chicago Pure Water Faucet, or equal.

For foot operated outlets: floor mounted, tin-lined, self-closing renewable unit with stainless steel single valve system. Water Saver Tin-Lined, Foot-Operated Single Valve with manufacturer's recommended coordinating deck-mounted, tin-lined gooseneck spout, or equal.

SUPPORTS

Piping 2 inches and smaller and all horizontal piping shall have continuous 16-gauge galvanized sheet metal trough support or maximum 2 foot support spacing system.

CLEANING

All pipe, fittings, valves, and system-related materials shall be cleaned before use. Minimum requirements for cleaning procedures are:

1. Alconox detergent and 30 percent hydrogen peroxide cleaning agents.

2. Circulating pump.
3. 1 percent potassium permanganate testing solution.
4. The deionizer equipment may be used for cleaning the piping system.

ULTRA PURE DEIONIZED SYSTEMS

Piping, joints and fittings: Unpigmented (natural) polypropylene, copolymer Type 1, Schedule 40 butt-fusion and/or socked fusion. The system shall be recirculating through deionized polishing bottles. The entire system shall be sterilized. For bench valves for ultra pure water, use Chicago 828PVDF (solid PVDF valve), or equal.