DIVISION 22 – PLUMBING

Includes the following sections:

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22 66 00	Chemical Waste and Vent Piping For Laboratory Facilities
22 67 00	Processed Water Systems for Laboratory Facilities

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

DESIGN REQUIREMENTS

The following design criteria shall be followed regardless of system type or size. Any deviations from these criteria shall be discussed and accepted by the University's Representative during the preliminary design phase of the project and prior to any construction.

PLUMBING SYSTEMS CONNECTIONS

Verify points of connection to existing utilities with the University's Representative and Division 33. All utility services include, but are not necessarily limited to, building water (domestic, fire protection, industrial, carbon filtered, softened, purified reverse osmosis (RO), purified deionized (DI), irrigation), sanitary sewer waste and vent, storm drainage, natural gas, and propane on site.

DESIGN DOCUMENTS REQUIRED: PLUMBING SYSTEMS STUDIES, SINGLE LINE DIAGRAMS, AND CALCULATIONS

The following shall be performed by the designer and submitted in addition to design drawings and specification documents for review:

1. Studies: Where new plumbing systems are being added to existing plumbing systems, the entire system shall be studied for sizing, flow capacity (DFU's, WFU's, CFH's, etc.), and performance (internal pipe velocities, head losses, etc.). Designer shall confer with UC Engineering staff and Physical Plant Plumbing Shop for known limitations or problems associated with each existing plumbing system that is being added to. Many

older plumbing system's equipment, valves, etc. are in poor shape and unsuitable for continued use and may be on a deferred maintenance list. Some existing sanitary sewer laterals to buildings have either root intrusion or so internally corroded the bottom of the pipe is gone. All of these issues should discovered and documented during the design phase to ensure the new plumbing systems are properly designed and budgeted for before going out to bid.

2. Coordination with Physical Plant Plumbing Shop: The service technicians have a lot of direct experience maintaining existing plumbing systems on Campus. They have design and equipment specification preferences that change regularly based on challenges encountered post construction, thus they should be engaged early in the design process to take advantage of lessons learned and identify designs and specifications of equipment they specifically don't want to have to maintain.
3. Single Line Diagrams Required:
    a) Where new plumbing systems are being added to existing plumbing systems, the entire system shall be depicted in a single line diagram including all connected equipment (appliances, valves, instrumentation, controls, etc.), pipe sizes, flow capacities, (DFU's, WSFU's, CFH's, etc.), and performance (internal pipe velocities, head losses, etc.).
    b) Domestic, Industrial, Sanitary, and Storm Drainage Systems: The single line diagrams shall be in the form of riser diagrams for multi-story buildings and include all items listed in part a).
    c) Natural Gas Fuel Piping System: The single line diagram shall include the anodeless riser, filter, regulator, meter, gas cocks, and distribution piping to every appliance, final connection including isolation gas cock, drip leg, and AGA certified stainless steel flex connector and union at point of connection to appliance. Single line diagram shall explicitly indicate if meter, regulator, and filter are provided by PG&E or UCSC.
    d) Generator Propane Systems: The single line diagram shall include the tank, regulator(s), valves, vaporizer (if needed), filter, drip leg, AGA certified stainless steel flex connector, and explicitly indicate which sections of piping shall be:
        i. Schedule 80 piping with 2000 psig welded fittings and 250 psig valve ratings per NFPA-58 and Title 8.
        ii. Schedule 40 piping with threaded fittings and 125 psig valve rating per NFPA-58 and Title 8.
4. Load Calculations Required:
    a) Water Supply Fixture Units (WSFU's) per UPC Chapter 6 and Appendix A sizing procedures. Calculation shall include UPC Charts A-2 through A-7 as applies and a flushometer valve sizing summary.
    b) Sanitary Waste and Vent Fixture Units (DFU's) per UPC Chapter 7 and 9 sizing procedures. Calculation shall include UPC Table 7-5.

c) Storm Drainage Projected Roof Areas per UPC Chapter 11 sizing procedures. Calculation shall include UPC Table 11-1 through 11-3.

d) Natural Gas Fuel Piping per UPC Chapter 12 sizing procedures.

e) Generator propane tank sizing including generator design run time, gallons per hour consumption, tank volume, and a determination of whether or not a vaporizer is required for proper performance.

5. Load Calculations Format: designer shall submit all calculations in Microsoft Excel spreadsheet format for future updating during remodels, alterations, etc.

6. Legacy of Single Line Diagrams and Calculations: It is the University's intent for the Single Line Diagrams and Calculations to be the building's perpetual living model documents that will be continuously modified and or updated for future building remodels, alterations, etc. For this reason, single line diagrams and calculations shall be updated and submitted by the Engineer of Record at the end of the project to reflect as-build conditions. In addition, as-built CAD and spreadsheet calculations shall be submitted in both native AutoCAD .DWG file format, Excel spreadsheet, and Acrobat PDF file formats. Before generating any single line diagrams or calculations, the Design Engineer should confer with Archives to determine if there are already AutoCAD single line diagrams and Excel spreadsheet files available to modify. The newer buildings on campus should have them, but the older ones won't. If Archives does not have them, they will need to be generated from scratch. It is the Design Engineer's responsibility to ensure they have included the appropriate time and fees in their proposal to generate and deliver these as-built single line diagrams and calculations.

SYSTEMS DEFINITION

WATER: Campus is served by three water distribution systems: potable, non-potable and agricultural water.

CAMPUS WATER DISTRIBUTION

The potable water is identified as the Campus Water Distribution System. This system serves each building's domestic water, industrial water, fire sprinkler water, and site irrigation 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 only.

UTILITY WATER (PURPLE PIPE)

The non-potable water supply system is intended to be designated in the future as the Utility Water Distribution System. It's intended primarily use will be for parallel purple pipe systems in buildings to flush toilets, provide irrigation outdoors, or potentially provide make-up water to evaporative cooling towers on Campus. This system is in its infancy and is not distributed throughout campus yet as a district level system. Only a few buildings on campus have purple pipe systems roughed in. The City of Santa Cruz is in the process of studying whether or not to

provide a non-potable water main to the base of Campus. At some time in the future the Campus may connect to this water source and distribute it throughout campus as a district distribution system.

IRRIGATION WATER

The non-potable water supply system is designated as the Irrigation System and is primarily used for landscape irrigation via hose bibbs with vacuum breakers, quick disconnects, lawn impact sprinklers, drip irrigation, etc. This system has a dedicated high hazard backflow prevention device that comes off the Campus Water 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 systems, and process water needs (i.e. DI, RO, etc.).

The building domestic water service shall provide the following:

1. Refer to Division 33 for requirements for reduced pressure backflow prevention devices (RPBP) and strainers.
2. 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.
3. Perform water pressure calculations to determine the need for a domestic water booster pump. Size water piping to avoid booster pump if possible. If needed, water booster pumps shall be controlled with VFDs and have pressure transducers.
4. Incoming domestic water shall be plumbed with injector fittings for water system chlorination testing.

FIRE WATER

This system utilizes domestic water for fire protection systems, including fire hydrants and sprinkler systems.

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. See section 22 67 00 Processed Water for Laboratory Facilities.

CARBON FILTERED WATER

Carbon filters are filled with activated carbon, and can be regenerated by a backwash cycle. Carbon filters shall be equipped with an electro mechanical metered Fleck valve, or equal. Carbon filters remove in-organic material (manmade) elements such as pesticides and chlorine. It

is important to remove these elements upstream of the reverse osmosis system (RO), because these elements quickly destroy the RO membrane.

SOFTENED WATER

Soft water is water that is treated by ion exchange within the softener. Elements such as iron, calcium, and magnesium are removed by ion exchange and replaced with sodium ions. This results in a slightly higher TDS. (From 360 TDS – 380 TDS) Water softeners shall be equipped with an electro–mechanical metered Fleck valve, or equal. (See Applied Membranes softeners)

REVERSE OSMOSIS (RO) WATER

Reverse osmosis is a filtration method that removes particles by passing water across a semipermeable membrane. During the RO process, 95 – 99 percent of all dissolved solids and bacteria are removed. Most RO systems on campus are set at a 50 percent recovery rate, but can somewhat be adjusted to waste less water at the risk of reducing the life of the RO membrane. The water produced has 1-3ppm and is approximately ½ megohm in quality.

DEIONIZED (DI) WATER

Deionized water results from a filtration method which removes the electrically charged atoms and molecules by passing water through ion exchange resins. The Campus uses mixed bed resin beads in the ion exchange DI bottles, which exchanges elements such as potassium, aluminum, manganese, etc., for hydrogen and hydroxide ions to form pure H2O. In non-circulating systems, 2-10 megohm water is produced. In circulating loop systems with ultra-violet and high purity filters, purity can be as high as 18.3 megohm.

SANITARY SEWER

The Campus wastewater system consists of the collection piping network. The entire sanitary sewer system flows to the bottom of Campus and out to the City of Santa Cruz treatment facility. Coordinate new building service lateral location with Division 33 30 00.

NATURAL GAS

The Campus natural gas system consists of a predominantly below grade 10 psig distribution piping network. The entire natural gas system is supplied by PG&E at the Utility Yard off Empire Grade at the base of Campus. Coordinate new building service lateral with Division 33 51 00.

COMMON REQUIREMENTS 22 05 13

GENERAL REQUIREMENTS

1. Piping shall not be installed in, pass through, or enter a telecommunications room, except as needed to serve the room itself. Example: condensate drain from a TR fancoil.
2. When sizing all domestic and industrial cold, hot, and hot recirculation piping the piping friction losses shall not exceed Xylem Brand Bell and Gossett System Syzer Calculator for Normally Used Design Range of 4.5 to 0.8 feet per 100 feet of accumulated fully developed pipe friction loss inclusive of all pipe, fittings, and valves.
3. When sizing domestic or industrial return piping systems, the piping shall be sized to limit the internal fluid velocity to a maximum of 3 feet/second. Specifications of these return

systems shall include the TAB subcontractor setting and recording the pump downstream circuit setter to limit the return flow to this requirement.

4. Existing Lab Buildings: When extending existing utilities into a new or remodeled lab, the new piping shall be the same full size as the point of connection to the existing piping. The new full size piping shall extend approximately 4 feet into the lab space with new isolation valves within 12 inches of the penetrated wall. At the end of the new extension, the new piping can be reduced to actual required pipe size for the service to appliances in the lab.

METERS & GAGES 22 05 19

Refer to the University's Standard Specification, Section 33 05 33, for Water Utility Metering and Gas Meter Utility Metering, for metering requirements. Note the water meter radio telemetry has to be programmed by the Physical Plant Energy Management shop. Also note the Physical Plant Energy Management shop typically monitors gas meter heads for pulse output of total CFH for buildings and generators.

VALVES 22 05 23

A. General Requirements:
   1. All water valves regardless of service type shall be lead free.
   2. Valves shall be located in readily accessible areas.
   3. Valves that are concealed are to be accessible via clearly marked access panels when located above or behind new or existing finished surfaces. Access panels shall be a minimum of 12 inches by 12 inches, or as needed for maintenance access and removal of valves.
   4. Each laboratory room shall have dedicated master manual shut off valve isolating all outlets in the lab and identified with explicit signage within the lab.
   5. Valves shall not be installed with handles in the downward position.
   6. Coordinate valve locations with all other obstructions to prevent ¼ turn valve handles from having to be bent to miss obstructions while turning. Bent valve handles are prohibited.
   7. All valves shall be tagged and listed in a project valve schedule. Coordinate valve tag naming convention with Physical Plant Plumbing Shop.

B. General Purpose Shut-off Valves:
   1. Performance Requirements: 1/4 turn, 2-piece, brass body, brass ball, brass stem with Teflon seats, threaded or flanged connection (depending on application)
   2. Products: Apollo, Milwaukee, Hammond or equal. AGA certified.

C. Pressure Reducing Valves:
   1. Performance Requirements: All brass, Teflon disc and diaphragm for hot water service, threaded or flanged connection (depending on application).
   2. Products: Watts, Wilkins, or equal.

3. Pressure Gauges: upstream and downstream piping of each pressure reducing valve shall have a pressure gauge with a range demonstrative and within the full operating pressure range of the reducing valve.

D. Fixture Shut-off Valves:
   1. Performance Requirements: All brass, quarter turn angle stops, threaded only.
   2. Products: Brass Craft or equal

E. Check Valves:
   1. Performance Requirements: All brass swing check or 1/2 lb. spring check type, threaded or flanged connection (depending on application). To minimize pump head pressure losses, a counter weighted mechanical swing check shall be considered.
   2. Products: Apollo, Milwaukee Hammond or equal.
   3. For parallel pumping applications, a non-slam butterfly type check valve shall be used.

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

G. Laboratory Valves (air, gas, vacuum):
   1. Performance Requirements:
      a. Laboratory grade with forged brass ¼ turn lever handles and removable hose barb.
      b. Rotating chrome plated brass ball and molded RFE seals
      c. Rated for use up to 75 psi
   2. Products: Water Saver, Chicago, T&S Brass, or equal

HANGERS AND SUPPORTS 22 05 29

A. LIFTING EYE AT SUMPS AND PITS
   1. General Requirements: Provide a lifting eye over any pump pit or sump located in a building to aid in removal of equipment.

B. ISOLATORS
   1. General Requirements: Provide felt or rubber lined hangers for non-insulated copper piping.

PLUMBING IDENTIFICATION 22 05 53

For more information, refer to the University's Standard Specification 22 05 53 Plumbing Identification.

FACILITY DRAINAGE SANITARY SEWER CLEANOUTS 22 05 76

A. Cleanouts:
   1. General Requirements:
      a. Make all cleanouts accessible with a minimum of 18" clearance in all directions.
      b. If cleanouts are installed in an accessible ceiling space, the cleanout shall be extended through to the floor above.
      c. Use graphite on all cleanouts with all threads being thoroughly greased after acceptable pressure test.
      d. Provide end of line clean outs on upper floor branch lines.
   2. Performance Requirements by type:
      a. In Floor or Grade: Adjustable, cast-iron body, brass plug and cover. Plug shall be installed within 1-inch of finished floor.
      b. In Wall: Cast-iron body, brass plug with stainless steel cover.

PLUMBING INSULATION 22 07 00

A. Insulation is required at the following conditions:
   1. Roof and overflow drain piping inside the building
   2. Water piping, 4-inches and smaller, exposed to the weather, including interior spaces subject to outside temperatures
   3. Domestic hot water piping
   4. Industrial hot water piping
   5. Traps and hot water supply at ADA compliant sinks and lavatories. Exception: public lavatories with only cold water supply.

COMMISSIONING OF PLUMBING 22 08 00

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

B. DISINFECTION OF WATER SYSTEMS
   1. Disinfect all domestic cold, hot, and hot recirculation water systems in accordance with the University's Standard Specification Section 33 13 00 Disinfection of Water Utility Distribution Systems.
   2. Disinfect all D.I. water systems in accordance with industry standards for high purity systems.

C. TESTS
   1. Test only new piping.
   2. Final connection between new and existing piping shall be tested at normal system operating pressures.
   3. Make no test against a service valve or meter.

4. 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:

System Tested	Test Pressure PSI	Test with
Sanitary and Lab, Waste, Drain, Vent	10 ft. head	Water
Compressed Air	150 PSI	Air & Soap
Deionized Water	100 PSI	Deionized Water
Industrial and Domestic Hot & Cold Water	150 PSI*	Water
Medical Gas	110 PSI	Air & Soap
Natural Gas p.c. 1204.3.2	Low Pres: 10 PSI/15 min. Med Pres: 60 PSI/30 min.	Air & Soap
Vacuum	110 PSI 27 inch vac.	Air & Soap

*or 1.5 times the operational pressure, whichever is higher

DOMESTIC WATER DISTRIBUTION 22 11 00

A. General Requirements
   1. The building plumbing systems shall have appropriate shut off valve zoning to allow for ease of maintenance with minimal shutdown impact to building occupants.
   2. At minimum, shut off valves shall be provided for the following: each floor, each toilet room, each laboratory room, each equipment room, and each kitchen.

B. Piping
   1. Above grade: Type L copper tubing
      a. 1-1/2 inches and below: soft drawn
      b. 2 inches and above: hard temper, cold drawn
   2. Below grade: Type K copper tubing
      a. 1-1/2 inches and below: soft drawn
      b. 2 inches and above: hard temper, cold drawn
   3. Thin walled Type M copper is prohibited.

C. Joints
   1. All above grade piping, 2 inches and larger, and all below grade piping, regardless of size, shall be brazed with silver solder (silver/phosphorus).

D. Fittings
   1. Copper tubing: Wrought copper or cast brass solder sweat type. The pulling of tees is prohibited.

E. Unions and Flanges
   1. General Requirements:

a. 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.
b. Flexible lines shall not be used in laboratories.
c. When connecting dissimilar metals, use brass nipples. Do not use devices with plastic components in contact with the flow stream.
d. 2 inches and smaller ground joint shall be cast brass unions.
e. 2-1/2 inches and larger shall be 150-lb flange, cast brass.

F. Water Booster Pumps
1. Performance Requirements: Provide a multistage vertical pump system equipped with an integral electronic transducer controlled variable frequency drive, complete controls, and an expansion tank for reduced pump on/off sequencing.
2. Products: Grundfos, Canaris, or equal

G. Water Hammer Arrestors
1. Performance Requirements:
a. Provide diaphragm type shock absorber, sized and located in accordance with Plumbing and Drainage Institute Manual WH-201.
b. Provide shut-off valves and access panels for arresters.

H. Valves
1. General Requirements:
a. Valves shall be located in open, readily accessible areas, and laboratory utilities valves located in open, hallway outside each laboratory.
b. 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.
2. Performance Requirements: Refer to Section 22 05 33

I. By-pass Loops
1. Provide valve by-pass loops at all major pieces of equipment.

J. Hose Bibbs
1. General Requirements: Vacuum breaker, loose key handle, 3/4-inch hose outlet, vandal proof bonnet. Turn keys over to Physical Plant Plumbing Shop.
2. Exterior Hose Bibbs: Shall be served by industrial or utility water services (not domestic). Provide at 100 feet maximum spacing along exterior walls. Shall be CP rough brass.
3. Interior Hose Bibbs: Shall be chrome plated brass.

K. Backflow Preventers
1. General Requirements:
a. Where required, provide backflow preventers to separate industrial water from domestic water, on make-up water to hydronic systems, on irrigation supplies, and any other locations where prevention of backflow is critical for safety.

b. On industrial water for labs, provide parallel backflow prevention devices sized at 50 percent of the flow each.
c. On make-up water to hydronic systems, provide a single backflow prevention device.
d. Reduced pressure type, with brass air gap fitting and piped to nearest floor drain.
e. Backflow prevention devices shall be located for easy access for maintenance. They shall not be installed higher than 5-feet above the finished floor, in ceilings, or in concealed spaces.

FACILITY SANITARY SEWERAGE 22 13 00

A. General Requirements:
   1. All toilet rooms, laundry rooms and first floor trash rooms shall have floor drains.
   2. Sewer lines at toilet room vanities shall be designed properly with sweeps rather than "Ts" to allow for snaking when blockage occurs.
   3. No reducing couplings allowed.

B. Piping:
   1. General Requirements:
      a. Service weight cast iron
      b. Above or underground no hub waste piping must use 4-band couplings
      c. No hub waste vent piping may utilize 2-band couplings
   2. Underground piping: no-hub or hub & spigot joined with compression gaskets.
   3. Above ground piping:
      a. >2 inch no-hub with stainless steel and neoprene coupling.
      b. <2 inch no-hub with stainless steel and neoprene couplings, or schedule 40 galvanized steel pipe joined with Durham type threaded drainage fittings.

C. Sanitary Sewer Ejection (Lift Station):
   1. General Requirements: Lift stations are a last resort design. Design Engineer will have to submit calculations to prove a lift station is required due to lack of available gravity fall to existing site's sanitary mains. Only the lowest building floors will be piped directly to a lift station. All other floors above shall be gravity piped to the existing sewer main. Lift Station pumps flow controls shall be set as individually operated; provide pumps with chopper blades; each pump's check valves shall be counter-balanced.
   2. Lift Station shall have N+1 reliability for pumps and the entire lift station system shall be on standby power. This includes both pump and controls power.
   3. Lift Station shall have BMS controls alarm monitoring for pump command verses status for each pump, and a high level alarm. BMS monitoring system shall be on standby power. Design Engineer shall coordinate with Divisions 25, 26 and 27 for fulfillment of these requirements.

FACILITY STORM DRAINAGE 22 14 00

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

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

C. Drains:
   1. General Requirements: cast iron, unless otherwise noted.
   2. Types:
      a. Area drain: Cast iron top
      b. Roof and overflow drains: Cast iron with flange, flashing ring, gravel stop, underdeck clamp, extension, sump receiver, dome strainer, vandal proof, standpipe (overflow only).
      c. Floor drain: Cast iron body, N.B. top, with sediment bucket.

FACILITY NATURAL GAS 22 16 00

DESIGN CRITERIA:

A. For new buildings to be connected to the campus natural gas system, the anticipated additional gas demand (in cubing feet per hour) should be identified early during preliminary planning. This anticipated gas demand should be submitted to the Principal Engineer for UCSC Physical Planning and Construction. Improvements to the campus system may be required to accommodate the additional demand. The Principal Engineer shall identify a suitable point of connection to the campus system and what system improvements may be necessary to accommodate the new service to the building or generator.
B. Coordinate with Division 33 51 00 for service lateral riser location with gas cock for point of connection where gas meter is to be installed.
C. Gas Systems shall be designed in accordance with the Uniform Fire Code with California Amendments and NFPA- 54.
D. For each new service provide a removable gas filter, a regulator to regulate service pressure from 10 psig to 7" water column (or higher pressure depending on the downstream equipment needs such as standby or emergency generators), and a meter (See Division 33 05 33 for gas meter requirements).
E. The meter shall be installed at service connection to the building in an accessible location with proper distance between regulator vent to openings into the building. Meter shall be capable of local and remote read-out by Division 25.
F. Each new building service shall have a seismically activated earthquake shutoff valve.
G. New service for standby and emergency generators shall be independently regulated, metered, but shall not have a seismically activated shutoff valve.
H. Coordinate with Division 25 for BMS requirements for summation of meter pulse output.
I. Coordinate with Division 26 for conduit run between gas meter and BMS panel.
J. Piping: Schedule 40, galvanized steel outdoors, black steel indoors.

MATERIALS:

STEEL PIPE

Pipe - Black steel, Schedule 40 with X-Trucoat, Greenline, or equal, factory wrap on buried lines.

Fittings

1. Above Ground: 3" and larger – butt-welded with laddich fittings, 2-1/2" and smaller - malleable iron threaded

Valves

1. Valves under 3" shall be threaded and made up with threaded nipples, in a vise, before inserting into the line by welding. Valves three inches and larger shall be generally flanged and attached to slip-on welding flanges.
2. Lubricated plug cock: 1 inch and larger, Rockwell 115, Walworth, or equal.
3. Corporation stops of dissimilar metal shall not be used.

Unions

1. Flanged or threaded metal-to-metal shall be used.
3. Dielectric (insulated) unions shall be installed at designated points for cathodic protection.
4. Regulators and meters shall be protected from damage.

Regulators

1. Indoor: individually terminate regulator vents full size outdoors with elbow face down.

Corrosion Control - In order to provide protection of metal pipe from external, internal and atmospheric corrosion, provide an external protective coating and a cathodic protection system designed to protect the pipeline in its entirety. Above grade piping shall be painted Safety Yellow.

1. Field Wrapping with cold - applied tape
    a. Field joints shall use "Protectowrap" #200 with 1170 primer or equal. When coating odd shapes containing bolts, voids, or hard-to-wrap surfaces, two coats of mastic-type primer shall be used instead of the above primer, with special care to assure that all surfaces are coated without introducing voids or pockets.
    b. The bare metal surface to be wrapped must be dry and cleaned of rust, dirt, oil, and weld slag.
    c. Whenever tape wrap is applied over yard wrap, the outer coating of Kraft paper, whitewash, mica, flakes, protective plastic outer wrap, etc., shall be removed.
    d. Plastic coated pipe, prime area to be wrapped plus a minimum length of 4 inches from the cutback edge.
    e. Tape shall be applied by first lapping over approximately one tape width of the prepared end of the wrap. The wrap should be spiraled along the line, with each spiral overlapping the previous spiral by one-half the tape width plus one-quarter inch, to assure a double thickness at all points. The tape should be applied with enough tension to achieve a tightly bonded smooth wrap, free of wrinkles or voids. Do not over-stretch.
2. Plastic or Tape Coating - On plastic-coated pipe, repairs shall be treated as a large defect by wrapping completely around the pipe as required. The entire plastic surface to be coated shall be cleaned. On tape-coated pipe, repairs shall be done by removing the outer wrap several inches back from the area of defect, then prime and apply tape to the damaged area. It is not necessary to remove the inner wrap.

Inspection of Materials - Each length of pipe and each other component must be visually inspected at the site to ensure it has not sustained any visual damage, and the pipe shall be inspected for holidays, using an approved holiday tester, prior to installation in trench. Coordinate

test with University's Representative for witnessing. At least 48 hrs. notice shall be given. Lacerations of the protective coating shall be carefully examined prior to the repair of the coating to see if the pipe surface has been damaged. All repairs, replacements, or changes shall be inspected before they are covered up.

Qualification of Welders - Only welders who are currently qualified in accordance with the following may perform welds on gas pipeline:

1. Section IX of the American Society of Mechanical Engineers Association (ASME) Boiler and Pressure Vessel Code.
2. Section 3 of American Petroleum Institute (API) Standard 1104
3. Appendix C of Federal Register, Vol. 35, No. 161.

PLUMBING EQUIPMENT 22 30 00

A. Domestic water softeners
   1. Performance Requirements:
      a. Equipped with an electro-mechanical metered valve.
      b. Valve bodies shall be lead-free brass
   2. Products: Valve: Fleck, or equal.

B. Carbon filters
   1. Performance Requirements:
      a. Equipped with an electro-mechanical metered valve.
      b. Filter shall be activated carbon and regenerated by a backwash cycle.
   2. Products: Valve: Fleck, or equal.

C. Reverse Osmosis
   1. Performance Requirements: Recovery rate shall be set at a minimum of 50 percent and shall be adjustable to reduce water use.

COMMERCIAL PLUMBING FIXTURES 22 42 00

A. Drinking Fountains with Bottle Filling Stations:
   1. General Requirements:
      a. Provide at least one per building, located at the ground floor.
      b. Drinking fountain shall have a high/low arrangement for both standard and accessible drinking heights.
      c. If drinking fountains are to be installed, provide a combined fountain/bottle filling station unit.
      d. Individual bottle filling stations shall be installed at an accessible height.
      e. Basin shall be designed to minimize splashing and standing water.
      f. 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.

2. Performance Requirements: The unit shall be lead-free; contain bayonet style, non-proprietary, built-in filtration system; and shall include antimicrobial protection.
3. Products: Elkay EZH20, Oasis Versacooler II, or equal.

B. Water Closet:
    1. General Requirements:
        a. Provide wall hung with cast iron floor mounted carrier or floor mount, depending on application.
        b. Height of flushometer valve shall allow for maintenance in locations with ADA grab bar.
    2. Performance Requirements:
        a. Provide vitreous china, siphon jet action, Maximum Performance (MaP) tested by IAPMO to exceed 500g capacity.
        b. Flushometer: Exposed, heavy duty commercial grade, diaphragm-type, manual 1.28 gallons per flush (GPF) flush valve. Battery operated flush valves prohibited.
        c. Seat: White, heavy-duty, commercial grade, elongated, open front, solid plastic, with stainless steel hinges.
    3. Products:
        a. Water closet: American Standard, Kohler, or equal
        b. Flushometer: Zurn, Sloan, or equal.

C. Urinals
    1. General Requirements:
        a. Urinals shall be accessible.
        b. For renovations, existing piping network shall be evaluated for size and slope.
    2. Performance Requirements:
        a. Wall hung, ultra-low flow 0.125 GPF, vitreous white china with in wall carrier
        b. Side discharge units are not acceptable.
        c. Flushometer: Exposed, heavy-duty commercial grade, diaphragm-type, manual ultra-low flow 0.125 GPF. Battery operated flush valves prohibited.
    3. Products: Zurn, Sloan, or equal

D. Wall-hung lavatory (with domestic hot water and cold water service in Residence Halls, Dormitories, Apartments):
    1. General Requirements: Visible traps should be chrome plated unless the project requires special finishes.
    2. Performance Requirements:
        a. 4-inch center vitreous china, with concealed carrier arm
        b. Sanitary waste traps for equipment shall be “P” type, 17 gauge, cast brass, slip joint nuts, chrome-plated brass escutcheons, and cleanout plug.
    3. Products: American Standard, Kohler, or equal
    4. Mounting height: may need to be adjusted to comply with current ADA requirements for rooms with ADA access requirements.
    5. Faucet: Heavy-duty commercial grade, ceramic cartridge, ultra-low flow 0.35 gpm spray; Moen, Zurn, or equal. Operation shall be ADA compliant where used to serve ADA compliant fixtures.

E. Wall-hung lavatory (with domestic cold water service only in common restrooms of Academic, Labs, Science Buildings):
   1. General Requirements: Visible traps should be chrome plated unless the project requires special finishes.
   2. Performance Requirements:
      a. 1-hole center vitreous china, with concealed carrier arm
      b. Sanitary waste traps for equipment shall be “P” type, 17 gauge, cast brass, slip joint nuts, chrome-plated brass escutcheons, and cleanout plug.
   3. Products: American Standard, Kohler, or equal
   4. Mounting height: may need to be adjusted to comply with current ADA requirements for restrooms with ADA access requirements.
   5. Faucet: Heavy-duty commercial grade, ceramic cartridge, metered ultra-low flow 0.35 gpm spray; Moen, Zurn, or equal. Operation shall be ADA compliant where used to serve ADA compliant fixtures.

F. Showers (with domestic hot water and cold water service in Residence Halls, Dormitories, Apartments):
   1. General Requirements: All exposed trim shall be chrome plated unless the project requires special finishes.
   2. Performance Requirements:
      a. Shower Head: Low-flow 1.5 gpm.
   3. Products: Fixture – American Standard, Kohler, or equal. Shower Heads: Bomar, Chicago, or equal.
   4. Shower Heads: may need to be provided with 60” hose and sliding shower head bar adjusted to comply with current ADA requirements for showers with ADA access requirements.
   5. Faucet: Heavy-duty commercial grade, ceramic cartridge, pressure independent anti-scalding mixing valve with integral stops. Operation shall be ADA compliant where used to serve ADA compliant fixtures.
   6. Drain: 3 inch with stainless steel grid strainer.

G. Sink, general purpose (within Academic Buildings):
   1. Performance Requirements:
      a. 18 gauge, type 304 stainless steel sink; 17 gauge chrome plated 1-1/2 inch by 1-1/2 inch trap
      b. Deck mounted low flow faucet, lever handle, gooseneck, rigid spout plain outlet.
   2. Products: Elkay, Just, or equal.
   3. Faucet: Heavy-duty commercial grade, ceramic cartridge, low flow 1.5 gpm; Moen, Zurn, or equal.
   4. Drain: 1-1/2 inch tailpiece, grid strainer

H. Laboratory sinks, general purpose:
   1. Performance Requirements:
      a. Epoxy resin, under-counter mount, chemical resistant
      b. Faucet: Deck-mounted, gooseneck spout, replaceable stainless steel seats, built in stops, low flow 1.5 gpm; self-closing for D.I. applications

c. Drain: 1-1/2 inch tailpiece, grid strainer

2. Products:
   a. Sink: Durcon or equal
   b. Faucet: Heavy-duty commercial grade, ceramic cartridge, low flow 1.5 gpm; Water Saver, Chicago, or equal.
   c. Emergency Eye Wash: heavy-duty fixture with 5lb force single actuation lever handle, Water Saver, Chicago, or equal.
3. Signage: Provide signage as follows: Non-potable water, do not drink."

I. Laboratory Sinks used for dry ice disposal:
   1. General Requirements: Provide one per laboratory
   2. Performance Requirements:
      a. Sink: 18 gauge, type 304 stainless steel
      b. Faucet: Deck-mounted, gooseneck spout, replaceable stainless steel seats, built in stops, low flow 1.5 gpm
      c. Drain: 1-1/2 inch tailpiece, grid strainer
   3. Products:
      a. Sink: Elkay, Just, or equal
      b. Faucet: Heavy-duty commercial grade, ceramic cartridge, low flow 1.5 gpm; Water Saver, Chicago, or equal.
      c. Signage: Provide signage as follows: Non-potable water, do not drink."

J. Floor Drain: 3 inch, with brass grid strainer in mechanical rooms, with chrome grid strainer in restrooms. Provide with trap primer.

EMERGENCY PLUMBING FIXTURES 22 45 00

A. Emergency Plumbing Fixtures (eyewash units and showers)
   1. General Requirements:
      a. Supplied by domestic water.
      b. 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.
      c. 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.
      d. Identified with a highly visible sign.
      e. Drain shall be plumbed to sanitary sewer.
      f. Located so as not to pose an electrical shock hazard. No electrical outlets within 6 feet unless GFI protected.
      g. Indoor units are not required to deliver tempered water.
   2. Performance Requirements: Shall meet the performance and installation requirements of the American National Standards Institute (ANSI) Z358.1.
   3. Unit shall have a local domestic cold water system isolation valve upstream of unit's total integral shut-off valve.

B. Emergency eye wash:
   1. General Requirements:
      a. Each laboratory using substances described below shall provide one emergency eye or eye/facewash located as close as possible to the hazard.
         1. Shall be provided in all work areas where, during routine operations of 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.
         2. Shall be provided if there will be processes that produce flying particles, including sawdust, metal shavings, biological agents, etc.
      b. Consult the University's Representative for selection of the appropriate type(s) from the following:
         1. For laboratory units installed at sinks, provide eyewash unit which swings spray head assembly over sink activating continuous flow of water.
         2. For Barrier Free units, provide wall-mounted, low-profile eyewash with plastic receptor and aluminum wall bracket.
         3. For recessed units, provide swing down eyewash in a fully recessed wall mounted stainless steel cabinet with drain pan.
         4. 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 the University's Representative for coordination with UCSC EH&S for review and approval of this configuration.
      c. Mounted such that the water nozzles are 33 inches to 45 inches from the floor level and spray head height shall be below 36-inches and 17 to 25-inches from bowl edge, wall, or obstruction; height should comply with Americans with Disabilities Act of 1990 (ADA) requirements and at least 34-inches of clearance around the eyewash must be maintained.
      d. Mounted such that spray nozzles, when activated, are no more than 18 inches from the counter front when located above work counters or benches.
      e. Drain shall be plumbed to sanitary sewer.
   2. Performance Requirements:
      a. Regulated to provide a spray force of three to six gallons per minute at 30 psi.
   3. Products: Haws, WaterSaver, or equal

C. Emergency showers:
   1. General Requirements:
      a. Emergency shower with integral eyewash unit is required if during routine operations there is a risk of a splash of corrosive or other skin hazardous material to the body.
      b. Units shall be adequately supplied with potable water to meet the requirements of each component.
      c. A combination eyewash/emergency shower shall be located within a research laboratory using hazardous chemicals; 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. (Code?)

d. The unit shall be installed and located so both the shower and eyewash can be used at the same time by one person.
e. 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. (Code?)
f. The center of the spray pattern shall be located at least 16 inches from any obstruction.
g. Installed such that the shower head is not less than 82 inches or more than 96 inches from the surface on which the user stands.
h. Supplied by a minimum pipe size of 1 inch.

2. Performance Requirements:
   a. The shower shall be able to deliver a minimum of 30 gallons per minute.
3. Products: Haws 8346 or Guardian G1909 HFC (GBF1909 Barrier Free), Haws 8355WC (recessed), Guardian GBF2150 (recessed), or equal.

COMPRESSED AIR SYSTEMS FOR LABORATORY FACILITIES 22 61 00

A. Compressed air systems
   1. General Requirements:
      a. Identify the design and installation requirements for compressed air quality, dew point, pressure, flow, and volume to meet project specific requirements.
      b. Compressors shall be oil-type except for medical or dental applications. Refer to CDG Section 22 63 00 for Ultra-Pure system requirements.
      c. Buildings utilizing compressed air for laboratory functions and HVAC systems shall have separate compressors.
      d. Provide refrigerant dryers. In locations where refrigerant dryers cannot be used, consult the University's Representative. If desiccant dryers are to be used, they shall be capable of standby mode. Desiccant dryers shall not be used in small air compressor applications.
      e. Coordinate with Physical Plant BMS shop for any compressor PLC controller points (including alarms) that can be integrated into the BMS system or any required discreet BMS points to create alarms if compressor fails.
   2. Air Compressors
      a. 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.
      b. Provide inter-cooled and after cooled, 2 stage compressors/pumps for all 5 HP systems and larger.
      c. Provide
      d. Provide single stage compressors only for applications requiring 100 pounds or less.
      e. Once through cooling water systems are prohibited.
   3. Compressed Air Piping:
      a. Above ground: Type L copper tubing, hard drawn.
      b. Below ground: Type K copper tubing, hard temper, cold drawn with brazed joints.

c. Joints: Silver brazing alloy, melting point above 1000 degrees F, 15 percent silver, 80 percent copper 5 percent phosphorous.
d. Fittings: Wrought copper or brass; solder sweat type. Couplings shall be of the staked stop type.
e. Valves: Ball type.
f. Lab Air Outlets: Line size, Ball valve or needle valves to match project requirements.
g. Points of connection to existing copper air piping in existing buildings shall be screwed, soldered, or brazed, depending on system.

VACUUM SYSTEMS FOR LABORATORY FACILITIES 22 62 00

A. Vacuum Systems
1. General Requirements: Identify the design and installation requirements for vacuum, pressure and flow to meet project specific requirements.
2. Performance Requirements:
a. Piping, Joints, Fittings, Valves, and Lab Air Outlets:
1. See Compressed Air System requirements above.
b. Vacuum Pump:
1. Furnish air-cooled duplex vacuum unit complete with base mounted pumps, tank drain, flexible connection, scrubber, check valves, relief valves, control panel including fused disconnect, vacuum switches and gauges, motors, starters, electrical alternator.
2. NEMA rating shall be specified based on the location of equipment.
3. Vacuum Pump Products: Ingersoll-Rand, or equal.

GAS SYSTEMS FOR LABORATORY FACILITIES 22 63 00

A. Specialty Gases
1. General Requirements:
a. This section applies to laboratories that require Ultra-Pure piping system for special gases including nitrogen, oxygen, CO2, Argon, etc.
b. Identify the design and installation requirements for quality, pressure and flow for all specialty gasses to meet project specific requirements.
c. Grounding: All oxygen, nitrous oxide and vacuum lines shall be grounded to the water supply system to reduce the possibility of static electric charges.
2. Performance Requirements:
a. 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.
b. 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.

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

CHEMICAL WASTE AND VENT PIPING FOR LABORATORY FACILITIES 22 66 00

A. Piping
   1. Performance Requirements:
      a. New construction: Schedule 40 flame retardant polypropylene pipe
      b. Existing buildings with glass piping: Chemically resistant glass drain line piping may be used for repair of material or polypropylene with adaptors.

B. Fittings
   1. Performance Requirements:
      a. General: fusion coil joints
      b. Provide mechanical joint fittings at all piping around benches and equipment, above ground and accessible piping, and all acid waste piping.
      c. Compression fittings are not allowed.
   2. Products:
      a. General piping: Enfield “Enfusion” or equal in walls or ceilings
      b. Piping around benches and equipment, under and around sinks, and in accessible areas: Enfield, "Labline" or equal

C. Traps
   1. Performance Requirements:
      a. Universal: 1-1/2 inch Polypropylene clear base
      b. Acid waste and fume hood sinks: drum trap with drain connection adapter and union connection
   3. Products:
      a. Universal: Enfield W5115, Harrington or equal.
      b. Acid waste: Nalgene 96025-1500, Sloane, or equal

D. Supports
   1. Performance Requirements: Horizontal polypropylene piping shall have a continuous 16-gauge galvanized sheet metal trough support or maximum 2 foot support spacing system.

E. Fixtures
   1. Performance Requirements:
      a. Funnel Sink: Cast iron, with trap and 6 inch diameter inlet.
      b. Cup Sink: Polyethylene, oval with integral waste fitting, 1-1/2 inch with polypropylene trap.

PROCESSED WATER SYSTEMS FOR LABORATORY FACILITIES 22 67 00

A. Processed water systems
   1. General Requirements:
      a. When program needs 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 the project specific requirements for water quality, quantity, pressure and flow to identify the design and installation requirements with the University's Representative.
      b. 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.
   2. Performance Requirements:
      a. Reverse Osmosis systems shall have a regenerating type of softener with backwashing carbon filters in lieu of exchange bottles.
      b. Deionized water systems shall be designed to provide for a minimum 10 megohm system unless otherwise required by the University's Representative. The entire DI system shall be recirculating; no 'dead legs'.

B. Ultra-Pure Deionized Systems
   2. Performance Requirements:
      a. The system shall be recirculating through deionized polishing bottles
      b. Piping, joints and fittings: Unpigmented (natural) polypropylene, copolymer Type 1, Schedule 40 butt-fusion and/or socked fusion.
      c. The entire system shall be sterilized.
   3. Products: For bench valves: use Chicago 828PVDF (solid PVDF valve), or equal.

Table 1: Water Quality and Equipment

Description	Use:	Quality	Equipment:	Piping:
Domestic Water (DW), plain	Consumption; fixtures	Potable	None	Copper
Softened Water	Process equipment, dishwashing, cage-washing	A minimum of 95 percent of TDS removed	Softener	Copper
Softened + R.O.	Process equipment, consumption, feed water for D.I. system	5 percent or less of TDS and bacteria; 1-3ppm; approx. 0.5	In addition to above: - Carbon Filter - R.O. Prefilter - R.O. System	Copper

		megohm		
Softened + R.O. + D.I.	Laboratory grade for non-critical purposes; lab equipment connections; Type I feed water	Type II or III, per ASTM D1193-6; verify with University's Representative	In addition to above: - UV Sterilizers - 0.2 micron vinyl filter - Mixed bed De-Ionization bottles - Resin Trap - Storage Tanks - Distribution Pumps	Schedule 80 PVC
Softened + R.O. + Ultra-pure D.I.	Critical laboratory applications; research/ medical grade	Type I, per ASTM D1193-6	In addition to above: - Polisher	Hi-purity polypropylene

C. Piping, joints, fittings, and unions
   1. General Requirements:
      a. Metric sizes are not acceptable.
      b. 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.
      c. Sanitizing: The entire distribution loop and components shall be sanitized per the requirements in the Specification Section 33 13 00, Domestic Water Piping Disinfection. Mixed beds shall not be connected to the distribution loop during sanitization.
   2. Performance Requirements:
      a. Polyvinyl chloride (PVC), Gray Standard Schedule 80.
      b. Joining shall be by socket weld, procedure as recommended by pipe manufacturer. No threaded joint or flexible connection shall be permitted.

D. Valves
   1. General Requirements: Provide isolation valve at each sink.
   2. Performance Requirements: 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.

E. Bench faucets:
   1. Performance Requirements:
      a. 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.
      b. For foot operated outlets: floor mounted, tin-lined, self-closing renewable unit with stainless steel single valve system.
   2. Products:

a. Bench faucets: Water Saver Pure Water Faucet, Chicago Pure Water Faucet, or equal.
b. For foot operated outlets: Water Saver Tin-Lined, Foot-Operated Single Valve with manufacturer's recommended coordinating deck-mounted, tin-lined gooseneck spout, or equal.

The following standard specification is intended to be edited according to the specifics of the project. Brackets [ ] and areas shaded in gray [e.g. format] indicate requirements that are optional depending upon the type of system being provided or per instructions associated with the [ ] and project requirements. Consult with University's Representative and campus stakeholders.

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SECTION 22 05 53 PLUMBING IDENTIFICATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Equipment identification
2. Valve identification
3. Piping identification
4. Signage

1.2 RELATED SECTIONS

A. Section 09 XX XX, Painting

B. Section 22 XX XX

C. Section 33 05 26, Utility Line Signs, Markers, and Flags

1.3 REFERENCE STANDARDS

A. ANSI/ASME A13.1 – Scheme for the Identification of Piping Systems.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples: Submit samples of each color, lettering style, and other graphic representation required for each identification material or system.

C. Schedules:

1. Valve identification chart and schedule, including valve numbering system, valve tag number location, function type, and valve manufacturer’s name and model number.
2. Lists of pipe and equipment to be labeled.
3. Submit access door numbering scheme and schedule, including access door type, location, size and service.
4. Include list of wording, symbols, letter size, letter style, and color coding for each system.

1.5 QUALITY ASSURANCE

A. Coordinate color coding with the University’s Representative for preferred color schemes and service abbreviations and valve and equipment numbering schemes prior to submittal review.

B. Coordinate installation of identifying devices with completion of covering of surfaces where devices are to be applied.

C. Coordinate installation of identifying devices with location of access panels and doors.

D. Install identifying devices, pipe identification and flow arrows before installing acoustical ceilings and similar concealment.

E. Coordinate painting schemes of plumbing piping, if required, with University's Representative prior to submittal review.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturer:

1. Brady/Seton
2. Stranco
3. Rowmark
4. Or equal

2.2 MANUFACTURER'S IDENTIFICATION

A. Manufacturer's nameplate, name, or trademark shall be permanently affixed to all equipment and material furnished under this Specification. The nameplates of the Subcontractor or Distributor are not acceptable.

2.3 EQUIPMENT IDENTIFICATION

A. Properly identify each piece of equipment with nameplates mounted on or near each operations device, including:

1. Main control and operating valves, safety devices, and hazardous units (?)
2. Pumps, compressors, and similar motor-driven units (?)
3. Expansion tanks, air separators, water treatment equipment, and similar equipment.
4. Chillers

B. Identify control panels and major control components outside panels with nameplates.

C. Identify equipment that is out of view behind access doors in unfinished rooms on face of the access door.

D. Small devices, such as inline pumps, may be identified with tags.

E. Label content:

1. Include equipment's Drawing designation or unique equipment number.
2. Area served
3. Year installed
4. Make and model
5. Equipment size / design capacity

2.4 NAMEPLATES

A. Provide plastic labels for mechanical engraving with predrilled holes for attachment hardware.

1. Material: rigid plastic laminated impact acrylic, 2 layer, exterior grade, UV stable
2. Thickness: 3/16 inch minimum
3. Maximum label size: Length and width vary for required label content, but no less than 2 inches wide by 1 inch high.
4. Background color:
   a. Normal power: Black, matte finish
   b. Standby power: Yellow, matte finish
   c. Emergency power: Red, matte finish
5. Lettering: White, machine engraved, Futura font, 3/8 inch high, all caps
6. Maximum temperature: Able to withstand up to 160 deg. F.
7. Fasteners: Self-tapping stainless steel screws, except contact type permanent adhesive where screws cannot or should not penetrate substrate.
   a. Mounting screw type to be #8- 18 x 1 /2 drilling or tapping style, 1/4 inch hex washer head, stainless steel, or similar, appropriate for material in which sign is

affixed to. A bead of silicone sealer shall be applied on back of sign and at screw locations prior to affixing sign to equipment.

b. For signs larger than 3 inches by 3 inches, use a minimum of 4 mounting screws.

2.5 VALVE IDENTIFICATION

A. Attached to stem of each control valve and line shutoff valve installed under Division 22, with No. 16 brass chain, color-coded plastic laminate tag. Engrave laminate tags with 1-inch designated numbers in accordance with typed schedule showing valve size, locations, service, similar to the following form:

RW: 3-inches
Shutoff, Toilets
3rd Floor
Column F-8

1. Engrave identification tags “normally open” (green) or “normally closed” (red).
2. Do not identify valves where the use is obvious, such as equipment isolation valves.
3. Tag all valves except fixture stops.
4. Label plumbing valves “Plbg” plus valve identification number.
5. Number tags to conform to directory listing number, location, and use.

B. Access panel markers: Provide manufacturer’s standard 1/16 inch thick engraved plastic laminate access panel markers, with abbreviations and numbers corresponding to concealed valve. Include 1/8 inch center hole to allow attachment.

2.6 PAINTED IDENTIFICATION MATERIALS

A. Stencils: Standard fiberboard stencils, prepared for required applications with the letter sizes generally complying with recommendations of ANSI A13.1 for piping and similar applications, but not less than 3/4 inch high letters for access door signs and similar operational instructions.

B. Stencil Paint: Standard exterior type stenciling enamel; black, except as otherwise indicated; either brushing grade or pressurized spray-can form and grade.

C. Identification Paint: Standard identification enamel of colors indicated or, if not otherwise indicated for piping systems, comply with ANSI A13.1 for colors.

2.7 PIPE IDENTIFICATION

A. General requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

C. Small pipes: For external diameters less than 6 inches (including isolation if any), provide full-band pipe markers, extending 360 degrees around pipe at each location, fastened by one of the following methods:

1. Snap-on application of pre-tensioned semi-rigid plastic pipe marker.
2. Adhesive lap joint in pipe marker overlap.
3. Laminated or bonded application of pipe marker to pipe (or insulation).
4. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 3/4 inch wide; full circle at both ends of pipe marker, tape lapped 1-1/2 inches.

D. Large pipes: For external diameters of 6 inches and larger (including isolation if any), provide either full-band or strip-type pipe markers, but not narrower than 3 times letter height (and of required length), fastened by one of the following methods:

1. Laminated or bonded application of pipe marker to pipe (or insulation).
2. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 1-1/2 inch wide; full circle at both ends of pipe marker, tape lapped 3 inches.

3. Strapped to pipe application of semi-rigid type, with manufacturer's standard stainless steel bands.

E. Pipe Label Contents: Include identification of piping service using piping system nomenclature as specified, scheduled or shown, and abbreviate only as necessary for each application. Include pipe size and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inches high.

F. Locate pipe markers as follows:

1. Within one foot of each valve, fitting, thermometer or gauge (except on plumbing fixtures).
2. At each branch or riser take off.
3. At each passage through walls, floors and ceiling construction.
4. At each pipe passage to underground.
5. On all horizontal pipe runs every 20 ft, at least twice in each room and each story traversed by piping system.
6. Identify piping contents, flow direction, supply and return.
7. Where capped piing is provided for future connections, provide legible and durable tags indicating symbol identification.
8. At wall and ceiling access panels.
9. Practicable variations or changes in locations and spacing may be made with specific approval of the University's Representative to meet specific conditions.

2.8 UNDERGROUND TYPE PLASTIC WARNING TAPE LINE MARKER

A. Refer to Section 33 05 26

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

B. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

3.2 PIPE SYSTEM IDENTIFICATION

A. General: Provide for all systems unless indicated otherwise.

B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. At access doors, manholes, and similar access points that permit view of concealed piping.
2. Near major equipment items and other points of origination and termination.
3. 50 feet intervals.

C. Types: Install pipe markers of one of the following types on each system, and include arrows to show normal direction of flow:

1. Stenciled markers, including color-coded background band or rectangle, and contrasting lettering of black or white. Extend color band or rectangle 2 inches beyond ends of lettering.

2. Stenciled markers, with lettering color complying with ANSI A13.1.
3. Plastic pipe markers, with application system as indicated under "Materials" in this Section. Install on pipe insulation segment where required for hot non-insulated pipes.
4. Stenciled markers, black or white for best contrast, wherever continuous color-coded painting of piping is provided.

D. Locate pipe markers and color bands as follows wherever piping is exposed to view in occupied spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums) and exterior non-concealed locations.

1. Near each valve and control device. Within one foot of each valve, fitting, thermometer or gauge (except on plumbing fixtures).
2. At each branch or riser take off, excluding short take-offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.
3. At each passage through walls, floors and ceiling construction, or enter non-accessible enclosures.
4. At each pipe passage to underground.
5. At access doors, manholes and similar access points which permit view of concealed piping. At wall and ceiling access panels. Practicable variations or changes in locations and spacing may be made with specific approval of the University's Representative to meet specific conditions.
6. Near major equipment items and other points of origination and termination.
7. Spaced intermediately at maximum spacing of 50 feet (15m) along each piping run, except reduce spacing to 25 feet (8 m) in congested areas of piping and equipment.
8. On all horizontal pipe runs every 20 ft, at least twice in each room and each story traversed by piping system.
9. On piping above removable acoustical ceilings, except omit intermediately spaced markers.
10. Where capped piping is provided for future connections, provide legible and durable tags indicating symbol identification.
11. Identify piping contents, flow direction, supply and return.

E. During back-filling/top soiling of exterior underground piping systems, install continuous underground-type plastic line marker, locate directly over buried line at 12-inches above pipe. Use metallic lined plastic line markers for non-metallic type piping.

3.3 VALVE IDENTIFICATION

A. General: Provide valve tag on every valve cock and control device in each piping system; exclude check valves, and similar rough-in connections of end-use fixtures and units. List each tagged valve in valve schedule for each piping system.

B. Valves Concealed in Suspended Ceilings: Provide 1/4 inch high plastic tape marker identifying the valve number on the nearest ceiling grid member.

3.4 PLUMBING EQUIPMENT IDENTIFICATION

A. General: Install engraved plastic laminate sign or plastic equipment marker on or near each major item of plumbing equipment and each operational device, as specified herein if not otherwise specified for each item or device.

1. Signs shall be placed on the equipment in a logical location, easily visible to maintenance personnel, e.g. near control panels, disconnect switches, nameplates, on or near equipment main access doors and panels, etc. Sign and drilling locations shall be approved by the University's Representative.

B. Optional sign types: Where lettering larger than 1 inch height is needed for proper identification, because of distance from normal location of required identification, stenciled signs may be provided in lieu of engraved plastic, verify with University's Representative.

C. Lettering size: Minimum 1/4 inch high lettering for name of unit where viewing distances less than 24 inches, 1/2 inch high for distances up to 6 feet, and proportionately larger lettering for greater distances. Provide secondary lettering of 2/3 to 3/4 of size of the principal lettering.

D. Plasticized tags: Where equipment to be identified is concealed above acoustical ceilings or similar concealment, use plasticized tags installed within concealed space to eliminate text in exposed sign (outside concealment). In rooms other than security area, mechanical rooms, storage, etc. use thumbtacks for exposed signs with color coded for each type of equipment. Verify with University's Representative.

3.5 ADJUSTING AND CLEANING

A. Adjusting: Relocate any plumbing identification device which has become visually blocked by Work of this Division or other Divisions.

B. Cleaning: Clean face of identification devices.

3.6 EXTRA STOCK

A. Furnish minimum of 5% extra stock of each plumbing identification material required, including additional numbered valve tags (not less than 3) for each piping system, additional piping system identification markers, and additional plastic laminate engraving blanks of assorted sizes.

1. Where stenciled markers are provided, clean and retain stencils after completion of stenciling and include used stencils in extra stock, along with required stock of stenciling paints and applicators.

END OF SECTION 22 05 53

The following standard specification is intended to be edited according to the specifics of the project. Brackets [ ] and areas shaded in gray [e.g. format] indicate requirements that are optional depending upon the type of system being provided or per instructions associated with the [ ] and project requirements. Consult with University's Representative and campus stakeholders.

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SECTION 22 08 00 COMMISSIONING OF PLUMBING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Commission all systems and equipment listed in the table below per the requirements of Section 01 91 00 Commissioning. The Installation/Start-up Verification (ISV) and Functional Performance Test (FPT) forms listed are required [and will be provided by the University]. Refer to the project website for standard commissioning forms.

[Edit the table and the checklists as required by the project.]

Equipment/System	ISV Form	FPT Form
Facility Water Distribution	ISV-22 11 00	FPT-22 11 00
Domestic Water Packaged Booster Pumps	ISV-22 11 23.13	w/ FPT-22 11 00
Facility Sanitary Sewerage	ISV-22 13 00	N/A
Facility Storm Drainage	ISV-22 14 00	N/A
Electric Domestic Water Heaters	ISV-22 33 00	w/ FPT-22 11 00
Commercial Gas Domestic Water Heaters	ISV-22 34 36	w/ FPT-22 11 00
Domestic Water Heat Exchangers	ISV-22 35 00	w/ FPT-22 11 00
Plumbing Fixtures	ISV-22 40 00	w/ FPT-22 11 00
Compressed-Air Systems for Laboratory and Healthcare Facilities	ISV-22 61 00	FPT-22 61 00
Vacuum Systems for Laboratory and Healthcare Facilities	ISV-22 62 00	FPT-22 62 00
Gas System for Laboratory and Healthcare Facilities	ISV-22 63 00	N/A
Processed Water Systems for Laboratory and Healthcare Facilities	ISV-22 67 00	FPT-22 67 00

1.2 RELATED WORK AND DOCUMENTS

A. Section 01 77 00 Closeout Procedures

B. Section 01 91 00 Commissioning

C. Division 22 Plumbing

1.3 COMMISSIONING DEFINITIONS AND ABBREVIATIONS

A. Refer to Section 01 91 00 Commissioning

1.4 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

B. Associated Air Balance Counsel (AABC) Guidelines for Balancing Procedures and Documentation

1.5 SUBMITTALS

A. Submit commissioning documents for all equipment and systems listed in table above per the requirements of Section 01 91 00 Commissioning.

PART 2 - PRODUCTS

2.1 INSTRUMENTATION

A. Refer to Section 01 91 00 Commissioning.

PART 3 - EXECUTION

3.1 INSTALLATION/START-UP VERIFICATION

A. Perform all checks and tests included in the ISV checklists and complete the checklists as specified in Section 01 91 00 Commissioning.

3.2 FUNCTIONAL PERFORMANCE TESTS

A. Perform all checks and tests included in the FPT checklists and complete the checklists as specified in Section 01 91 00 Commissioning.

3.3 TRAINING OF UNIVERSITY PERSONNEL

B. Provide training of University's personnel for the number of hours specified in the table below and as specified in Section 01 77 00 Closeout Procedures.

[Edit the table as required by the project. Project Manager to coordinate with DCM Engineering and FM]

Equipment/System	Section Number	Orientation Hours	Training Hours	DVD Recording
Facility Water Distribution System	22 11 00	2	8	N/A
Facility Sanitary Sewerage System	22 13 00	2	N/A	N/A
Facility Storm Drainage System	22 14 00	2	N/A	N/A
Compressed-Air Systems for Laboratory and Healthcare Facilities	22 61 00	2	4	N/A
Vacuum Systems for Laboratory and Healthcare Facilities	22 62 00	2	4	N/A
Gas System for Laboratory and Healthcare Facilities	22 63 00	2	4	N/A
Processed Water Systems for Laboratory and Healthcare Facilities	22 67 00	2	4	N/A

END OF SECTION 22 08 00