SECTION 22 - PLUMBING

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22-1 INTRODUCTION

A. The following plumbing guidelines shall be utilized to design and document new construction and renovation projects for the University. All designs are subject to review and approval by the University and appropriate authorities having jurisdiction.

B. In the following text, UCSF Medical Center shall be referred to as the "University" which includes: UCSF Medical Center Facilities, referred to as "Facilities" and UCSF Medical Center Office of Design and Construction, referred to as "D&C".

C. The guidelines describe criteria, performance, and materials requirements for plumbing systems. Design professionals can recommend changes to specific guidelines as appropriate to meet the project program and goals, but shall not incorporate changes without the University's written approval. Recommended changes that reduce quality, utility, flexibility, and energy efficiency criteria described herein shall be submitted with cost/benefit analyses.

D. This document was prepared prior to the opening of the new Mission Bay Hospital, and does not address guidelines for renovations or future development at the UCSF Medical Center at Mission Bay.

E. See Section 23 - HVAC guidelines for additional requirements.

22-2 PLUMBING OVERVIEW

University Plumbing Infrastructure: The following are brief descriptions of plumbing infrastructure in non-Mission Bay Medical Center Buildings. Descriptions are not necessarily up-to-date. For renovation projects, review archive drawings, survey existing conditions, recommend testing of existing systems where appropriate, and interview Facilities personnel to ascertain current conditions.

A. Moffitt Hospital Plumbing Systems Overview

1. Domestic Water System: Domestic water service is provided by a metered high pressure main. The main takes off from a high pressure service fed from the Parnassus Campus Central Utility Plant, an OSHPD SPC-4/NPC-3 rated building. The service enters the 1st Floor of Moffitt Hospital and continues through to the Medical Sciences Building (MSB), a non-OSHPD building.

   Water is distributed from the main to multiple risers on the 1st Floor. Risers are primarily located next to multiple building columns. Risers serve three zones in the building; Basement through 4th Floor, 5th through 9th Floors, and 10th through 15th Floors. Duplex pressure reducing valves are provided for the Basement through 4th Floor zone. Water storage tanks serving the campus are connected to the system to provide water supply in the event of an emergency.

2. Domestic Hot Water System: Three steam-to-water heat exchangers provide domestic hot water for Moffitt. Steam for these systems is provided from boilers located in the Parnassus Campus Central Utility Plant.

Each system serves one of three zones in the hospital; Basement through 4th Floor, 5th through 9th Floors, and 10th through 15th Floors. The University operates the systems at 140ºF. Hot water is distributed from the water heaters to common piping at the top floor of each zone. Water draws down the zones through multiple risers which are primarily located same as domestic cold water system risers next to multiple building columns. Risers connect again to common piping at the bottom floor of each zone. The common piping at the bottom floor serves as the return line for circulating hot water throughout the zone. Circulating pumps are located at the water heaters. Circulation through the systems serving the 5th through 15th Floors is poor due to exceedingly long branch runouts and improperly placed or partially closed isolation valves used for system balancing.

There is a project currently under design that will replace water heating equipment and improve distribution and recirculation in Moffitt.

3. Purified Water Systems: Non-clinical grade deionized (DI) water is provided from the Parnassus Campus Central Utility Plant for low demand loads primarily from laboratory sinks. DI water is distributed directly to areas of use in a non-circulating single pass system fed from a riser in the West Wing that is connected on the 13th Floor to storage tanks in The Medical Science Building (MSB). Because of the feed from a non-OSHPD building, new loads shall not be connected to this system.

4. Sanitary Waste, Vent, and Vapor Vent System: Multiple waste and vent risers located same as domestic water system risers next to multiple building columns provide gravity drainage in two zones; high rise and basement. Reuse of existing piping shall be carefully evaluated with the University as cracks have been known to exist in some locations, especially in the Basement.

   Drains from both zones collect independently of acid waste and storm drains underground below the Basement floor slab and connect to the city sewer system at multiple locations on the Parnassus side of the building. Sterilizer and similar equipment drains are provided with separate vapor vent risers extending directly to the roof independently of sanitary vent risers.

5. Acid (Laboratory) Waste and Vent System: Waste and vent risers located same as domestic water system risers next to building columns provide gravity drainage independent of sanitary drains for all laboratory waste in two zones; high rise and basement. Drains from both zones collect independently of sanitary waste and storm drains underground below the Basement floor slab and connect to the city sewer system at multiple locations on the Parnassus side of the building.

6. Storm Drain System: Multiple drain risers located same as domestic water system risers next to multiple building columns provide drainage by gravity of all roof and area drains. Drains collect separately of all other drains underground below the Basement floor slab and connect to the city sewer system at multiple locations on the Parnassus side of the building.

7. Medical Gas and Vacuum Systems: Medical gas and vacuum are distributed from the Basement through multiple risers primarily located at multiple building columns along the building perimeter. A medical vacuum system is provided for Moffitt Hospital and connected in the Basement with a manual bypass to the medical vacuum

system serving Long. A medical air compressor system and gas cylinder manifolds in Long Hospital provide medical air, carbon dioxide, nitrogen, and nitrous oxide services for Moffitt. Oxygen is provided from bulk liquid oxygen storage equipment at the Parnassus Campus Central Utility Plant. Medical Air and oxygen riser bypasses are installed on the 7th Floor of Moffitt to provide a means for backfeeding between risers in each system (not cross-connected).

8. Laboratory Gas and Vacuum Systems: Compressed air and low pressure natural gas for low demand laboratory outlet loads is provided from the Parnassus Campus Central Utility Plant. Vacuum is provided from the medical vacuum pumps in the Basement. Services are distributed directly to areas of use from risers originating in the Basement.

9. Natural Gas System: In addition to laboratory gas loads, natural gas is provided to the Hospital for Kitchen gas loads. Gas is distributed directly to areas of use at low pressure from the Basement.

B. Long Hospital Plumbing Systems Overview

1. Domestic Cold Water System: Domestic water service is provided by a metered high pressure main. The main takes off from a high pressure service fed from the Parnassus Campus Central Utility Plant. Water is distributed from the 1st Floor to multiple risers primarily located in multiple shafts located to prevent horizontal distribution piping from crossing shear walls in Long. Risers serve three zones; Basement through 5th Floor, 6th through 9th Floors, and 10th through 15th Floors. Duplex pressure reducing valves are provided for the Basement through 5th Floor zone. Water storage tanks are connected to the system to provide water supply in the event of an emergency.

2. Domestic Hot Water System: Two steam-to-water heaters provide domestic hot water for Long. Steam for these systems is provided from boilers at the Parnassus Campus Central Utility Plant.

   Each system serves one of two zones in the hospital; Basement through 9th Floors, and 10th through 15th Floors. The University operates the systems at 140ºF. Hot water is distributed from the water heaters to the lowest floor in each zone. Multiple risers then distribute hot water to the upper floors in the zones. Risers are primarily located same as domestic cold water system risers in multiple shafts to prevent horizontal distribution piping from crossing shear walls. Separate return risers and return branch lines on each floor parallel supply piping for circulating water throughout the zones. Circulating pumps are located at the water heaters. Balancing valves are provided to balance return flows.

   There is a project currently under design that will replace water heating equipment and improve recirculation in Long.

3. Purified Water Systems: Non-clinical grade DI water is provided from the Parnassus Campus Central Utility Plant for low demand loads primarily from utility wash sinks in Sterile Processing. DI water is distributed directly to areas of use in a non-circulating single pass system fed from storage tanks in the Health Science Instruction and Research (HSIR) Building, a non-OSHPD building. Because of the

feed from a non-OSHPD building, new loads shall not be connected to this system.

4. Sanitary Waste and Vent System: Multiple waste and vent risers located same as domestic water system risers in multiple shafts provide gravity drainage. Drains collect independently of acid waste and storm drains underground below the Basement floor slab and connect to the city sewer system at multiple locations on the Parnassus side of the building.

5. Acid (Laboratory) Waste and Vent System: Waste and vent risers located same as domestic water system risers in multiple shafts provide gravity drainage independent of sanitary drains for laboratory waste loads. Drains collect independently of sanitary waste and storm drains underground below the Basement floor slab and connect to the city sewer system at multiple locations on the Parnassus side of the building.

6. Storm Drain System: Multiple drain risers located same as domestic water system risers in multiple shafts to prevent horizontal distribution piping from crossing shear walls provide drainage by gravity for all roof and area drains. Drains collect separately of all other drains underground below the Basement floor slab and connect to the city sewer system at multiple locations on the Parnassus side of the building.

7. Medical Gas and Vacuum Systems: Medical gas and vacuum are distributed from the Basement and 2nd Floor through multiple risers in multiple shafts to prevent horizontal distribution piping from crossing shear walls. Medical vacuum and air systems are provided. The vacuum system is also provided with a manual bypass connected to the vacuum system serving Moffitt. Medical gas cylinder manifold systems with automatic switchover provide carbon dioxide, nitrogen, and nitrous oxide services for Long and Moffitt. Oxygen is provided from bulk liquid oxygen storage equipment at the Parnassus Campus Central Utility Plant.

8. Laboratory Gas and Vacuum Systems: There is no laboratory air, natural gas, or vacuum loads currently in Long Hospital.

9. Fuel Oil System: Emergency generators serving Long and Moffitt are provided with remote aboveground fuel oil storage tanks and transfer pumps feeding fuel oil day tanks located at the generators. The fuel oil system and generators are located on the 1st Floor of Long. Capacity of the fuel oil system allows for 24-hour operation of the generators.

C. Parnassus Ambulatory Care Center (ACC) Building Plumbing Systems Overview

1. Domestic Water System: Domestic water service is provided by a metered high pressure main. The main takes off from a high pressure water district utility line at Parnassus Avenue. The service enters the building at the core mechanical room on Level P6.

   Water is distributed from the main to high pressure zone, low pressure zone, and irrigation risers. Low pressure zone risers serve Level B1 through the Fifth Floor. High pressure zone risers serve the Sixth Floor through the Eighth Floor. Risers are primarily located at northeast and southwest corners of the building core.

2. Domestic Hot Water System: Steam-to-water heat exchangers in the core mechanical

room on Level P6 provide domestic hot water for the ACC. Hot water is then distributed to risers serving high and low pressure zones just like the domestic cold water system. Hot water is circulated continuously throughout the building by circulating pumps located at the water heaters. Steam for this system is provided from boilers located in the Parnassus Campus Central Utility Plant.

3. Purified Water Systems: There is no purified (DI) water system in the ACC.

4. Sanitary Waste, and Vent System: Multiple waste and vent risers located same as domestic water system risers at northeast and southwest corners of the building core provide gravity drainage. Reuse of existing piping shall be carefully evaluated with the University as cracks have been known to exist in some locations.

   Drains collect independently of storm drains below the floor slab on Level B1 and connect to the city sewer system at multiple locations from the building core on Levels P7 and P3.

5. Acid (Laboratory) Waste and Vent System: There is no acid waste and vent system in the ACC.

6. Storm Drain System: Multiple drain risers located same as domestic water system risers at northeast and southwest corners of the building core provide drainage by gravity of all roof drains. Roof drain risers collect below the floor slab on Level B1 and connect to the city sewer system independently of sanitary waste piping from the building core on Level P3.

   Area and deck drains at Level B1 and on Levels P1 through P7 in the garage collect separately of all other drains below the parking deck slab on Levels P6 and P2 before connecting to the city sewer system at multiple locations.

7. Gas and Vacuum Systems: Compressed air for building system controls and other non-patient use is provided from the Parnassus Campus Central Utility Plant and distributed to various loads from risers at the building core. Medical air and oxygen cylinder manifolds, medical air compressors, and medical vacuum pumps located in equipment rooms on Level P8 provide medical gas and vacuum to the outpatient surgery center on Level B1.

8. Natural Gas System: There are no natural gas loads in the ACC.

D. Mt. Zion Hospital Campus Plumbing Systems Overview

   The Mount Zion Campus consists of very old (1914 Hellman Building) to relatively new (2010 Osher Building) structures. The great varieties of plumbing systems preclude description in this brief overview. Buildings include critical care hospital buildings, the Helen Diller Family Comprehensive Cancer Center, a Cancer Research Building, Women's Health Center, Osher Center for Integrative Medicine, and numerous medical office buildings. For renovation projects, review archive drawings, survey existing conditions, and interview Facilities personnel to ascertain current conditions.

   OSHPD Status: OSHPD 1 buildings at Mt. Zion include Buildings A, B, D, and R.

Buildings A, B, and D are seismically rated SPC-2 and NPC-2. Building R is seismically rated SPC-4 and NPC-2. UCSF received an exemption from NPC-3 requirements at Mt. Zion until 1/1/2030.

E. Design Considerations

1. Design systems for proper function, control, and code compliance. See Section 23 - HVAC guidelines for additional considerations.

2. Services feeding Long Hospital or the Parnassus Campus Central Utility Plant from Moffitt Hospital are not allowed. Additionally, no service from a non-OSHPD building shall feed Moffitt, Long, or the Parnassus Campus Central Utility Plant. This is due to varying or non-existent OSHPD seismic performance ratings of the buildings. While Long, Moffitt, and the Parnassus Campus Central Utility Plant all carry the same Non-structural Performance Category-3 (NPC-3) rating, Moffitt's Structural Performance Category (SPC) rating is lower at SPC-2 than Long's which has a rating of SPC-4s and the Parnassus Campus Utility Plant which has a rating of SPC-4.

3. UCSF Capital Projects & Facilities Management (CPFM) is responsible for operating and maintaining the Parnassus Campus Central Utility Plant. Work involving services provided from the Parnassus Campus Central Utility Plant must be reviewed and approved by CPFM.

4. When crossing shear walls in Long Hospital, existing openings should be used and new penetrations avoided due to thick embedded steel plates which make cutting new openings very costly. Where existing openings are not reused, penetrating pipes shall be removed and holes covered to meet requirements for maintaining existing fire rated construction.

5. When possible review medical gas design with certifying agency used for the project. At a minimum review master alarm panel locations, zone valve, zone alarm panel and transducer locations with the certifier.

F. Energy and Resource Efficiency Criteria

1. Design systems to meet energy performance targets established by the University of California Office of the President (UCOP), UCSF Medical Center, and/or other entities. See Section 23 - HVAC guidelines for additional requirements.

2. LEED Certification: See Section 23 - HVAC guidelines for requirements. Incorporate water use reduction features and assist in achieving agreed upon LEED certification level. For most projects:
   - Specify ultra-low flow fixtures for as many LEED Water Use Reduction credits as possible.
   - Specify metering on equipment and fixtures not qualified for Water Use Reduction credits and/or other strategies for as many Innovation in Design credits as possible.
   - Fixtures using non-flushing technologies shall not be used.

G. Building Information Modeling (BIM)

1. Requirements should be reviewed on a project-by-project basis with the University. In general, the BIM plan as a minimum shall address the following:
   - BIM goals for the project.
   - Key Team BIM contacts.
   - Model assembly and coordination tools.
   - Definition of what the BIM uses will be for the project such as; coordination, fabrication, costing, etc.
   - What each discipline will model and to what tolerance.
   - Coordination method and process.
   - Information exchange process and schedule.
   - University BIM and Data requirements and how they will be delivered.
   - BIM quality control and review.

22-3 BASIS OF DESIGN (BOD) AND SYSTEM DESCRIPTIONS

A. Basis of Design Document: See Section 23 - HVAC guidelines for requirements. In addition to the applicable topics listed under those guidelines, include the following as appropriate:

1. Design Criteria:
   - Minimum fixtures and outlets for each type of space.
   - Water, drain, vent, fuel gas, compressed gas and vacuum load criteria and diversity factors (known loads and assumptions).
   - Hot and purified water circulation strategies.
   - Criteria for sizing major plumbing equipment.
   - Pipe sizing criteria.

2. System Descriptions for each New and Modified Plumbing System:
   - As listed for Section 23 - HVAC guidelines.

3. Impacts on Building Infrastructure:
   - As listed for Section 23 - HVAC guidelines.

B. Description of Systems: The BOD shall be augmented with system diagrams and layout sketches commensurate with the current design stage.

C. Plumbing Systems Diagrams: See Section 23 - HVAC guidelines for requirements. Include diagrams for domestic, industrial and purified water, waste and vent, storm drain, medical and laboratory gas and vacuum, and fuel gas and oil systems.

22-4 PLUMBING DESIGN CRITERIA

A. Codes and Standards: See Section 23 - HVAC guidelines for requirements.

B. OSHPD 1 Requirements

1. For critical care hospital spaces under OSHPD jurisdiction, design Plumbing systems for full OSHPD 1 compliance as described in the California Plumbing Code (CPC). Significant design requirements are described in the following sections of the 2013 CPC, although all applicable requirements in the CPC must be followed.

210.0:	Handwashing fixtures.
221.0:	Scrub sinks.
222.0:	Toilets and toilet rooms.
310.9:	Drainage piping over operating and delivery rooms, nurseries, food prep centers, food-serving facilities, food storage areas, and other sensitive areas.
310.10:	Floor drains in operating, delivery rooms, and cystoscopic rooms.
310.12:	Services/systems and utilities.
313.8:	Seismic anchoring and bracing requirements.
319.0:	This section for medical gas and vacuum systems is not to be used for OSHPD facilities.
403.3.1:	Waterless urinals not allowed in OSHPD facilities.
413.3:	Operation of sensor operated flush valves during loss of normal power.
422.1:	Fixture counts in OSHPD facilities per Table 4-2.
422.2.1:	Separate toilet facilities for patients, staff, and visitors in OSHPD facilities.
604.1:	Use of CPVC not permitted in OSHPD facilities.
605.3.3.2:	Pressed fittings in copper water pipe or tubing not permitted in OSHPD facilities.
605.10.1:	Limited use of PEX plastic water tubing and joints in OSHPD facilities.
605.16:	Dielectric unions required at connections of dissimilar metals.
606.8:	Sectionalizing valves required at risers and branch piping. Stops required at fixtures.
609.9:	Disinfection of potable water system.
613.0:	Domestic hot water systems.
614.0:	Dialysis water systems.
615.0:	Potable and non-potable water.
615.4:	Emergency water supply.
701.1(2)(b):	ABS and PVC drain piping not allowed in OSHPD facilities.
727.0:	Emergency sanitary drainage.
903.1.3:	ABS and PVC vent piping not allowed in OSHPD facilities.
906.2.1:	Vent piping terminating no less than 25 feet from air intakes and vent shafts.
1014.1:	Grease interceptors shall comply with 1014.1A, 1014.1B, and 1014.1C.
1015.0:	Fats, oil, and grease (FOG) interceptor system grease interceptors shall comply with 1015.6, and 1015.7.
1101.3.2:	ABS and PVC storm drain piping not allowed in OSHPD facilities.
1301.2:	Medical gas systems for OSHPD facilities to be per 2005 NFPA 99. Number of oxygen, vacuum, and medical air station outlets to be per 2013 California Building Code (CBC) Table 1224.2.

2. Minimum plumbing fixtures shall comply with CPC requirements. See CBC Section 1224 for additional fixture requirements in OSHPD 1 facilities.

C. OSHPD 3 Requirements

1. For critical care hospital spaces under OSHPD jurisdiction, design Plumbing systems for full OSHPD 3 compliance as described in the California Plumbing Code (CPC). Significant design requirements are described in the following sections of the 2013 CPC, although all applicable requirements in the CPC must be followed.

210.0:	Handwashing fixtures.
221.0:	Scrub sinks.
222.0:	Toilets and toilet rooms.
310.9:	Drainage piping over operating and delivery rooms, nurseries, food prep centers, food-serving facilities, food storage areas, and other sensitive areas.
310.10:	Floor drains in operating, delivery rooms, and cystoscopic rooms.
313.8:	Seismic anchoring and bracing requirements.
319.0:	This section for medical gas and vacuum systems is not to be used for OSHPD facilities.
403.3.1:	Waterless urinals not allowed in OSHPD facilities.
413.3:	Operation of sensor operated flush valves during loss of normal power.
422.1:	Fixture counts in OSHPD facilities per Table 4-2.
422.2.1:	Separate toilet facilities for patients, staff, and visitors in OSHPD facilities.
604.1:	Use of CPVC not permitted in OSHPD facilities.
605.3.3.2:	Pressed fittings in copper water pipe or tubing not permitted in OSHPD facilities.
605.10.1:	Limited use of PEX plastic water tubing and joints in OSHPD facilities.
605.16:	Dielectric unions required at connections of dissimilar metals.
606.8:	Sectionalizing valves required at risers and branch piping. Stops required at fixtures.
609.9:	Disinfection of potable water system.
613.0:	Domestic hot water systems.
614.0:	Dialysis water systems.
615.0:	Potable and non-potable water.
701.1(2)(b):	ABS and PVC drain piping not allowed in OSHPD facilities.
903.1.3:	ABS and PVC vent piping not allowed in OSHPD facilities.
906.2.1:	Vent piping terminating no less than 25 feet from air intakes and vent shafts.
1014.1:	Grease interceptors shall comply with 1014.1A, 1014.1B, and 1014.1C.
1015.0:	Fats, oil, and grease (FOG) interceptor system grease interceptors shall comply with 1015.6, and 1015.7.
1101.3.2:	ABS and PVC storm drain piping not allowed in OSHPD facilities.
1301.2:	Medical gas systems for OSHPD facilities to be per 2005 NFPA 99. Number of oxygen, vacuum, and medical air station outlets to be per 2013 California Building Code (CBC) Table 1224.2.

2. Minimum plumbing fixtures shall comply with CPC requirements. See CBC Section 1226 for additional fixture requirements in OSHPD 3 facilities.

D. Hazard Analysis & Critical Control Point (HACCP) Risk Management

1. the University uses a HACCP risk management plan to aid in the prevention of legionellosis associated with buildings. Designers shall review the plan with the University to determine how to implement requirements into their designs and record documents for the following aspects of the plan:
   - Method for monitoring critical control points, including how and where water samples are taken.

- Sampling locations shall account for sampling frequency and accessibility during operational hours.
- Critical control points include, but are not limited to the following:
  - Domestic hot water systems with water heaters that operate below 140º F and deliver water to taps below 122º F.
  - Water lines that operate at temperatures above 68º F and reach 98.6º F for patient comfort.
  - Materials with rubber washers and fittings, including water hammer arrestors and rubber hoses with spray attachments.
  - Organic compounds leached from plumbing materials such as; plastic materials used for service pipes made from PVC (polyvinyl chloride), HDPE (high density polyethylene), GRP (glass fiber reinforced polyester), or PEX (cross-bound PE); epoxy lining used on concrete and on stainless steel in pipes and basins; lubricants used for fitting pipes together, as well as in the production of, for instance, stainless steel pipes.
  - Humidifiers and decorative fountains that create a water spray or mist and use water at temperatures favorable to Legionella growth.
  - Cooling towers, evaporative condensers, and fluid coolers that use evaporation to reject heat.
  - Other sources including stagnant water in bypass lines and infrequently used lines, such as for eye washes and safety showers.

- Method for implementing approved disinfection and flushing of piping systems for routine maintenance measures and for corrective actions if critical control point monitoring determines Legionella concentrations exceed critical limits. This may involve installing isolation and drain valves and injection ports so that water piping to individual patient rooms, units, and floors can be isolated and chemically disinfected or sterilized by thermal heating and flushing.
- Water system diagrams, drawings, or design/process flow diagrams to indicate where potential Legionella exposure points (critical control points) are within a system and the critical limits for each.
  - May involve updating existing diagrams and drawings for HACCP plans already in place.

E. Seismic Criteria: See Section 23 - HVAC guidelines for requirements.

F. Emergency and Standby Power Provisions

1. The following plumbing equipment in OSHPD 1 facilities shall be on emergency power and shall remain in operation during periods of utility power outage:
   - All water circulating and pressure boosting pumps, including their controls.
   - Domestic hot water systems and controls.
   - Medical and laboratory gas and vacuum equipment, controls, and alarms.
   - Purified water systems and controls.
   - Fuel oil equipment, including their controls and alarms.
   - Electronic sensor activated faucets and flush valves without back-up batteries.

2. For OSHPD 3 and non-OSHPD facilities, establish and coordinate emergency and standby power requirements for plumbing equipment and systems for code compliance. For equipment and systems not required by code to be on emergency

power, review if certain equipment and systems are required to remain in operation during periods of utility power outage with the University.

G. Fixtures, Outlets, and Equipment

1. Load Calculations

- Calculate fixture water and drain loads based on the CPC and Table 2-2 - Hospital Plumbing Fixtures from the American Society of Plumbing Engineers (ASPE) Plumbing Engineering Design Handbook Volume 3, Special Plumbing Systems.
- Calculate estimated equipment loads based on specific equipment manufacturer's data.
- Calculate medical gas and vacuum equipment loads based on flow rates and diversity factors listed in Tables 2-5 - Medical Air Peak Demand Chart, 2-6 - Outlet Rating Chart for Medical Vacuum Piping Systems, and 2-7 - Medical Vacuum Peak Demand Chart (Medical/Surgical Vacuum System) from ASPE Handbook Volume 3.
- Include allowances for identified future fixtures, outlets, and equipment.

2. Specify fixtures using a minimum of water consistent with fixture application. Install flow control devices to limit water use, except in tank and flushometer water closets and urinals. Conservation of water shall be carefully considered and reviewed with the University.

H. Connections to Medical, Clinical Laboratory, and Kitchen Equipment

1. Medical, laboratory, and kitchen equipment are normally specified in the specification section for the equipment.

2. Include a schedule on the plumbing drawings for the rough-in and final connections to all equipment.

3. Coordinate furnishings for all equipment trim, such as traps, faucets and valves, with the equipment drawings and specifications.

4. Provide a pressure regulating valve, pressure gauge, pressure relief valve, thermometer and shock absorber in the high temperature (180° F) lines serving equipment such as dishwashers, etc.

I. Connections to Clinical Laboratory Casework

1. Include the rough-in for all laboratory casework (benches) in the plumbing drawings and specifications. Terminate rough-ins with valved services and temporarily capped drains.

2. Coordinate with laboratory casework specifications to make sure final plumbing connections are properly accounted for and specified in the appropriate specification sections.

J. Risers

1. Include a single-line, no-scale, riser diagram of each piping system on the plumbing drawings for all multistory buildings. Riser diagrams shall include soil, waste, vent, hot and cold water, gas and vacuum, and purified water systems.

2. Riser diagrams shall show pipe sizes, sectionalizing valves, expansion/seismic joints, water hammer arrestors and all fixtures and equipment in the system. Show design quantities and pressure, where applicable, for both branch and riser at each connection point.

3. Indicate the basis used in sizing the pipes below the title of each diagram.

K. Valves

1. Show all isolating valves on the drawings. Do not rely on listing in the specifications or a statement of general requirement clauses such as, "where (or as) required", etc. Review isolating valve locations in all cases with the University.

2. Zone distribution systems with valves to ensure that only limited areas will be disturbed for maintenance and future renovations. At a minimum, specify isolating valves at the following locations:
   - Base of risers
   - At branch take-offs from vertical risers
   - To isolate clinics or departments
   - At branch that services individual patient and restrooms
   - At each equipment connection
   - To permit separate disinfecting, cleaning, flushing, and certification of systems in phased construction where occupancy may occur in increments as construction is completed.

3. Refer to NFPA 99 for isolation valve requirements in medical gas and vacuum systems.

4. Do not specify isolation valves for single fixtures. The stop valve at the fixture is sufficient.

5. Co-locate isolation valves with HVAC reheat coil isolation valves serving the same zones/rooms.

6. Provide isolating valves on each side of backflow preventers to meet requirements of the device's certifying agency approval.

7. Provide isolating valves at all pressure regulating, balancing, master thermostatic mixing, solenoid, and check valves.

L. Domestic Water Systems

1. Provide two meters in parallel for domestic cold water service to prevent service interruptions for each building. Locate meters inside the building in an accessible

location to permit reading and maintenance. For medical office and administration buildings, specify meters to meet CalGreen requirements only. Review requirements for connecting meters to the energy management and control system (EMCS) with University.

- Size each meter for 100% of the estimated building cold water demand. Do not include fire sprinkler demand. Because of potential for meter failure, 100% demand on both meters must be met. Hospital buildings must have full demand met at all times.
- Provide strainers and isolating valves at meters to permit operation with one meter out of service.
- Provide meters in all make-up water connections.

2. Provide two water pressure regulators (PRV's) in parallel for hospital buildings, regardless of existing static pressure. System shall maintain a maximum of 80 pounds per square inch at the lowest point of use.
   - Locate regulators in the mechanical room for ease of maintenance. Provide proper drainage for pressure relief valve and leaks.
   - Size each regulator with a rated capacity at the reduced pressure for 100% of the estimated cold water building demand. No device shall be sized with inlets or outlets smaller than size of supply piping.
   - Provide low and high pressure gauges, strainers, pressure relief valve, and isolating valves at regulators to permit operation with one regulator out of service.
   - Adjust pressure differential settings so that one regulator will operate on low demands and the second opening on increased demands.
   - Where no regulation is required by present static pressure, set PRV's to no more than present static pressure.
   - Note that regulators must be provided to meet the building water demand. There may be low, medium, and high volume demand at various pressure requirements. As many as three regulators in parallel may be required.

3. Provide backflow protection (BFP) at any building water system as required by the CPC and where there are connections, actual or potential, to a contaminating liquid. Examples include connection from domestic system to heating hot water makeup (HHW) and cooling towers.
   - Provide two BFP's piped in parallel for water mains to hospital buildings and other water supplies with critical operation requirements.
   - Backflow may be prevented by installing a backflow prevention device at each individual point of possible contamination, where devices such as vacuum breakers or air gaps may be employed, or at a single point where an industrial water piping system takes off from the domestic water piping. Industrial water used for service sinks, medical equipment, and labs is assumed to be non-contaminated. The industrial system must be protected from HHW, cooling towers, etc., by additional backflow protection devices.
   - Select the type of backflow prevention system appropriate to each individual case in accordance to requirements of the CPC. Generally, a separate industrial water system will be justified in buildings having numerous outlets that are susceptible to contamination.

4. Specify water hammer arrestors in accordance with the American Society of Sanitary Engineers (ASSE) Standard 1010, Water Hammer Arrestors. Size and locate arrestors per Plumbing Drainage Institute (PDI) Standard PDI-WH 201, latest edition. Show water hammer arrestors on plans and riser diagrams. Specify at all quick closing valves including flush valves, solenoid valves and electronic hands free fixtures. Water hammer arrestors shall be installed in accessible locations behind access panels with inlet isolation valves.
   - Review requirements for providing water sampling ports with the University and the University's Department of Hospital Epidemiology and Infection Control for HACCP plan compliance.

5. Design new and modifications to existing systems with short pipe runs and no dead leg piping in both hot and cold domestic water systems. Removal of existing dead leg piping in project area, whether reused or not, shall be included in the project scope.

6. Faucets at patient sinks, or staff sinks which could be used by patients in nursing units, including accessible sinks, shall not be electronic type.
   - Review requirements for providing double layer sterilizing grade filtration on patient and staff sink faucet outlets with the University and the University's Department of Hospital Epidemiology and Infection Control for HACCP plan compliance.

7. Shower systems shall be designed with self-draining piping between the shower control valve and head.
   - Review requirements for providing double layer sterilizing grade filtration shower heads in patient showers with the University and the University 's Department of Hospital Epidemiology and Infection Control for HACCP plan compliance.

8. Hot water tanks and other water storage vessels should have a drainage point to allow for flushing of the system and insulated recirculating loops.

9. Provide hose bibbs at prominent outside entrances to a building for washing down purposes. Locate these as inconspicuously as possible consistent with accessibility. Provide a ground level hose bibb for wash down at all large concrete areaways or shafts. Hose bibbs shall be supplied from an industrial water system or have separate BFP device or vacuum breaker and backflow preventer on each hose bibb.
   - Landscape irrigation hose bibbs and backflow preventer are normally under a separate landscaping contract. Provide a valved branch from the building service outside the building for future connection. Review size and location with the University. Note that all hose bibbs require a backflow preventer.
   - Provide 4" plastic pipe sleeves below all roads and walks to permit later installation of irrigation system to reach all areas from the service point without cutting new work. Install sleeves with 18" minimum cover and mark locations.

10. Emergency Showers and Eyewash Station Locations - The scope and application of the updated Cal/OSHA regulations are expanded from corrosive liquids to all hazardous substances, including materials that are otherwise harmful and likely to

cause injury. All emergency eyewash and showers must comply with CCR Title 8, Section 5162, ANSI standard Z358.1-1981 and the following:

- An emergency eyewash/shower shall be provided in work areas where the eyes and/or body may come into contact with hazardous substances. The eyewash and shower shall be located such that they can be reached from any point in the space within 10 seconds and be used simultaneously. Eyewash and shower must be readily visible (using signs, bright paint, etc.) and area must be well lighted. Eyewash and shower may be located between laboratories, ancillary spaces or corridors provided ANSI standards are met.
- The floor space below an emergency show/eyewash must be kept free and clear of obstructions at all times for a distance of 30" diameter circle. In addition, the free floor space shall be delineated by 2" wide yellow tape.
- Personal eyewash/shower equipment (i.e., squeeze bottles, hand held drench hoses, etc.) may be installed to support shower and eyewash units but shall not be substituted for them.
- All equipment shall be connected to a potable water supply. Showers shall be connected with 1-1/2" minimum pipe size.
- All units require valve hold-open devices. Water flow must be intentionally shut off.

M. Domestic Water Heating

1. Design domestic hot water system with a pumped circulation loop. Design systems for 140° Fahrenheit and reduce to required temperatures at or near the points of use to minimize conditions that promote the growth of disease causing bacteria and microorganisms. Provide point-of use booster heaters for areas requiring higher water temperatures.

2. Design hot water piping and circulation system to ensure minimum hot water response time to all fixtures and equipment. Provide pumped circulation for all hot water systems and manually calibrated circuit balancing valves to set flows in return branch piping. Exclude circulating pumps from energy conservation measures and design pumps for continuous operation to minimize conditions that promote the growth of disease causing bacteria and microorganisms. Design system with a system heat loss not exceeding 10˚F. Select return piping sizes based on uniform friction loss. Limit velocity in return piping to maximum 2 feet per second. Minimum pipe size to fixtures shall be 3/4".

3. Table of Service Requirements

Description of Service	*Expectation of domestic hot water delivery time*	*Comments*
Hand Wash Sink	Within one cycle of the electronic faucet, maximum of 10 seconds	Code required hand wash fixture
Scrub Sink	maximum of 10 seconds	
Public Lavatory	15 sec	
Clean / Soiled Utility Sink	15 sec	
Lounge / break room	30 sec	

Description of Service	*Expectation of domestic hot water delivery time*	*Comments*
Dietary	15 sec	
Showers	30 sec	
General lavatory (admin)	30 sec	
Patient room sink	30 sec	

4. Design heat traps on all cold water makeup inlet and outlet connections to all hot water storage tanks.

5. Specify alarm downstream of mixing valves set to distribution temperature in OSHPD 3 facilities. Specify local audio and visual alarm, and an alarm signal to the EMCS. Review need for high temperature shut-off with the University.

6. Where a centralized domestic hot water system is not applicable, such as a small tenant improvement, electric point-of-use type water heaters are acceptable.

N. Drain, Waste, and Vent Systems

1. The standard system for drain waste, and vents is to be gravity. Alternate methods, such as vacuum, are to be considered only after review with the University.

2. Grade interior piping, above ground, at 1/4" per foot minimum; 1/8" is not acceptable.

3. Vent all fixtures as required by CPC. Review proposed combination waste and vent systems with the University. Such systems must meet criteria set forth in the CPC.

4. Specify connections to sanitary waste systems for purified and dialysis water drains using laboratory waste piping materials.

5. In general, grease interceptors should be avoided except where required by code or other regulations. If required, locate for easy access and servicing, preferably outside, with proper venting. Provide plaster, sediment, or sand interceptors at sinks that could discharge these materials into the waste system. Consider the use of a single large interceptor for a series of sinks or an area. All interceptors located below sinks shall be accessible, with easy-opening top.

6. Do not specify caulked joints in pipes receiving periodic discharges of hot liquids (boiler blowdown, dishwashers, pot sinks, steam kettles, etc.). Pay particular attention to joints occurring above operating and delivery rooms, nurseries, general storage, food storage or food preparation areas, and other sensitive areas - or better, avoid locating piping above these areas. Sewage lines shall not be installed above such areas.

7. Threading of cast iron pipe for any purpose is not permitted. Joints between cast iron and other dissimilar metals shall be made with proper transition type compression couplings.

8. Include provisions in the specifications for coordination of drain and clean-out elevations with other work such as concrete and waterproofing.

9. Carefully coordinate with the Architect and Mechanical Engineer in the selection of drains for appearance (as in toilet rooms, terraces, and other visible locations); type of clamping ring (built-up and single-ply roofing); size and type of waterproofing flange (for liquid applied systems); two-level drains; type of strainer, including removable internal strainers or buckets; gravel guards (ballasted or built-up roofs); method of anchorage to roof and floor decks; movement due to seismic or deflection (steel framing systems) - ensure that movement is accommodated in leader below roof, not at roof membrane.

10. Locate toilet room floor drains out of foot traffic below water closet partitions or between urinals.

11. Specify galvanized cast iron type roof and areaway drains with dome strainers.

12. Where floor drains are roughed in for future use, cover with a flush plate and gasket for protection against fume leakage.

13. Provide trap primers to retain trap seals on floor drains installed in areas where floors are not washed periodically or there is no regularly used water outlet to replenish the trap seal. Do not make a general statement to install as required, where required, etc.

14. All floor drains to have 3" or larger traps plus trap primers.

15. Cleanouts:
    - Provide at the end of the run for all horizontal drain runs on every floor.
    - Provide on main drain stacks installed on each floor.
    - Provide clean-out extended from the base to a floor clean-out or a wall clean-out above the change in direction for vertical to horizontal changes in main risers that occur above furred ceilings.

O. Medical and Laboratory Gas and Vacuum Systems

1. Obtain all necessary information required from the University when determining system design and types of services. Review location, quantity, and type of equipment, outlets, inlets, and alarm panels with the University.

2. Medical gas and vacuum systems serving patients shall be independent of all other gas and vacuum systems.

3. Coordinate requirements for use of ventilators with the University. Design oxygen and medical air systems to accommodate required flow demands.

4. Specify at least one nitrogen control panel (NCP) within rooms containing nitrogen station outlets. Coordinate with the University to determine quantity and location.

5. Locate station inlets and outlets at an appropriate height to prevent physical damage to attached equipment and accessories. Station inlets and outlets located above countertops shall be provided with sufficient space to allow usage and attachment of

equipment without interferences by countertop, backsplash or overhead cabinets. Specify sufficient spacing between station inlets and outlets to allow simultaneous use with vacuum collection bottles, regulators, adaptors or any other equipment attached. Specify slide retainer bracket for collection bottle attachment adjacent to each vacuum station inlet.

6. Medical air compressors and vacuum pumps shall be multiplexed with receiver tanks and sized such that 100 percent of the design load is carried with the largest single unit out of service. Increase the calculated (SCFM) load by 25 percent to accommodate future system expansion. In designing a medical air system where ventilators are expected to be utilized, add the ventilator requirement of 200 L/min (7 SCFM) for each ventilator in use to the compressor sizing.

7. Specify sufficiently sized, properly ventilated and constructed room for medical gas cylinder storage and manifold systems in accordance with NFPA 99. Coordinate with the University to determine space required for storage of additional non-manifolded cylinders. Gas cylinder storage rooms shall be located at ground level with at least one exterior wall and be specified with a minimum 42 inch door opening to the outside.

8. Bulk liquid oxygen supply systems shall be designed and located in accordance with NFPA 99 and carefully reviewed with the University and their designated oxygen supplier. Specify emergency oxygen inlet on exterior wall of each building served. Insure that location of inlet allows truck access and that concrete pavement is specified where truck will park during transfer of oxygen.

9. Coordinate master alarm panel locations with the University. When determining alarm locations, consider emergency power circuits, engineering control center data relay interface locations, and the facility's established procedures for monitoring alarm signals. EMCS systems must not be exclusively relied upon to monitor medical vacuum and gas alarms.

P. Purified Water Systems

1. Where steam is available, use steam heated stills with fully automatic controls, including self-starting, stopping, and flushing.

2. Provide welded steel fully block tin lined or polyvinyl chloride storage tanks. Provide dial level indicator, filter, sealed access cover, and proper inlet and outlet fittings.

3. Review still and storage capacities, alternative gas or electric heating when steam is not available, and other storage tank materials such as aluminum or stainless steel, with the University.

4. Demineralized (deionized) water may have sufficient purity for many uses. In some buildings this may be all that is required, or a dual system of distilled and demineralized water may be used to reduce still and storage size for specific areas only. Review type and size of purified water system equipment with the University, especially with regard to reverse osmosis systems.

Q. Fuel Gas Systems

1. Design single meters per building. Use elevated gas pressure where most economical. Investigate utility company's guarantee of service pressure when considering the use of elevated gas pressure.

2. Show a separate natural gas service to any room or area where gas boosters are used. Provide a check valve to prevent a backflow of the higher pressure gas into the building natural gas distribution system.

22-5 GENERAL REQUIREMENTS

See Section 23 - HVAC guidelines for requirements.

22-6 BASIC MATERIALS AND METHODS

See Section 23 - HVAC guidelines for requirements.

22-7 INSULATION

See Section 23 - HVAC guidelines for requirements.

22-8 BASIC PLUMBING MATERIALS AND METHODS

A. Domestic and Industrial Water System Piping

1. Design Criteria:
   - Size piping based on the CPC. Include an allowance for 20% future increase in design flow rate.
     - For extension of piping into areas with limited service, consult with the University as to whether piping should be further increased in size to accommodate future growth in demand.
   - The minimum water supply pressure to all parts of the domestic water system shall be 30 PSI. Review pressure requirements for equipment and design service and distribution to provide the necessary pressure and flow at each location.
   - Maximum velocities in copper water distribution piping shall be as follows:
     - 6 feet per second (FPS) for cold water
     - 8 FPS for cold water branch lines no more than 30 feet long
     - 5 FPS for hot water lines up to 140ºF
     - 3 FPS for hot water lines hotter than 140ºF
   - Take particular care in designing and sizing cold water piping to any shower, or shower room, where the use of adjacent flush valve fixtures could affect pressure and cause excessive temperature fluctuations. Consider the use of pressure balancing valves between hot and cold water supplies in such cases, or separate line from a point that would not be affected by flushing fixtures.
   - Normally closed bypass or other non-circulating piping with infrequent use that allows water to stagnate and provide areas of growth for disease causing bacteria and microorganisms shall not be used. When such piping is necessary for the required operation of the building, keep these lines as short as possible and provide them with a means to conduct higher than normal testing/monitoring and

isolation for administering approved sterilizing treatment measures without disrupting the operation of the remainder of the system. For new bypass piping, call for lines to be completely drained and normally kept in a dry state during normal system operation before placing bypasses in service. Valves in lines provided for future connections shall be installed no more than 6" from the branch connection to the active main and completely drained on the capped side of the valve before permanently capping.

2. Materials:
   - 4 Inches and Smaller Piping: Copper tube, Type L, hard drawn, ASTM B88, NSF/ANSI 61-G. Use Type K, soft (annealed) temper, for underground piping with brazed joints and wrought copper fittings.
     - Fittings: NSF/ANSI 61-G, ANSI B16.22 wrought copper, solder joint. For fittings not available in copper, specify NSF/ANSI 61-G, ANSI B16.18 cast bronze, solder joint.
     - Joints 2 inches and smaller shall be soldered. Specify lead-free solder Canada Metal "Silvabrite 100", J. W. Harris "Bridgit", or equal.
     - Joints 2-1/2 inches and larger shall be brazed. Specify brazing alloy containing minimum 15 percent silver with copper and zinc, maximum five (5) percent phosphorous (BCuP-5), Bellman-Melcor "Silvaloy 15", J.W. Harris "Stay-Silv 15", or equal.
     - Nipples: Standard weight/Schedule 40 seamless red brass (85% copper/15% zinc), ASTM B687-88, NSF/ANSI 61-G, and ANSI/ASME B1.20.1 NPT threads.
     - Unions: In piping 2 inches and smaller, specify ASTM B62, ANSI B16.22, NSF/ANSI 61-G wrought copper bronze with ground joint and soldered ends; Nibco 633-W, Mueller Brass "Streamline," or equal.
     - Flanges: In piping 2-1/2" and larger, specify ANSI B16.24, Class 150, cast copper alloy. Refer to Flanges, Unions, and Couplings in Section 23 - HVAC guidelines for additional requirements. "CTS" companion flanges not permitted.
     - Use threaded joints for valves and piping specialties in copper piping, 2 inches and smaller.
   - 4 Inches and Larger Piping (Aboveground): ASTM A53, Grade B, Type E or S, standard weight, welded galvanized steel.
     - Fittings: ASTM A234 Grade WPB/ANSI B16.9, standard weight, seamless, welded galvanized steel.
     - Flanges: Class 150. Refer to Flanges, Unions, and Couplings in Section 23 - HVAC guidelines for additional requirements. "CTS" companion flanges not permitted.
     - After fabrication of spool pieces, grind smooth all protrusions, slag, weld beads, edges, corners, etc. Then clean and hot-dip galvanize in accordance with ASTM A123 and Standard Specifications of the Hot-Dip Galvanizers Association, Inc. Specify minimum coating thickness of two ounces of zinc per square foot of pipe wall on each side. Do not weld piping after galvanizing.
   - 4 Inches and Larger Piping (Underground): Ductile iron, Class 52, AWWA C151, with standard cement mortar lining, AWWA C104.
     - Fittings: Ductile iron or grey iron, mechanical joint, cement mortar lined, Class 250, AWWA C110.

- Joints. Elastomeric gasket joints with non-toxic gasket lubricant, AWWA C111.
- Encasement: Specify 8-mil tube or sheet polyethylene encasement of iron pipe and pipe fittings, AWWA C105.

B. Sanitary Waste, Vent, and Storm Drain System Piping

1. Design Criteria:
   - Size and grade sanitary drainage, vent, and storm drain piping based on the CPC. Include an allowance for 20% future increase in design flow rate.
     - For extension of piping into areas with limited service, consult with the University as to whether piping should be further increased in size to accommodate future growth in demand.
     - 1/8" per foot slope for above or below ground piping inside buildings is not acceptable.
   - Vent all sanitary fixtures as required by CPC. Review any proposed combination waste and vent systems with the University. Such systems must meet criteria set forth in the CPC.
   - Kitchen or Food Service Waste System: Design a separate waste system for any lower floor kitchen or food service where there are toilet rooms above. Keep this system separate and connect at a point in the building sanitary sewer system where a stoppage below the connection will not back sewage up to kitchen or food service floor drains or sinks. Review use of backwater valves with the University.
   - Use laboratory waste pipe in any location where the waste may contain corrosives. Keep such waste and vent systems separate from the building plumbing soil, waste and vent systems to a point outside the building. In buildings with minor isolated points of corrosive use, review method of handling with the University.
   - Use gravity flow for all building drainage systems. Where this appears to be impractical, review installation of pumps with the University and obtain approval before proceeding with design
   - Elevator Pit Drains:
     - Carefully review requirements with the University. Because of heavily restricted access to elevator hoistways by non-elevator maintenance personnel, consider providing no drainage at elevator pits.

2. Materials:
   - 2 Inches and Larger Piping: Hubless cast iron pipe, service weight, ASTM A-888, CISPI 301; Tyler, AB&I Foundry, or equal.
     - Fittings: Hubless cast iron fittings, service weight, ASTM A-888, same manufacturer as pipe.
     - Joints: ASTM C1540 heavy duty multiple band (four minimum) stainless steel and neoprene type no-hub coupling with 0.015-inch thick 304 stainless steel corrugated shield, ASTM C564 one-piece molded groove and bead neoprene sealing sleeve, 304 stainless steel axially slotted heavy duty worm drive hex-head sealing clamps with floating eyelets, FM 1680 compliant; Mission “HeavyWeight”, Husky Series 4000, or equal.
     - 4 Inches and Smaller Piping Above Sensitive Areas (such as Operating Rooms): Type DWV copper drainage pipe with solder joint fittings as

described below for 1-1/2 inches and smaller sanitary waste, rainwater, and vent piping.

- 1-1/2 Inches and Smaller Piping: Type DWV copper tube, ASTM B306.
  - Fittings: Cast copper drainage fittings (DWV), ANSI B16.23, or wrought copper drainage fittings (DWV), ANSI B16.29.
  - Joints: Lead free (<0.2%) solder conforming to ASTM B32, and flux conforming to ASTM B813.
  - Optional: Galvanized Steel, Schedule 40, Type F, Grade A, ASTM A53, with cast iron threaded drainage fittings, ASTM B16.12.
- All Sizes Underground: Hub and spigot pipe, service weight, ASTM A74, fully coated with coal tar pitch, Tyler "Ty-Seal," AB&I Foundry "SV," or equal.
  - Fittings: Hub and spigot fittings, service weight, ASTM A74, fully coated with coal tar pitch, same manufacturer as pipe.
  - Joints: Neoprene rubber compression gaskets, ASTM C564.
  - Make connections to existing sewer pipes using cast iron "MG Couplings" with neoprene gaskets, and stainless steel bolts and nuts. American Brass and Iron Foundry, or equal.
- 4 Inches and Smaller Pressurized Soil, Waste and Rainwater: Type L copper tube, hard drawn, ASTM B88.
  - Fittings: ANSI B16.29 wrought copper drainage fittings (DWV), solder joint. For fittings not available in copper, specify ANSI B16.23 cast copper drainage fittings (DWV).
  - Joints: Lead free (<0.2%) solder conforming to ASTM B813; and flux conforming to ASTM B32.
  - Optional: Galvanized steel, Schedule 40, Type F, Grade A, ASTM A53, with cast iron threaded drainage fittings, ASTM B16.12.

C. Laboratory Waste and Vent System Piping

1. Design Criteria:
   - Size laboratory waste and vent piping based on criteria provided in the CPC for sanitary drainage and vents. Include an allowance for 20% future increase in design flow rate.
     - For extension of piping into areas with limited service, consult with the University as to whether piping should be further increased in size to accommodate future growth in demand.
   - Provide laboratory waste piping for dialysis wall box drains. Connect drains to sanitary waste piping system.
   - See Sanitary Waste, Vent, and Storm Drain System Piping guidelines for additional requirements.

2. Materials:
   - High silicon cast iron, service weight, hubless pattern, 14.5% silicon content, ASTM A518 and A861. Duriron, or equal, no known equal.
     - Fittings: Hubless high silicon cast iron, service weight, ASTM A888, same manufacturer as pipe.
     - Two-bolt mechanical joint with chemical resistant PTFE inner sleeve, Neoprene rubber outer sleeve, and 300 series stainless steel outer band. Duriron "MJ" coupling, or equal, no known equal.

- Optional (Review with the University Prior to Design): Schedule 40 flame retardant PVDF (polyvinylidene fluoride), ASTM D3222, ASTM F1673, flame spread of less than 25 and smoke developed index of less than 50 when tested in accordance to ASTM E84, UL723 and NFPA 255, GF Piping Systems "Fuseal 25/50," or equal.
  - Fittings: Same as piping manufacturer.
  - Joints: Electrofusion welds with polyvinylidene fluoride jacketed wire inserted into the fitting socket at factory, mandrel wound and heat fused on the outer surface, wire leads terminated with duplex receptacle connector for attachment to the fusion unit cables.

D. Laboratory Gas and Vacuum System Piping

1. Design Criteria:
   - Size laboratory gas and vacuum piping based on flow rates listed in Table 12-5 - Sizing for Oxygen, Nitrogen, and Air, Table 12-6 - Factors for Sizing Any Gas Based on Specific Gravity, and Chapter 12, Laboratory Gases from ASPE Handbook Volume 3. Laboratory gas, vacuum, and water branch piping with small numbers of outlets used for average purposes may be sized per Table 12-7 - Typical Laboratory Branch Sizing Chart from ASPE Handbook Volume 3. Include an allowance for 20% future increase in design flow rate in all cases.
     - For extension of piping into areas with limited service, consult with the University as to whether piping should be further increased in size to accommodate future growth in demand.
   - Size distribution systems for all compressed gases and vacuum using a maximum 5% loss of initial pressure to furthest point of use under maximum demand.

2. Materials:
   - ASTM B88 Type K or L hard drawn copper tubing conforming to ASTM B280 ACR (air-conditioning and refrigeration) with silver brazed joints. Piping and fittings shall be factory cleaned, deoxidized, dehydrated, and sealed by the manufacturer prior to shipment. Sizes 1/4-inch and smaller shall be annealed (soft).
     - Fittings: ANSI B16.22 wrought copper, solder joint. All fittings shall be rated for 300 psi working pressure.
     - Joints: Specify brazing alloy containing minimum 15 percent silver with copper and zinc, and maximum 5 percent phosphorous (BCuP-5), Bellman-Melcor "Silvaloy 15," J.W. Harris "Stay-Silv 15," or equal. Dry nitrogen shall be continuously purged through the line during brazing.

E. Purified (DI) Water System Piping

1. Design Criteria:
   - Provide constant circulation for new systems not supplied by the purified water system from the Parnassus Central Utility Plant.
   - Velocity in the distribution piping system shall be sufficient to maintain turbulent flow, approximately 3 to 5 FPS.
   - Limit outlet branch piping to a maximum of 6 feet and pitch piping at a minimum grade of 1/8" per foot to allow complete drainage of these lines.

2. Materials:
   - 3/4 Inch and Smaller Piping: ASTM A269 seamless tubing, thoroughly cleaned at the factory or shop and plugged for shipping and handling, with Bi-Lok Series "D," Swagelok, or equal, tube fittings consisting of hardened stainless steel bodies, nuts, and ferrules conforming to ASTM A479 and A182.
     - Dual Ferrule Tube Fittings: Type 316 stainless steel ASTM A479 ferrules, threaded nuts, threaded bar stock fitting bodies, or ASTM A182 threaded forged fitting bodies shipped fully assembled and individually bagged. Compose fittings of four precision machined component parts: 1) fitting body, 2) front ferrule, 3) back ferrule, 4) nut. Provide fittings cleaned at factory. Fittings shall be completely component intermixable with Swagelok brand tube fittings and compatible for use with Swagelok Gap Inspection Gauges.
   - 1 Inch through 2 Inch Piping: ASTM A312 seamless Type 316, Schedule 40, thoroughly cleaned at the factory or shop and plugged for shipping and handling.
     - Fittings: Class 150, Type 316 stainless steel, ASTM A351, threaded.
   - Optional: Polyvinylidene fluoride (PVDF) manufactured from natural, unpigmented, virgin PVDF homopolymer conforming to ASTM D-3222. Schedule 40. Stress-relieved.
     - Fittings: Non-contact infrared butt fusion or socket fusion joints.
     - Perform joining in strict accordance with manufacturer's recommended procedures with manufacturer's specified equipment.
     - Cut piping in strict accordance with manufacturer's recommended procedures.
     - Clean components prior to fusion conscientiously and in strict compliance with manufacturer's recommendations.
     - Form joints using non-contact butt fusion with equipment made specifically for this use by manufacturer of material.

F. Natural Gas System Piping

1. Design Criteria:
   - Size piping based on the CPC. Include an allowance for 20% future increase in design flow rate.
     - For extension of piping into areas with limited service, consult with the University as to whether piping should be further increased in size to accommodate future growth in demand.
   - Show a separate natural gas service to any room or area where gas burners are used with other gases, or air, under a greater pressure. Provide diaphragm-operated check valves, or equal, to prevent a backflow of the higher pressure gas into the building natural gas distribution system. Vent check valve discharge outside building.

2. Materials:
   - 2 Inches and Smaller Piping: ASTM A53, Type F, Schedule 40, carbon steel, hot-dip galvanized.
     - Fittings: ASTM A126/ANSI B16.4, Class 125 cast iron, or ASTM A197/ANSI B16.3, Class 150 malleable iron, threaded, hot-dip galvanized.
     - Unions: Malleable iron, Class 250, hot-dip galvanized. Refer to Flanges, Unions, and Couplings below.

- 2-1/2 inches and Larger: ASTM A53, Grade B, Type E or S, Schedule 80, carbon steel, welded.
  - Fittings: ASTM A234 Grade WPB/ANSI B16.9, standard weight, seamless, carbon steel, welded.
  - Flanges: Class 150. Refer to Flanges, Unions, and Couplings under Section 23 - HVAC guidelines.

G. Flanges, Unions, and Couplings:

1. Dissimilar Waste Piping Adapters: Specify coupling specifically designed for the piping materials being joined. Transition couplings shall be one-piece rubber gasket with removable rubber bushings wrapped in an extra-wide stainless steel sleeve with minimum of two stainless steel tightening clamps. Fernco "Proflex", Mission "Band-Seal", or equal.

2. See Section 23 - HVAC guidelines for additional requirements.

H. Jointing: See Section 23 - HVAC guidelines for requirements.

I. Piping Specialties

1. Escutcheons:
   - Flat or low profile polished chrome plated brass or stainless steel with spring tab or set screw grip.
     - Specify white painted escutcheons where pipes penetrate acoustic tile ceilings.
     - Specify paintable escutcheons and paint to match wall or ceiling color at exposed penetrations through walls hard ceilings.

2. Sleeves and Packings: See Section 23 - HVAC guidelines for requirements.

J. Water System Specialties

1. Strainers:
   - 2 Inches and Smaller, Copper Pipe: Y-Type, bronze body with blowoff outlet, lead-free, threaded ends, Type 304 stainless steel standard mesh screen, Class 125; Mueller Steam Specialty Model LF351, Apollo Valve YB 59LF Series, or equal.
   - 2 Inches and Smaller, Steel Pipe: Y-Type, cast iron or ductile iron body, threaded ends, Type 316 stainless steel or monel screen, maximum 40 mesh, bronze plug, 250 psi class; Spirax/Sarco Model IT, Mueller Steam Specialty No. 11FCB, Armstrong Type AISC, or equal.
   - 2-1/2 Inches and Larger: Y-Type, ASTM A126 Class B cast iron body, flanged ends, Type 316 stainless steel or monel screen, maximum 1/16 inch perforations up to four (4)-inch size and 1/8-inch perforations for larger sizes, bolted screen retainer with off-center blowdown connection, 250 psi class, Spirax/Sarco CI-250, Mueller Steam Specialty No. 752, Armstrong Type A1FL-250, or equal.
     - Domestic water strainers shall have FDA approved, heat fused, epoxy coated interior.
     - Strainers located outdoors shall have epoxy coated exterior.

2. Water Hammer Arresters:
   - Type 1 (For Flush Valves, Backflow Preventers, and Top of Main Risers): All stainless steel construction with welded nesting bellows, pressurized compression chamber, nontoxic mineral oil surrounding bellows, and threaded nipple connection. J.R. Smith Hydrotrol 5000 Series, Precision Plumbing Products (PPP) SS Series, Zurn, or equal.
   - Type 2 (For Individual Sinks, Showers, and Quarter-Turn or Similar Fast Closing Shutoff Valves): Piston type arrester with Type L copper construction, EPDM O-ring seals, and threaded connection. PPP Model SC-500, Sioux Chief Model 652-A Hydra-Rester, or equal.

3. Water Supply and Waste Wall Boxes:
   - Dialysis Machine Hook-Ups: Acorn Hose and Supply Box 8196-SV or equal, recessed Type 316 stainless steel supply and waste wall box with continuous welded seams, adjustable heavy gauge Type 304 stainless steel wall flange secured with screws at each corner of box, satin finish, welded hose bracket for holding up to two (2) dialysis machine discharge hoses, 2-3/8 inch O.D. plain end waste connection tailpiece, single stainless steel ball valve with EPDM seals and O-ring, and flushing nipple for flushing lines into waste receptor. Provide flush fitted door to box with concealed hinge, key-operated cam cylinder lock, and two keys.

4. Pipe Flexible Connectors:
   - See Section 23 - HVAC guidelines for requirements.
   - Seismic Joints: Specify flexible seismic loops with two flexible sections of hose and braid assembled so that piping does not change direction and maintain its course along a single axis. Loops shall be factory supplied with center support nut and a drain/air release plug located on the return fitting at the end of the loop joining the two flexible sections together. Loops shall impart no thrust loads to system support anchors or building structure. Materials of construction and end fitting types shall be consistent with pipe material and equipment/pipe connection fittings. Flexible seismic loops shall be Metraflex "Metraloop," FleXicraft “ML,” or equal.
     - Confirm and specify lateral motion required with structural engineer.
     - Specify minimum ratings of 150 psi design pressure, 225 psi test pressure, and 400°F. Provide 600°F minimum rating for natural gas.
     - Specify NSF 61 drinking water certified for loops in domestic water service.

5. Backflow Preventers:
   - Reduced Pressure Principle Assembly, 2 Inches and Smaller: Lead-free RP assembly rated to 180ºF intermittent/140ºF continuous operating temperature and supplied with full port quarter turn bronze ball valves and threaded ends, ASTM B584 bronze body, bronze or stainless steel trim, differential pressure relief valve located between two spring-loaded check valves, replaceable stainless steel valve seats, and ball valve test cocks. Assembly shall be AWWA C-511 compliant and ASSE 1013 listed. Wilkins Model 975XL, Watts No. LF909QT, or equal.
   - Reduced Pressure Principle Assembly, 2-1/2 inches and Larger: Lead-free RP assembly supplied with full port resilient seated gate valves and flanged ends. The main body and access cover shall be epoxy coated ASTM A536 Grade 4

ductile iron or stainless steel, the seat ring and check valve shall be thermoplastic construction, the stem shall be ASTM A276 stainless steel, seat disc elastomers shall be EPDM. All internal parts, including checks and the relief valve shall be accessible for maintenance through a single cover without removing the device from the line. Assembly shall be certified to NSF/ANSI 372, be AWWA C-511 compliant, and ASSE 1013 listed. Wilkins Model 375A, Watts 994, or equal.

- Pressure Vacuum Breaker Spill-Resistant Type Assembly, 2 Inches and Smaller: Lead-free SVB assembly supplied with full port bronze ball valves and threaded ends, ASTM B584 bronze body, integrated thermoplastic modular check and float assembly, stainless steel springs, air inlet separation diaphragm. Assembly shall be certified to NSF/ANSI 372 and ASSE 1056 listed. Wilkins Model 460XL, Watts No. LF008PCQT, or equal.
  - Specify for all interior locations where PVB type pressure vacuum assemblies are allowed.
- Install assemblies with upstream strainer and isolation valve. Provide 1/2-inch hose bibb and 3/4-inch hose cap for strainer blowoff connection.

6. Ice Machine Water Filters: Dual filter type with pre-filter and 0.5 micron primary filter cartridges suitable for minimum 0.5 gpm flow rate, compliant with ANSI/NSF 42 and 53. Provide with inlet isolation valve, discharge pressure gauge, flushing valve, and wall mounting bracket. Rigidly mount filter housing at an easily accessible location below counter and immediately above or adjacent to floor sink. Provide stainless steel drip pan and/or drain piping so that filter cartridges can be replaced without spilling water on floor. Follett QC4-FL4S, Balston, Cuno, or equal,

7. Pressure Regulating Valves: See Section 23 - HVAC guidelines for requirements. Specify equivalent models meeting lead-free requirements.

8. Balancing Valves: See Section 23 - HVAC guidelines for requirements. Provide in stainless steel to meet lead-free requirements.

9. In-Line Hot Water Circulating Pumps:
   - General:
     - See centrifugal pump requirements in Section 23 - HVAC guidelines.
     - Schedule capacities and required utilities on Drawings.

   - Materials:
     - 1/2 HP and Larger: Pipeline mounted, single suction type with lead-free bronze casing, rated for 175 PSI working pressure and 225°F continuous/250°F intermittent operating temperature. Casings with tapped and plugged openings for vent, drain, and suction and discharge gauge connections. Single suction enclosed type bronze impeller, hydraulically and dynamically balanced, keyed and locked to carbon steel pump shafts and protected by replaceable bronze shaft sleeves. Impellers directly hung from motor shafts without using flexible couplings. High strength carbon steel shaft, sealed and gasketed from pumped fluid. Furnish with mechanical seals of single unbalanced type with rotating element and ceramic stationary seat. Regreasable ball bearings for motor and pump. Bell and Gossett Series 90, Armstrong, Taco, or equal.

- 1/3 HP and Smaller: Pipeline mounted, single suction type with lead-free bronze casing, rated for 150 PSI working pressure and 225°F continuous operating temperature. Provide Noryl impeller with ceramic shaft supported by carbon bearings. Bearings shall be lubricated by circulating fluid. Provide motor stator isolated from circulating fluid by stainless steel can and rotor sheathed in stainless steel. Motors shall be non-overloading at any point on pump curve. Provide 1/3 HP motors with built-in thermal protection. All other motors shall be provided with built-in impedance protection. Bell and Gossett NBF System Lubricated Circulator, Armstrong, Taco, or equal.

- Pump Installation and Start-up:
  - See centrifugal pump requirements in Section 23 - HVAC guidelines.

10. Hot Water Expansion Tanks:
    - Diaphragm type with welded steel tank, ASME code construction and stamped, 125 psi working pressure; Wessels, Amtrol, or equal. Specify with system connection, air charging valve, and drain plug, and internal parts complying with FDA regulations and approvals. Integral heavy-duty butyl rubber diaphragm shall provide permanent sealed-in air cushion, be removable for inspection or replacement, and comply with NSF/ANSI 61. Schedule sizes and charging pressures on the Drawings.

11. Water System Relief Valves: See Section 23 - HVAC guidelines for requirements.

K. Drainage System Specialties

1. Cleanouts:
   - Specify in material appropriate to sanitary or laboratory waste and drain systems.
   - Specify recessed cleanout plugs with taper-threads where fittings are used as cleanouts.
   - Floor Cleanouts: Ferrule type with adjustable top, scoriated cover and frame, and taper-thread plug. Specify model specific to type of flooring installed.
   - Wall Cleanouts: Countersunk ferrule, taper-thread plug, secured stainless steel access cover.

2. Floor Drains, Floor Sinks, and Funnel Drains:
   - Specify with caulked or no-hub connection required by piping system being connected. Specify internal seepage collar and weep holes to allow drainage of drains embedded in floor construction. Specify auxiliary inlet fittings where trap primer connections are required. Specify model specific to type of flooring installed in material appropriate to sanitary or laboratory waste and drain systems.
   - Floor Drains: Specify 5 or 8 inches round or square strainers.
   - Indirect Waste Floor Drains: Specify with 8 inches round strainer and funnel secured to strainer.
   - Floor Sinks: Type 304 stainless steel, 14 gauge, with #4 satin finish interior, 6 inches deep, 1/2-inch trap primer tapping, and with 12 inches square medium duty stainless steel "heel proof" grate.
     - Specify minimum 10 inches deep with appropriate half, no, or oval funnel drain grate for equipment with pumped discharges.

- Funnel Drains:
  - Sanitary Waste Systems: Polished chrome plated cast bronze with 6 inches diameter funnel and P-trap.
  - Laboratory Waste Systems: Acid resistant interior and exterior coated cast iron with 6 inches diameter funnel and P-trap.

3. Trap Primers:
   - Pressure drop activated brass trap primer with removable filter screen, Precision Plumbing Products (PPP) Model P-2, Mifab M-500, or equal.
     - Provide shutoff ball valve at connection to water main.
     - Specify installation in accessible location for filter screen servicing.
     - Connect to sanitary and laboratory waste systems with appropriate materials; copper for sanitary waste and stainless steel or PVDF for laboratory wastes.
   - For floor drains, floor sinks, and funnel drains located under or adjacent to sinks, specify 1-1/2 inch sink tailpiece trap priming assembly with braided 3/8-inch stainless steel flexible priming make up water line, 1/2-inch compression fittings, and chrome plated escutcheons for both wall tube and make-up water line. PPP Model LPT-1500, Mifab MI-750, or equal.

4. Roof Drains and Overflow Drains:
   - Specify cast iron body with adjustable collar, cast iron flashing ring, gravel stops, 10" diameter cast iron dome strainer, and cast iron underdeck clamp. J.R. Smith 1010Y-RC-CID, or equal.
     - Expansion joints shall be cast iron joint with bronze pipe sleeve and neoprene gasket. J.R. Smith 1710, or equal.

L. Domestic Hot Water Heaters

1. General:
   - Intent is to select highly efficient equipment and appropriate accessories.
   - At the beginning of design, identify all water heater types and sizes that reasonably meet the project program. Review selections, reliability, life-expectancy, and cost with the University. Also review alternative system configurations, redundancy, and installation sequencing. Proceed with design approach selected by the University.
   - Appropriate replacement water heaters will depend on current system configuration, demand, required redundancy, and required capacity during construction.

2. Semi-Instantaneous Domestic Water Heaters:
   - Heaters shall be vertical U-tube semi-instantaneous type with service water in the shell and steam or heating hot water in the tubes. The ratio of service water volume to steam or heating hot water volume shall be a minimum of 5:1. The U-tube shall be atmospherically vented with clearly labeled, visible leak detection port.
   - The water vessel shall be designed to allow no greater than 5 fps average water velocity when traveling through the shell at design flow conditions to ensure no heat exchanger erosion. Total domestic water pressure drop through the heater shall not exceed 10 psi at design flow. The tube bundle shall be constructed of double wall tubing and be of baffle free design.

- The water pressure vessel shall be designed and manufactured in accordance with ASME Section VIII, Div. 1 for not less than 185 psig at 400°F working pressure and temperature. The tube bundle shall be designed and manufactured in accordance with ASME Section VIII, Div. 1 for not less than 250 psig at 400°F working pressure and temperature.
- An integral demand anticipator requiring no electrical hook-up shall be provided to maintain final temperature to +/-4°F under all domestic load conditions. Circulating pumps and/or blending valves shall not be required for temperature control.
- All pressure vessel and heat exchanger surfaces in contact with the domestic water shall be copper or copper alloy. Materials of construction shall be: minimum 3/16" carbon steel shell lined with minimum 0.024-inch sheet copper, minimum 0.038" outer wall and minimum 0.025inch inner wall copper tubes, minimum 0.25" Naval Brass upper tubesheet and lower tubesheet liner and bronze top head.
- Heaters shall be supplied ready to accept existing steam, condensate and domestic water lines, and be furnished with the following accessories:
  - Minimum 1-1/2 inches thick resilient insulation having "K" value of 0.25 BTU-in/hr-ft2-°F, meeting or exceeding ANSI/ASHRAE/IES standard 90.1.
  - Bronze Temperature & Pressure relief valve, conforming to ANZI Z21.22 and 1-1/2 inches bronze ball type shell drain valve.
  - Control box with dual solenoid valve over-temperature limit system. One solenoid shall disable steam control valve, and one solenoid shall perform as a secondary water relief valve. Provide power on/tripped status lights, liquid-filled remote capillary thermometer and compound steam pressure gauge.
  - Pneumatic control valve and temperature controller. Provide with steam control valve of the balanced, pilot-operated type, having a soft seat for bubble tight shut-off and equal percentage flow characteristics. Valve shall be applied directly for scheduled steam pressure without the need for additional pressure regulating valves.

- Provide written extended warranties for the following:
  - Heat Exchanger: The heat exchanger, comprised of the coils and risers, shall carry an unconditional, non-prorated 10 year guarantee against failure due to thermal shock, mechanical failure, manufacturing or material defect or erosion.
  - Pressure Vessel: The pressure vessel consisting of shell, and top head shall carry an unconditional, non-prorated 10 year guarantee against leakage due to internal corrosion.
  - Anticipator: The integral demand anticipator unit shall carry an unconditional, non-prorated 10-year guarantee against any failure.
  - All other components shall carry a 1 year from start-up/18 months from shipment guarantee against failure due to manufacturing or material defects.
- AERCO Model SWDW, Reco USA, Patterson Kelly, or equal. Specify specific model numbers and required capacities in schedules on Drawings.

3. Semi-Instantaneous Industrial Water Heaters:
   - Heaters shall be vertical cross-flow 2-pass semi-instantaneous design with service water in the shell and steam or heating hot water in the coils. The ratio of

service water volume to steam or heating hot water volume shall be a minimum of 7:1. Steam shall travel a minimum distance of 20 feet through the heat exchanger, from point of entrance to point of exit. To ensure condensate subcooling, an additional subcooling coil shall be incorporated into the last pass of the heat exchanger design. Condensate temperature shall not exceed 160°F when incoming domestic water temperature is 110°F or lower. An orifice shall be required for incoming water temperatures up to 100°F.

- The heat exchanger shall be constructed of multiple, individually replaceable, helically wound coils, capable of withstanding up to 30 inches wc internal vacuum and having no baffles that could interfere with the natural expansion and contraction of the copper. Each heater shall automatically self-descale for any hard water supply (hard water having 7-10 grains hardness per gallon, as defined by the Water Quality Association). The heat exchanger design shall be suitable for cleaning by the method of thermal shock. The coil and riser assembly shall be designed and manufactured in accordance with ASME Section VIII, Div. 1 for not less than 250 psig at 400°F working pressure and temperature.
- The water vessel shall be designed to allow no greater than 1 fps average water velocity when traveling through the shell at design flow conditions to ensure no heat exchanger erosion. Total domestic water pressure drop through the heater shall not exceed 4 psi at design flow. The water pressure vessel shall be designed and manufactured in accordance with ASME Section VIII, Div. 1 for not less than 235 psig at 400°F working pressure and temperature.
- An integral demand anticipator requiring no electrical hook-up shall be provided to maintain final temperature to +/-4°F under all industrial load conditions. Circulating pumps and/or blending valves shall not be required for temperature control.
- All pressure vessel and heat exchanger surfaces in contact with the industrial water shall be copper or copper alloy. Materials of construction shall be: minimum 3/16-inch carbon steel shell lined with minimum 0.024-inch sheet copper, minimum 0.049-inch thick copper coils, schedule 80 red brass steam riser and bronze top and bottom heads.
- Each heater shall be supplied ready to accept existing steam, condensate and water lines, and be furnished with the following accessories:
  - Minimum 1-1/2 inches thick resilient insulation having "K" value of 0.25 BTU-in/hr-ft2-°F, meeting or exceeding ANSI/ASHRAE/IES standard 90.1.
  - Bronze Temperature & Pressure relief valve, conforming to ANZI Z21.22 and 2 inches bronze ball type shell drain valve.
  - Condensate outlet piping with union orifice and swing check valve.
  - Control box with dual solenoid valve over-temperature limit system. One solenoid shall disable steam control valve, and one solenoid shall perform as a secondary water relief valve and be piped to drain. Provide with "Power On" and "Tripped" status lights, liquid-filled remote capillary thermometer and compound steam pressure gauge.
  - Pneumatic control valve and temperature controller. Provide with steam control valve of the balanced, pilot-operated type, having a soft seat for bubble tight shut-off and equal percentage flow characteristics. Valve shall be applied directly for scheduled steam pressure without the need for additional pressure regulating valves.
- Provide written extended warranties for the following:

- Heat Exchanger: The heat exchanger, comprised of the coils and risers, shall carry an unconditional, non-prorated 10 year guarantee against failure due to thermal shock, mechanical failure, manufacturing or material defect or erosion.
- Pressure Vessel: The pressure vessel consisting of shell, liner and heads shall carry an unconditional, non-prorated 10 year guarantee against leakage due to internal corrosion.
- Anticipator: The integral demand anticipator unit shall carry an unconditional, non-prorated 10-year guarantee against any failure.
- All other components shall carry a 1 year from start-up/18 months from shipment guarantee against failure due to manufacturing or material defects.

- AERCO Model B+II Waterwizard, Reco USA, Patterson Kelly, or equal. Specify specific model numbers and required capacities in schedules on Drawings.

4. Gas-Fired Domestic Hot Water Heaters:
   - Specify a complete packaged system, factory assembled and tested, consisting of natural gas fired heaters, storage tank, piping, specialties, and controls. Heaters for OSHPD 1 facilities shall also fire with standby diesel fuel. Heaters shall be copper fin-tube design with integral fins spaced at 7 fins per inch. Provide with the following:
     - Low voltage control system, including 120/24 volt transformer, intermittent ignition, electronic pilot supervision with main gas shutdown, manual gas cock, gas pressure regulator, aquastat with automatic reset, ASME temperature and pressure relief valves.
     - Draft hoods.
     - Circulating pumps with pump controller.
     - Vertical ASME storage tank, cement lining, carrying 10-year warranty, with high-density insulation, covered with steel jacket, enameled paint finish, and thermometer mounted on tank.
     - The entire assembly shall be mounted on a base platform and not exceed the floor space documented on the Drawings.
     - Major components shall be removable for installation into confined spaces.
     - California Energy Commission listed, certified by American Gas Associates, and carry a 5-year warranty.
   - Schedule capacities and required utilities on Drawings.

5. Dishwater Booster Heaters: Electric, UL listed, with 5-gallon silicon bronze tank, 150 psi working pressure, ASME temperature and pressure relief valve, and anode rod. Specify with pilot light, low water cutoff, shock absorber, stainless steel cabinet, and under-counter mounting pan. A. O. Smith Dura-Power Electric Model CM-9, Lochinvar, or equal. Specify specific model number and required capacity and voltages in schedule on Drawings.

6. Point-of-Use Undercounter/Ceiling Mounted Water Heater: ISO, UL listed, 12-gallon capacity, corrosion-resistant storage tank, insulated and jacketed in steel. 1500 watt heating element. Provide with mounting bracket and temperature/pressure relief valve. Bradford White Model LD-WH12U3-1C015, or equal. Specify model number and required capacity and voltages in schedule on Drawings.

7. Point-of-Use Undercounter Water Heaters at Sinks: 2-1/2 gallon, 1500 watts. Provide with temperature/pressure relief valve, cord, and grounded plug. Locate under sink to accommodate ADA clearances. In-Sink-Erator Model W-152, A. O. Smith, or equal. Specify model number and required capacity and voltages in schedule on Drawings.

M. Laboratory Specialties

1. Cup Sinks: Where cup sinks occur in laboratory casework, cabinets or fume hoods, specify the following:
   - Fixture supply and stop; Chicago Faucet #1006, Water Saver, or equal.
   - 1-1/2 inches corrosion resistant P-trap. Material and joint type to match that of waste system.
   - Final waste, vent and water connections to fixture.
   - Piping, as specified, to respective outlets.
   - Setting fixture, faucet, tailpiece and drain.

2. Where eyewash units and water, gas, and vacuum outlets occur in laboratory benches, specify providing specified piping, connections to outlets, and setting piping and outlets in provided spaces within benches. Coordinate fixture stops and supply piping locations with other services in provided bench spaces and umbilicals.

3. Specify the following for fume hoods:
   - Fume hoods shall be pre-piped for laboratory gas and water services to outlets and valves on hood.
   - Provide rough-in piping to point of connection and final connections to hood. Provide isolation valve and specified flexible connectors on each service.
   - Provide setting of cup sinks, faucets, drains and sink tailpieces.
   - Provide 1-1/2 inches corrosion resistant P-trap and waste and vent piping to and from hood. Material and joint type to match waste system piping.
   - Provide fixture supplies and stops; Chicago Faucet #1006, Water Saver, or equal.

4. Specify the following for laboratory equipment:
   - Provide isolation valve and union for each service.
   - Provide quick-connect outlets for final connection of gas services; Hanson Coupling #3-HK, or equal.
   - Provide pressure relief device between isolation valves and quick-connects on pressurized gas services; Ross L-O-X Series 15, or equal.

5. Compressed air specialties:
   - See Section 23 - HVAC guidelines for requirements.

6. High-pressure laboratory gas cylinder manifolds:
   - Specify with integral pigtail check valves, pressure regulator, dual pressure gauges, and built-in relief valves. Pipe relief valves to the outside. Provide two stainless steel pigtails, Western PF, CU, R24. Western Enterprises Accu-Trol Model SD-4-2, Littell, or equal.

7. Automatic dewar or combination dewar/high-pressure gas cylinder changeover manifolds:

- Manifold and regulator assembly inside a tamper-resistant case with two supply bank headers - one “Service” and one “Reserve” - to provide an uninterrupted gas supply. Control shall include automatic changeover from the depleted “Service” supply bank to the “Reserve” supply with no loss or drop in delivery pressure, and remote annunciation of the depleted supply bank. Standard and optional features shall include:
  - Adjustable line pressure regulators.
  - Bank No.1, Bank No. 2, and outlet pressure gauges.
  - 1/2-inch NPT male outlets.
  - 36 inches stainless steel braided flexible pigtails with check valves.
  - Master shut-off valves and individual cylinder shut-off valves.
  - Pressure relief safety valve.
  - Power supply.
  - Service bank light indicator.
  - Complete mounting hardware including rigid wall-mounting headers.
  - Remote changeover status and alarm panel.
  - Electric heater (for CO2 manifolds).
- Spectra Gases Series F2400 Automatic Changeover Regulator, Victor, Scott, or equal.

N. Natural Gas Specialties

1. Gas Pressure Regulators:
   - 2 Inches and Smaller: Cast iron body, aluminum spring case, plated steel spring, Nitrile diaphragm and disc, threaded, 150 psi WOG, -20°F to 160°F, Fisher Type S100, S200, or S300, Rockwell, American, or equal.
     - Furnish valves 3/4-inch and larger with vent connections.
     - Specify capacity and performance on Drawings.

2. Pipe Flexible Connectors:
   - See Section 23 - HVAC guidelines for requirements.
   - Appliances: Appliance connectors shall be corrugated brass tubing with protective exterior coating, brass valve with non-displaceable rotor, brass outlet fitting, and AGA certified. Connector length shall be as required to allow servicing of appliance. Inside diameter of connector shall be 3/8" for appliances up to 60,500 Btu per hour and 1/2" for appliances up to 106,000 Btu per hour. Connectors shall be Brass-Craft "Super Armoplast" SD4L Series, SC4E Series, or equal.
   - Seismic Joints: Specify flexible seismic loops with two flexible sections of hose and braid assembled so that piping does not change direction and maintain its course along a single axis. Loops shall be factory supplied with center support nut and a drain/air release plug located on the return fitting at the end of the loop joining the two flexible sections together. Loops shall impart no thrust loads to system support anchors or building structure. Materials of construction and end fitting types shall be consistent with pipe material and equipment/pipe connection fittings. Flexible seismic loops shall be Metraflex "Metraloop," FleXicraft “ML,” or equal.
     - Confirm and specify lateral motion required with structural engineer.
     - Specify minimum ratings of 150 psi design pressure, 225 psi test pressure, and 600°F.

3. Cathodic Protection:
   - Specify complete galvanic anode type cathodic protection system for underground steel gas piping, including devices to electrically isolate system being protected.

O. Valves

1. Domestic Water System Isolation Valves, 2-1/2 Inches and Smaller: Full port ball valves, lead-free bronze body with threaded ends, Type 316 stainless steel ball and stem, reinforced TFE seat rings and packing, blowout-proof stem, rated for 400 psi CWP, MSS SP-110 conformance. Provide plastic covered steel lever handles for uninsulated valves and extended vertical insulated tee handles for insulated hot water valves. Apollo 77FLF140, Nibco, Jenkins, or equal.

2. Domestic Water System Isolation Valves, 3 Inches and Larger: Full lug style ASTM A216 WCC carbon steel body, Type 316 or 416 stainless steel stem, continuous stem pinned to disc or two-piece stem in full compliance with MSS-SP-68, with machined rectangular drives and sockets, Type 316 stainless steel disc, PTFE seats suitable for 250° F water, bronze bushings to isolate the rotating stem from the stem journal, stem extended minimum two inches to clear insulation, rated for bubble-tight end-of-line service at 250 psi and 200° F water. Body and operators shall be epoxy coated. Nibco Model LCS-6822 (Class 150), Kennedy, or equal.
   - Do not specify butterfly valves for whole building isolation. Specify gate valves for this service.
   - Attach to specified flanges with heavy hex bolts and lock washers. Piping shall be removable on one side while valve is closed. Apply Never-Seez, or equal, lubricant rated for minimum 1800° F on all lug bolts to ease future disassembly.
   - Operators:
     - Valves 4 Inches and Smaller within 8 Feet of Floor: Galvanized steel handle with minimum of nine positions to lock valve disc, including positive stops at full open and closed positions.
     - Valves 5 Inches and Larger and 4 Inches Size where Elevated Location Requires Chainwheel Operators: Heavy-duty gear operated handwheel, or chainwheel where required, with position indicator, marked dial plate, and locking memory stop.
     - For outdoor or penthouse applications, metal parts shall be hot-dip galvanized or factory finished with epoxy coating system. Gear housings shall be weatherproof. Replace all fasteners, nuts, bolts, and washers on the face of lever or gear housings with stainless steel fasteners, nuts, bolts, and washers.

3. Domestic Water Gate Valves:
   - 2 Inches and Smaller: Threaded ends, union bonnet, rising stem, bronze body rated for 150 psi SWP and 200 psi WOG, conforming to MSS SP-80; Nibco T134, Jenkins 49U, or equal.
   - 2-1/2 Inches and Larger: Flanged ends, bolted bonnet, OS&Y, iron body, bronze trim, rated for 125 psi SWP and 200 psi WOG, conforming to MSS-SP-70; Nibco F617-0, Jenkins 651A, or equal.

4. Domestic Water System Check Valves, 2 Inches and Smaller: Horizontal swing type, screw-in cap, TFE seat disc, renewable seat and disc, lead-free bronze body and wetted parts, threaded ends, rated for 200 psi CWP. Apollo 163SLF, Nibco, Jenkins, or equal

5. Domestic Hot Water Return System In-Line Check Valves, 3 Inches and Smaller: Spring loaded check, straight-through flow, lead-free bronze or bronze/Type316 stainless steel construction, threaded ends, 1/2 psi rated opening pressure, 400 psig CWP at 100 degrees Fahrenheit, NSF 61 and NSF/ANSI 372. Apollo CVB 61LF-100 Series "Ball-Cone", Circle Seal Control, or equal.

P. Instrumentation: See Section 23 - HVAC guidelines for requirements.

Q. Sump Pumps and Controllers

1. Pumps shall be submersible sump duplex, floor mounted type, 1-1/4 inches discharge. The motor shell and volute shall be high strength ASTM A48-83, Class 30, close grain iron. The sump impeller shall be constructed of a heavy duty ASTM A48-83, Class 30 cast iron. The impeller shall be a multi-vane, semi- open type. Type 316 stainless steel shaft, stainless steel fasteners, both upper sleeve and lower bearings shall be double sealed and permanently lubricated. The pump sealing system shall incorporate a double opposed (both seals in an oil bath) mechanical seal system. The upper seal shall consist of carbon against ceramic and lower seal consisting of silicon carbide against silicon carbide. Lip seals shall not be acceptable. There shall be a magnetic plug in the seal chamber cavity to collect any fine metal particles from the oil. All elastomers shall be Buna-N (Nitrile) material. Basis of Design; Weil Model 1408.

2. Motors shall be NEMA 6 air filled hermetically sealed with class F (155 degree C) insulation, capacitor and start relays, built-in thermal overload protection sized for non-overloading over entire pump curve. Motor shall have a moisture sensor. Motor shall include a temperature limiter. The motor shell shall have cooling fins to permit motor operation while submerged for up to 15 min. The motor cover shall include a cable sealing system to prevent water from entering the motor. Oil filled motors shall not be acceptable.

3. Specify model number and required capacity and voltages in schedule on Drawings.

4. Pump controls shall include:
   - Four UL Listed float switches (Lead pump On, Lag pump On, Pumps Off, High water level alarm) Weil Model 8234, or equal.
   - Controller shall have pump alternator and alarm panel with combination magnetic starter, circuit breaker motor protectors, TOA switch, run light and resettable overload heaters for each pump; warning light; horn; test switch; labeled terminal switch and devices; tamperproof design, intrinsically safe relays; NEMA reinforced polyester enclosure, UL Listed. Weil Model 8131, or equal.

5. Pump accessories shall include:
   - 100 foot power cord, cut to exact lengths required.

- Duplex Sewage Pump Valve Assembly. Discharge check valve, full port ball valve and union for each pump.
- 6 feet minimum stainless steel lifting cable.

6. Sump:
   - Pour-in-place Concrete Basin, field erected, minimum interior size of 3'-0" Diameter x 5'-0" deep. Watertight construction and coated with Waterproof system "Futura", or equal.
   - Basis of Design: "Futura", or equal coating.
   - Provide light duty cover, Neenah #R-6118 Type G, or equal with frame, cast iron. Provide adequate access to each motor, per manufacturer's recommendations.

7. Weil, Zoeller, Aurora/Hydromatic, or equal.

R. Domestic Water Booster Pumps

1. Triplex water booster pumps, variable speed pump controller, automatic pump alternation, individual pump isolation valves, check valve discharge, thermal relief system, ETL listed, No-Flow shutdown, low suction pressure cut-off, high system pressure alarm, vertical pump orientation, 6" copper header, bronze or stainless steel body, bronze or stainless steel impeller. Hydro-pneumatic tank included with skid (Mounted separately).

2. Specify required capacity and voltages in schedule on Drawings.

3. G&L Pumps, Grundfos, or equal.

S. Laboratory and Medical Equipment/Instrument Air Compressors

1. General:
   - Intent is to select highly efficient equipment and appropriate accessories.
   - At the beginning of design, identify all compressor types and sizes that reasonably meet the project program. Review selections, reliability, life-expectancy, and cost with the University. Also review alternative system configurations, redundancy, and installation sequencing. Proceed with design approach selected by the University.
   - Appropriate replacement compressors will depend on current system configuration, demand, required redundancy, and required capacity during construction.

2. Provide skid mounted compressed air supply system consisting of two or more compressors, automatic compressor alternation, discharge check valves of brass construction, ASME safety relief valves, intake and discharge flexible connectors, solenoid valve discharge line unloaders, isolation valves, air-cooled aftercoolers, moisture separators with automatic drains, and high discharge temperature shut down switches on each cylinder, UL listed control panel, dual desiccant air dryers, dual filter and regulator bank with sample ports, CO Monitors with alarms, and all bypass piping. ASME rated receiver tank equipped with a pressure gauge, safety relief valve,

block and by-pass valves, condensate sight gauge and tank drain valve included with skid.

3. The compressors shall be belt driven oil-less rotary scroll single stage, air-cooled oil-less construction with absolutely no oil needed for operation. The rotary design shall not require any inlet or exhaust valves and shall be rated for 100% continuous duty. Direct drive compressors shall not be used. Tip seals shall be of a composite PTFE material and be rated for 10,000 hours operation. Compressor bearings shall be external to the air compression chamber and shall all be serviceable for extended compressor life. Bearing maintenance shall not be required until10,000 run hours. Compressors with bearings that are not accessible for service have a limited life span and shall not be accepted. Compressors shall have an integral radial flow fan for cooling and shall not require and additional electrical cooling fans. Each compressor shall have an air-cooled after cooler.

4. Specify required capacity and voltages in schedule on Drawings.

5. Each compressor shall be belt driven by a 1750 RPM, ODP NEMA construction motor. OSHA approved belt guards shall be provided. Motor shall not operate in the service factor.

6. The system shall include an ASME rated air receiver, rated for 200 PSI MAWP. The tank shall be equipped with a pressure gauge, safety relief valve, discharge shut-off valve, flexible piping coupler on the tank outlet, and automatic tank drain.

7. Air-cooled aftercoolers shall be provided for each compressor and shall be sized to provide an approach temperature of 20 degrees F. Each unit shall be constructed of copper tubing and shall be installed on the tank.

8. The standard inlet filter screens directly into the pump inlet and is a pleated element.

9. The Powerex air drying system shall be tank mounted with compressors, and shall provide air at a 35-38 degree F pressure dew point. Provide flexible piping coupler on the discharge of the dryer. The refrigerated compressed air dryer is non-cycling, direct expansion, using R-134a refrigerant. A constant pressure expansion valve is provided to maintain a 38 degree F evaporator temperature. The dryer is self-regulating for large load swings, and includes a 3 micron filter/separator with automatic condensate drain. Refrigerated dryers are to be powered from a separate supply, not through the compressor controls.

10. Compressor Controls:
    - The UL listed controls operate the multiple air compressor modules as needed in response to a pressure signal from a pressure transducer mounted in the panel. An illuminated on/off push button controls power to the motor starters. The control logic automatically stages each compressor on or off individually based on actual system demand.
    - An HMI touch screen interface displays system status and alarm conditions. Pressure settings are user adjustable within factory predetermined setting limits. The PLC will alternate each compressor module based on demand as well as timed alternation. If a compressor module is running longer than ten minutes continuously, the control will alternate to the next available compressor module

to equalize run time and synchronize maintenance intervals. On initial start up or if air pressure drops rapidly, simultaneous motor starts are prevented by a programmed three second stagger. One 120VAC control circuit transformer with primary and secondary fuses is installed for control circuit voltage.

- Motor circuit breakers with lockable disconnects are provided for each compressor module. Operating hours, high temperature alarms, motor overload alarms, run indication, and hours to scheduled maintenance for each compressor module are displayed on the screen. All alarm history is kept in the alarm log. Easily navigated menus are provided to allow the user to select the display conditions and acknowledge the alarms. Dry contacts are provided for remote monitoring of compressor fault conditions.
- COMMUNICATION CARD: The controls contain an Energy Management and Control System (EMCS) communication gateway with BacNet IP protocol and Web server features. The EMCS communication gateway can support hundreds of pre-configured, labeled, and listed individual data points and utilizes a 10/100 BaseT Operation Ethernet port connection. Web server features include email notifications in case the system is in alarm for any reason or has achieved one of its maintenance intervals and requires service. The controls will allow remote monitoring of the following:
  - System pressure
  - Compressor On/Off status (for each compressor)
  - Compressor run hours (for each compressor)
  - High Temperature alarm status (for each compressor)
  - Motor overload status (for each compressor)
  - Maintenance required indication
  - Motor warning – too frequent starts
  - System Auto restart setting status – On/Off
  - System External control setting status – On/Off
  - Daily load factor percentage
  - System hi/lo pressure set points
  - System serial number

T. General Installation

1. Prohibit bull-head tee connections in either mixing or diverging water flow.

2. Natural gas shall not be installed below building floor slab or footings. Grounding to gas piping is prohibited. Gas piping in plenum ceilings is prohibited. Dirt legs are typically not required at the University because of the dry grade of gas supplied by PG&E. Isolation valves shall be accessible in case of emergency; installed minimum 5 feet from equipment.

3. Sloping and Draining:
   - Require continuously graded horizontal drain and waste lines at 1/4-inch per foot. Verify with authority having jurisdiction before allowing other slopes.
   - Arrange discharge at funnels, fixed air gaps, and other indirect waste receptors for equipment drains so that no splashing occurs.
   - Pitch horizontal natural gas piping downward minimum 1 inch per 60 feet in direction of flow toward risers or appliances. Provide minimum 4 inches deep

dirt leg at bottom of vertical runs and at appliances. Make branch connections to mains from top or side.

4. Wherever alteration work results in removal of piping and water outlets, no dead end branches shall be left in the water system. All dead end water lines shall be cut back, valved, and capped within 6 inches of a live main.

5. See Section 23 - HVAC guidelines for additional requirements.

U. Cleaning and Flushing

1. Require openings in piping to be kept closed with plugs or caps to prevent entrance of foreign matter during construction. Pipes, fittings, valves, and specialties shall be clean prior to connecting to system.

2. Require bypass to drain at downstream ends of new water piping and flush new piping in accordance with water systems sterilization and disinfecting procedures.

3. Clean and flush drainage systems with water after successful pressure testing.

4. Purge gas and vacuum systems with dry nitrogen until system is clean and free of oil and construction debris.

V. Domestic and Industrial Water Systems Disinfecting and Sterilization

The following procedures, to be followed by the Contractor, shall be included in the project Specifications.

1. Prior to utilization of water systems, all affected water piping, including emergency shower and eyewash piping, shall be sterilized using procedures prescribed in CPC 609.9.

2. Provide all valves necessary to isolate new piping for disinfection and testing. Provide valves to isolate all new pipe drops and fixtures and at all tie-ins to existing lines and risers.

3. Supervision and Testing: The University's Office of Environmental Health and Safety (EH&S), will oversee the disinfection operation through an EH&S-approved vendor. University's EH&S will review the results and submit written approval of satisfactory disinfection results.

4. Contractor's Responsibility: Disinfect water systems in conformity with procedures and standards described herein and requirements of regulatory agencies. Make tests, take water samples, procure bacteriological analysis by an approved independent testing agency, and issue a written Certificate of Disinfection confirming satisfactory disinfection results to the University's Representative and the University's Office of Environmental Health and Safety. Certificate shall identify all segments of disinfected pipe for which it is issued and include a plan highlighting the piping involved.

5. Daily Reports: Arrange for daily inspections during system disinfecting and sterilizing. Project Inspector shall observe disinfecting agent, preliminary preparations, and procedure. Submit daily reports, signed by Contractor and the University's Inspector of Record, certifying disinfecting and sterilizing procedures, exact extent of system disinfected and sterilized, and date, time, and location of taking water samples.

6. Disinfecting Agent: Use one of the following:
   - Hypochlorite, calcium, or sodium, aqueous solution.
   - Purex, Clorox, or equal commercial product with 5.25% or 16% available chlorine in water solution.

7. Preliminary Preparation:
   - Service Cock: Provide a 1/2" or 3/4" service cock or valve within 3 feet of the supply line for introducing a disinfecting agent into the lines.
   - Flushing: After final pressure tests, each fixture or outlet shall be left wide open until flow shows only clear water.

8. Procedure:
   - Drain all piping to be disinfected.
   - Inject disinfectant into system through the service cock by means of pump or pressure device at a slow, continuous rate simultaneously with reduced flow from water main until an orthotolidin test at each outlet shows chlorine residual concentration of at least 50 parts per million (ppm).
   - Close all outlets and valves, including main service valve and injection cock, to retain chlorinated water. Maintain this condition for 24 hours.
   - An orthotolidin test, after 24-hour period, shall indicate a chlorine residual concentration of not less than 50 ppm. An orthotolidin test reading less than 50 ppm shall result in repetition of the procedure.
   - After satisfactory completion of the above test, the domestic water system shall be drained and flushed until orthotolidin tests show chlorine residual of not more than 0.5 ppm.
   - Remove, clean, and replace strainer screens.

9. Alternate Procedure for Short Runs: For alteration work involving branch lines of 20-foot length or less, the following alternate procedure may, at Contractor's option, be followed:
   - Ascertain before installation that all pipe and fittings are substantially clean.
   - Using a solution of one part "Purex," "Clorox," or equal, to ten (10) parts water, soak lengths of pipe and thoroughly swab pipe and fittings immediately prior to assembly.
   - Immediately after assembly, cap or plug assembled piping against entry of contamination, in a manner acceptable to the the University's Representative. Maintain this condition until final connection.
   - Immediately after connection, flush new piping thoroughly with water.
   - Provide bacteriological analysis specified herein.

10. Preliminary Approval: After satisfactory completion of disinfection procedure, the University's Office of Environmental Health and Safety may issue a temporary

approval for immediate use of piping system pending bacteriological analysis of water samples.

11. Bacteriological Analysis of Water:
    - After final flushing, water samples shall test negative for coliform aerogenes organisms.
    - Analysis shall indicate total plate count less than 100 bacteria per cc.

12. Final Approval: Upon satisfactory completion of analysis, approval of water system disinfection results will be given by the University's Office of Environmental Health and Safety. If analysis results are not satisfactory, disinfection procedure shall be repeated until specified standards are met.

13. Submit Certificates of Sterilization/Chlorination with daily reports and floor plans highlighting the extent of piping covered by the certificate. At the end of the project include all certificates and highlighted floor plans with the project closeout documents to demonstrate that all new piping for the project has been disinfected.

14. After final approval, drain existing piping to make connections, remove hose bibs and connect piping to existing piping, first swab all fittings and ends of existing piping with Clorox, Purex, or equal. Flush piping while filling system until swabbing residue is washed out.

W. Cleaning and Handling of Purified Water Piping

The following procedures, to be followed by the Contractor, shall be included in the project Specifications.

1. Inspection and Handling Procedures:
    - Immediately upon arrival at the site, visually inspect each and every length of pipe to assure the interior is free of stains, discoloration, oils, residue, or other impurities. Immediately remove piping with any impurity from job site.
    - Store pipe, fittings, and valves in a clean, dust-free environment. Open bags only when components are used.
    - Contractor shall be responsible for purity and cleanliness of installed system.

2. Hand Cleaning Procedures for Pipe:
    - Cleaning Solution: Mix SPI Tritton X-100, Dow, or equal, nonionic surfactant and filtered distilled water at the rate of 1 teaspoon to 4 gallons.
    - Rinse the pipe with filtered distilled water at 2 gpm for 2 minutes. Use filtered water once only and discard.
    - Blow dry with clean, filtered nitrogen to remove residual moisture.
    - Immediately seal pipe ends with clean plastic caps.
    - Cover pipe ends with small polyethylene bags and secure with PVC tape. Do not allow tape to adhere to the pipe, only the bag.

3. Hand Cleaning of Valves and Fittings:
    - Place fittings in a clean polyethylene basin containing the surfactant mix noted above and allow to soak 10 minutes.

- Using new soft nylon bottle-type pipe brushes scrub all fitting surfaces and wetted surfaces of valves.
- Blow dry fittings with clean filtered nitrogen.
- Inspect fittings for contaminants. If contaminants are observed, repeat complete cleaning process.
- Immediately place valves and fittings in clean polyethylene bags and seal with tie wrap.

4. Fabrication:
   - Protect piping system components from contamination at all times. Re-clean any system component contaminated during fabrication and installation.
   - Do not leave ends of system and components exposed to the environment when work is not in progress.
   - Cut pipe with a wheel-type cutter. Deburr each cut with the pipe oriented vertically and the deburred end pointing downward. Cut pipe ends square.
   - Following any cutting, deburring, and internal cleaning of pipe ends, maintain piping in vertical position to blow particles from inside of pipe using filtered nitrogen. Install pipe and fittings during the shift it is cleaned.
   - Joints:
     - Socket Fused: Make up piping strictly in accordance with manufacturer's instructions.
     - Threaded: Use only at equipment and valve connections. Make up with Teflon tape using no more than 2 wraps beginning at the large end of threads, wrapping toward small end, leaving 2 end threads exposed.
   - Valves and Specialties: Locate valves and piping specialties to be readily accessible for operation and maintenance. Provide unions at valves and equipment connections.
   - Hangers: Securely support piping with cushioning to prevent swaying and vibration, allowing the pipe to move when thermal expansion and contraction occur. Install supports at maximum 3-foot intervals.
   - Workmanship;
     - Submit sample socket fusion for inspection prior to the start of the project.
     - The University's Representative reserves the right to suspend socket fusion operations for reasons of noncompliance with specified procedures or standards.
     - Remove any piping which, in the University's Representative's opinion, does not meet specified standards and installation requirements, or is otherwise unacceptable.

5. Do not connect to existing deionized water system until cleaning, flushing, testing, and final flushing with distilled water is complete. After pressure testing, drain and flush with distilled water until a purity of 500,000 ohms conductivity is reached in all parts of new system. Submit test results.

X. Testing

1. See Section 23 - HVAC guidelines for general requirements.

2. Test Pressures and Methods:

- Test all soil, waste, vent, and drain piping hydrostatically at 10-foot minimum head on every joint and allow to stand for a minimum of 24 hours. Provide separate standpipe above highest point tested or extend system to obtain required head. Head shall be maintained for at least 30 minutes before test starts.
  - Alternatively, provide hydrostatic test pump to obtain required pressure and test at 5 psig.
- Test all water and sump pump discharge piping hydrostatically at 150 psig; retain this pressure for a minimum of 24 hours.
- Test all compressed air, carbon dioxide, oxygen, nitrogen, and other similar gas piping with an up to ±65 psi operating pressure with compressed air at 150 psig; retain this pressure for a minimum of 24 hours.
  - Isolate any devices which could be damaged by this pressure.
- Test all high pressure compressed air, carbon dioxide, oxygen, nitrogen, and other similar gas piping with a ±100 to 125 psi operating pressure with clean, dry compressed air at 200 psig; retain this pressure for a minimum of 24 hours.
  - Isolate any devices which could be damaged by this pressure.
  - Following successful completion of testing and connection to source, completely flush piping with the gas being carried.
- Test vacuum piping with dry compressed air at 25 psig; retain this pressure for a minimum of 24 hours.
- Test all natural gas piping with dry compressed air at 50 psig for a minimum of 24 hours. Soap test each joint during test period. Following successful completion of testing and connection to source, completely flush piping using natural gas vented to the outside.
- Test purified water piping hydrostatically using distilled water; retain pressure for a minimum of 24 hours.
  - Test PVDF piping at 100 psig.
  - Test stainless steel piping at 150 psig.

22-9 PLUMBING FIXTURES

A. General:

1. Provide in accordance with project program and the CPC. Carefully review substitutions with the University.

2. Specify fixtures from the following manufacturers:
   - Water Closets: American Standard, Kohler, or equal.
   - Wall Mount Lavatories: Duravit, American Standard, Kohler, or equal.
   - Stainless Steel Sinks: Just, Elkay, or equal undermount type. Drop-in type not acceptable.
   - Solid Surface Lavatories: Integral to countertop.
   - Scrub Sinks: Getinge, or equal.
   - Clinic Sinks and Hoppers: American Standard, Kohler, or equal.
   - Janitor Sinks: Fiat, Florestone, Bradley, or equal.
   - Flush Valves, Manual and Electronic: Sloan, Zurn, or equal.
   - Manual Faucets: Chicago Faucets, Sloan, or equal.
   - Electronic Faucets: Sloan, no equal.
   - Fixture Supplies and Stops: BrassCraft, no equal.
   - Sink Drains: McGuire, Just, Elkay, or equal.

- Sanitary P-Traps: McGuire Mfg. Co., Engineered Brass Co., or equal.
- Toilet Seats: Bemis, Beneke, Church Seat Co., Olsonite, or equal.
- Fixture Carriers: Zurn, J. R. Smith, Josam, or equal.
- Insulated Covers for Sink Traps and Supplies: Truebro Inc., McGuire, or equal.
- Undersink Protective Enclosures: Truebro Inc., Sloan, or equal.
- Bedpan Washers: Chicago Faucets, Zurn, or equal.
- Shower Systems, Valves, Heads, Wall Supplies, Hoses, and Fittings: Powers, American Standard, Kohler, or equal.

3. Specify the following trim for all fixtures:
   - Stops: Lead-free quarter turn angled stop with 1/2 inch FIP inlet and 3/8 inch compression outlet connections, chrome finish, and stuffing box-lock shield-loose key bonnets. BrassCraft Model No. KTR17X C, or equal.
   - Traps:
     - Sinks: Minimum 17 B&S gauge chrome plated cast brass p-trap without cleanout plugs.
     - Floor Drains and Sinks: P-traps same material as waste piping system being connected.
   - Insulated Covers for Accessible Sink Traps and Supplies: 1-piece molded form fitting PVC covers containing microbial/anti-fungal and UV inhibitors with self-extinguishing flammability characteristics, smooth tamper-resistant and non-abrasive snap-lock fastening system, and internal trim grooves for adjustable fitting to 1-1/4" or 1-1/2" sink strainer, tailpiece, and cast brass or tubular P-trap assemblies and 3/8" or 1/2" hot and cold angle stop assemblies. Drain covers shall be provided with a weep hole at the lowest point for leak drainage and ventilation. Supply covers shall be provided with removable caps for water shut-off access. Truebro Inc. "Lav Guard 2", or equal. Insulated wraps not acceptable.
     - Seal around fittings.
     - Covers are not required at sinks with undersink protective enclosures.
   - Undersink Protective Enclosures:
     - Rigid high-impact, stain-resistant paintable PVC material, 0.093" nominal wall thickness, white fine Haircell finish with UV protection, tamper resistant stainless steel mounting screws, UL listed per ADA Article 4.19.4, UL-94 V-0, 5VA ASTM D-635-91 4 (ATB) 2.1 (AEB) compliant for flammability, bacteria/fungus resistant per ASTM G21 and G22. Truebro Inc. Lav Shield, or equal.
     - Vitreous china or similar enclosures provided with sinks are cumbersome and difficult to work with and shall not be specified.

B. Handwashing Sinks (Lavatories):

1. Select fixtures for minimal splashing. This is an infection control issue more than it is a housekeeping issue.

2. For wall mounted lavatories, Duravit "Starck 3" Washbasin Model No. 030055.30 or equal, 21-5/8-inch x 16-7/8-inch, vitreous china, faucet holes on 4-inch centers, rear overflow, and concealed arm carrier support.

3. Provide electronic faucets only at lavatories designated for public use and where required by footnote 33 in Table 4-2, Minimum Plumbing Facilities in the CPC.
   - Sloan Optima Systems "Solis" Model EAF-275-ISM-IC or equal, for electronic faucets, solar-powered automatic sensor activated chrome plated faucet, 0.5 gpm non-aerating multi-stream laminar flow outlet, automatic self-adapting double infrared sensor, microprocessor based logic, 6-volt DC Lithium battery back-up, programmable automatic purge, integral spout temperature mixer with fixed setting.
     - Provide faucet with OSHPD extension kit #EF-40-A to locate outlet no less than 5 inches above fixture rim.
     - Set faucet automatic purge interval to 12 hours. Remove faucet temperature mixing lever after setting outlet temperature and turn lever over to University. Plug hole in faucet housing with cap provided with faucet.
   - Provide sterilizing grade filters on faucet outlets in patient rooms and patient room toilet rooms. Pall "QPoint" Model QJ212U outlet filter with QDTC quick connector or equal, double layer sterilizing grade filter rated and validated at 0.2 µm with integral 1.0 µm pre-filter to protect against waterborne particulates and pathogens, minimum 99% bacteriostatic efficiency, 1.5 gpm at 15 psi, 75 psi maximum upstream operating pressure at 140 degrees Fahrenheit maximum continuous operating temperature, 167 degrees Fahrenheit intermittent peak temperature, non-aerating multi-stream laminar outlet flow.

C. Toilets:

1. Select floor mounted fixtures with rear discharge. Where wall mounted toilets are necessary, provide 750 lbs duty carriers.

D. Staff Lounge and Break Room Sinks:

1. Provide single compartment solid surface sink integral to countertop with compact garbage disposer and hot and cold drinking water dispenser.
   - Locate drain outlet at rear end of bowl for ADA clearance with garbage disposer.
   - Specify installing drinking water dispenser filter in accessible location in cabinet below sink.

E. Showers:

1. For accessible showers, provide fixed and handheld shower heads with diverter valves.
   - For showers in patient room toilet rooms, Pall "Aquasafe" Model AQF4A shower head filter or equal, with SHO1/2MNN quick connector and 32-1425 union adapter handheld head with double layer sterilizing grade filtration rated and validated at 0.2 µm with integral 1.0 µm pre-filter to protect against waterborne particulates and pathogens, minimum 99% bacteriostatic efficiency, 1.5 gpm at 15 psi, 75 psi maximum upstream operating pressure at 140 degrees Fahrenheit maximum continuous operating temperature.

22-10 MEDICAL GAS AND VACUUM SYSTEMS

A. Medical Gas and Vacuum System Piping

1. Design Criteria:
   - Size medical gas and vacuum piping based on station flow rates listed in Table 2-4 - Inlet/Outlet Station Data and Chapter 2 Plumbing Design for Healthcare Facilities from ASPE Handbook Volume 3. Comply with NFPA 99, Health Care Facilities, for required system pressures. Include an allowance for 20% future increase in design flow rate in all cases.
     - For extension of piping into areas with limited service, consult with the University as to whether piping should be further increased in size to accommodate future growth in demand.
   - Size distribution systems for all compressed gases and vacuum using a maximum 5% loss of initial pressure to furthest point of use under maximum demand.

2. Materials:
   - Review with the University prior to design.
   - Compressed Medical Gas Piping: Pre-cleaned Type K or L hard-drawn seamless copper tubing, ASTM B819 Class 1, with temporary capped ends. Pipe shall be marked "OXY", "MED", "OXY/MED", "ACR/OXY", or "ACR/MED" in blue (Type L) or green (Type K).
     - Specify Type K copper tubing and Schedule 40 PVC containment pipe for underground installations.
     - Fittings: Wrought copper fittings with brazed joints conforming to requirements of ANSI B16.22. Cast fittings not permitted.
     - Joints: ASTM B260-52T, 7.0% to 7.5% phosphorus, balance copper, AWS/A5.8 Class BCuP-2, free flowing at 1475 degrees Fahrenheit, with brazing range of 1350 to 1500 degrees Fahrenheit; Bellman-Melcor “Bazeit-0”, J.W. Harris "Harris 0", or equal.
   - Medical Vacuum and WAGD Piping: Same as compressed medical gas piping. Type L hard-drawn seamless copper tubing, ASTM B88, or Type L ACR hard-drawn seamless copper tubing, ASTM B280, may be specified as an option provided that requirements for prominently labeling and handling optional piping separately from compressed medical gas piping in accordance with NFPA 99-5.1.10.2.2.1 are also specified.
     - Joints 2 inches and smaller shall be soldered. Specify lead-free silver-bearing solder, Canada Metal "Silvabrite 100", J. W. Harris "Bridgit", or equal.
     - Joints 2-1/2 Inches and Larger shall be brazed as specified above for medical gas piping.

3. Pipe Flexible Connectors:
   - See Section 23 - HVAC guidelines for requirements.
   - Seismic Joints: Specify flexible seismic loops with two flexible sections of hose and braid assembled so that piping does not change direction and maintain its course along a single axis. Flexible loops shall be factory supplied with center support nut and a drain/air release plug located on the return fitting at the end of the loop joining the two flexible sections together. Flexible loops shall impart no thrust loads to system support anchors or building structure. Materials of construction and end fitting type shall be consistent with pipe material and equipment/pipe connection fittings where loops are installed. Flexible seismic loops shall be Metraflex "Metraloop," FleXicraft “ML,” or equal.
     - Confirm and specify lateral motion required with structural engineer.

- Specify with minimum ratings of 150 psi design pressure, 225 psi test pressure, and 400°F.
- Specify with joints specifically manufactured for medical gas and vacuum service. Factory clean and seal medical gas and vacuum seismic joint assemblies in accordance with NFPA 99 requirements.

B. Outlets, Zone Valves, and Alarms:
- BeaconMedaes or equal.
- Provide in accordance with program requirements and the CPC. Review outlet locations and types with User Groups in all cases and with the University.
- Specify outlets with quick connect fitting.
- Carefully review the use of DISS fittings with the University. DISS outlets are used in many areas of the existing hospital, but are being phased out.
- Butterfly Valves for Medical Vacuum Service, Over 4 Inches: Full lug style iron body, Type 316 or 416 stainless steel stem, continuous stem pinned to disc or two-piece stem in full compliance with AWWA C504-80 with machined rectangular drives and sockets, Type 316 stainless steel or ASTM B148 Alloy 9-C aluminum bronze disc, EPDM seats suitable for 250 degrees Fahrenheit water, bronze bushings to isolate the rotating stem from the stem journal, rated for bubble-tight end-of-line service at 150 psi and 200 degrees Fahrenheit water. Body and operators shall be epoxy coated. Centerline Series WL, Grinnell Series 8000, or equal.
  - Attach to 150 psi copper flanges with heavy hex bolts and lock washers.
  - Operators: Galvanized steel handle with minimum of nine (9) positions to lock valve disc, including positive stops at full open and closed positions.

C. Air Compressors and Vacuum Pumps

1. General:
   - Intent is to select highly efficient equipment and appropriate accessories.
   - At the beginning of design, identify all compressor and vacuum pump types and sizes that reasonably meet the project program. Review selections, reliability, life-expectancy, and cost with the University. Also review alternative system configurations, redundancy, and installation sequencing. Proceed with design approach selected by the University.
   - Appropriate replacement compressors and vacuum pumps will depend on current system configuration, demand, required redundancy, and required capacity during construction.

2. Packaged Medical Compressed Air System:
   - Schedule capacities and required utilities on Drawings.
   - Medical air package shall be fully compliant with NFPA 99 and feature a common base with single point connections for electrical, intake air, discharge air, and condensate drains. The common base shall be separable for transport through standard 34.5" doorway. Package shall be designed and manufactured with ISO 13485 processes and be completely tested before shipment. OSHPD 1 buildings shall be provided with package pre-approved by OSHPD for Special Seismic Certification and include:
     - Compressor towers which accommodate a maximum of two “oil-less” scroll compressors and motors.

- Duplex desiccant drying system with purge control.
- Integral pre-wired control panel.
- Corrosion resistant vertical air receiver.

- The compressors shall be continuous duty rated scroll type, single stage and air-cooled. The compressors shall have one fixed and one orbiting scroll sealed with PTFE tip seals. Compressors shall include:
  - Field replaceable tip seals.
  - Dust and contamination protection from two part face seal.
  - Grease filled orbiting and pin crank bearings rated for maintenance intervals of 10,000 hours for 10 HP and 8,000 hours for 15 HP.
  - Integral cooling fan.
  - V-belt driven compressor protected by totally enclosed belt guard.
  - Fully adjustable motor mounting base to achieve belt tensioning.
- Motors shall be NEMA rated and comply with motor requirements in Section 23 - HVAC guidelines.
- Piped intake manifold shall include one inline inlet air filter and isolation valve per compressor and a high inlet vacuum switch to protect the compressors. The compressor discharge assembly includes:
  - Integral air-cooled aftercooler with a maximum approach temperature of 15°F above ambient and integrated drain trap with automatic solenoid drain valve.
  - Discharge lines with heat-shielded flex connector, safety relief valve, isolation valve and check valve.
  - Integral valve per compressor to provide load-less starting and rapid air evacuation at shutdown.
- A four-point, heavy duty isolation system rated for minimum 95% isolation efficiency shall fully isolates the compressor / motor tower from the system. Finite Element Analysis shall be conducted to minimize vibration transfer.

3. Packaged Medical Vacuum System:
   - Schedule capacities and required utilities on Drawings.
   - Medical vacuum package shall be fully compliant with NFPA 99 and feature a common base with single point connections for the electrical panel and vacuum intake. Each pump and the receiver shall be connected to a common intake manifold. The common base shall be separable for transport through standard 34.5" doorway. Package shall be designed and manufactured with ISO 13485 processes. OSHPD 1 buildings shall be provided with package pre-approved by OSHPD for Special Seismic Certification. Each system shall be completely tested before shipment and include:
     - Two "oil-less" claw rotary vacuum pumps with motors.
     - Integral pre-wired control panel.
     - Vertical air receiver with full-size three-valve bypass system sized for appropriate demand.
   - Each pump shall be direct driven, non-contacting claw type, capable of operating continuous duty at 23.4" Hg (sea level). The pumping chamber shall be oil free. The pump shall be completely air- cooled with no water requirements. Each pump shall contain:
     - 5 micron inlet air filter.
     - Vacuum relief valve.
     - Check valve to prevent backflow through off-cycle units.

- Flexible connector and isolation valve.
- High discharge temperature sensor.
- Oil drain valve and oil sight glass.

- Motors shall be NEMA rated and comply with motor requirements in Section 23 - HVAC guidelines.
- Provide each vacuum pump with a factory piped intake with integral flex connector, isolation valve, and check valve. Interconnecting piping shall consist of powder-coated steel tubing and flanges.
- The vacuum receiver shall be ASME Code stamped, and rated for a minimum 150 PSIG design pressure. Provide receiver with full-size three-valve bypass system to allow for draining without interrupting vacuum service. A manual drain shall be provided on the receiver.

4. Packaged Medical Instrument/Equipment Compressed Air System:
   - See guidelines for Laboratory Compressed Air Systems.

D. Automatic Changeover Manifolds

1. Specify manifolds that accommodate multiple high pressure cylinders equally divided into two banks for a specific gas service. The cylinder banks shall be arranged in a staggered configuration and provide an uninterrupted supply of gas for the specific gas application. The manifold shall be cleaned, tested, and prepared for the indicated gas service and constructed in accordance with requirements of the latest edition of NFPA 99 and CGA.