VII. PIPING SYSTEMS

EXECUTIVE SUMMARY

The new 40,000 sq. ft Engineering Building is to be designed with similar types and quality of systems as in the Applied Research Center. Primary function of this new building is for engineering labs, teaching labs, and offices. This building will have independent piping systems and not be connected to the ARC.

SYSTEM DESCRIPTIONS

Storm and Clearwater Drainage

System Description

A storm drainage system will be provided to convey rainwater from flat roofs to site storm sewers

Secondary roof drainage will be accomplished by using a dedicated piped overflow drainage system separate from the primary storm drainage system which will discharge through the building wall onto grade.

Clearwater waste from air handling units, coolers, and other devices and equipment that discharge clearwater will be conveyed by gravity flow through a separate piping system and will connect to the building storm drain.

Design Criteria

The primary storm drainage system will be sized based on a maximum rainfall rate of 5 in/hr. The secondary storm drainage system will be sized based on the same design criteria as the primary system.

The sizing for all clearwater discharge from equipment system will be based on the maximum flow rate of the equipment.

Equipment and Material

Storm and clearwater drainage systems which cannot discharge to the storm sewer by gravity flow will be drained by gravity to a sump with pump(s) and will be pumped into the building storm drainage system.

Sump pumps will be connected to the emergency (standby) power system to permit operation during a loss of normal power.

Distribution

Storm and Clearwater Waste Systems Materials			
System	Below Ground	Above Ground	
		Outside of Return Air Plenum	Within Return Air Plenum
Storm and Clearwater Waste and Vent	Schedule 40 PVC with DWV pattern solvent cement socket fitting joints	Schedule 40 PVC with solvent cement socket fitting joints	Hubless cast-iron pipe with heavyweight no-hub couplings with stainless steel clamps
Pressurized Storm and Clearwater Waste and Vent	Schedule 40 PVC with solvent cement socket fitting joints	Schedule 40 PVC with solvent cement socket fitting joints	Hubless cast-iron pipe with heavyweight no-hub couplings with stainless steel clamps

Roof and overflow drain bodies and above ground storm, secondary roof drainage and clearwater waste piping will be insulated.

Waste and Vent Systems

System Description

A sanitary waste and vent system will be provided for all plumbing fixtures and other devices that produce sanitary waste. Plumbing fixtures will be drained by gravity through conventional soil, waste and vent stacks, building drains and building sewers to the site sewer.

Plumbing fixtures in laboratories and laboratory support spaces will be provided with a drainage system separate from the sanitary drainage system. The laboratory waste system will drain by gravity flow to a sampling manhole located exterior to the building. The effluent from the sampling manhole will discharge to the sanitary sewer outside the building.

All fixtures will have traps and will be vented through the roof. Vent terminals will be located away from air intakes, exhausts, doors, openable windows and parapet walls at distances required by the plumbing code.

Design Criteria

The waste and vent piping will be sized in accordance with code requirements.

Equipment and Material

Floor drains in the Civil Engineering Lab will have their trap seal protected with an electronic automatic trap primer.

Distribution

Waste System Materials			
System	Below Ground	Above Ground	
		Outside of Return Air Plenum	Within Return Air Plenum
Gravity Sanitary Waste and Vent	Schedule 40 PVC with DWV pattern solvent cement socket fitting joints	Schedule 40 PVC with solvent cement socket fitting joints	Hubless cast-iron pipe with heavyweight no-hub couplings with stainless steel clamps
Pressurized Sanitary Waste	Schedule 40 PVC with DWV pattern solvent cement socket fitting joints	Copper water tube, Type L, soldered joints and fittings	
Laboratory Waste and Vent	CPVC, Sch 40, ASTM D1784 and ASTM F2618 with SWV pattern fittings, ASTM D3311. Solvent joints, ASTTM F493.	CPVC, Sch 40, ASTM D1784 and ASTM F2618 with SWV pattern fittings, ASTM D3311. Solvent joints, ASTTM F493	Schedule 40 noncombustible, PVDF, ASTM D3222, UL Listed 94, with socket fusion joints

Waste piping will be pitched according to code to maintain a minimum velocity of 2 fps when flowing half full.

Vents and the venting systems will be designed and installed so that the water seal of a trap will be subject to a maximum pneumatic pressure differential equal to 1" water column. This will be accomplished by sizing and locating the vents in accordance with the venting tables contained in the plumbing code.

Elevator Sump Pumps

System Description

An elevator sump shall be required in the base of each elevator pit. Unless noted otherwise sump pit shall be formed into the elevator hoist-way base. Sump pump discharge will be with an air gap to a receptor and into the building sanitary drainage system.

Design Criteria

Sump pump will be sized in accordance with code requirements. Provide a pump sufficient to discharge 50 gpm per elevator hoist-way.

Equipment and Material

Sump pump shall be submersible type. Sump pumps will be connected to the emergency (standby) power system to permit operation during a loss of normal power.

Distribution

Piping shall be the same material and joint type as pressurized sanitary waste system.

Domestic and Nonpotable Water

System Description

Domestic water will be provided to all toilet room fixtures, electric water coolers/drinking fountains, sinks, emergency shower/eyewash units, and any other devices that require a domestic water supply.

Water softeners will be provided for DHW systems.

Domestic hot water (DHW) will be delivered at 120°F to all fixtures and devices that require hot water. DHW serving lavatories in public toilets will be delivered at a temperature of <110°F per Florida Plumbing Code.

Emergency showers and eyewashes will be supplied with tepid water per the ANSI Z358.1 definition of tepid water.

All sinks and equipment located in laboratories and lab support spaces that require water will be supplied from the domestic water system. All lab sinks and equipment will be provided with vacuum breakers to provide isolation for the domestic system per the Lab Planners layout.

Non-potable water system will provide make-up water mechanical (HVAC) systems such as heating hot water, chilled water, and cooling towers. A reduced pressure backflow preventer will protect the domestic water supply.

Design Criteria

Each water heater will be sized for 50% of the design hot water load at an outlet temperature of 140°F.

Backflow preventers will be sized for 100% of the design flow.

Equipment and Material

The building's water system will be isolated from the municipal water system by duplex reduced pressure backflow preventers located exterior of building.

Domestic hot water will be produced by gas-fired, storage-type water heaters.

The hot water system temperature will be maintained by recirculating the hot water through a continuous loop(s) with an in-line circulating pump.

Water hammer arrestors will be provided at all quick closing solenoid valves and at other potential water hammer sources.

Tepid water to emergency fixtures will be provided by a local ASSE 1071 compliant mixing valve at each fixture.

Sub-metering of domestic water main supply into building, water supply to the Public Toilet cores and domestic hot water supply will be added for compliance with LEED water metering credits.

Distribution

Water System Materials		
Size	**Below Ground**	**Above Ground**
2-1/2" and smaller: Copper	Copper water tube, Type K, soldered joints and wrought copper fittings	Type L copper tube with soldered joints and wrought copper fittings
Underground (3" and larger): Ductile Iron	Ductile iron, Class 52, AWWA C151, cement mortar lined with restrained mechanical joints and ductile iron fittings	Not applicable
Copper (3" and larger)	Not applicable	Type K copper tube with brazed joints and wrought copper fittings with rolled groove couplings

Piping 2-1/2" and larger and located in mechanical equipment rooms may be rolled groove mechanical joints.

The hot water system will be insulated in accordance with Code. Isolation valves will be provided at all riser connections, branch piping run-outs to fixture groups, and at devices requiring maintenance.

The piping will be sized to limit the velocity in any section of the system to a maximum of 7 fps for cold water system and 4 fps for hot water and hot water circulating systems.

Plumbing Fixtures			
Fixture	**Type**	**Operation**	**Flow Rate**
Water Closets	Wall hung, vitreous china, with elongated bowls, high efficiency.	Flush valves will be piston type, sensor operated, hard wired	1.28 gallon flush
Urinals	Wall hung, vitreous china, high efficiency	Flush valves will be piston type, manual operated	0.125 gallon flush
Lavatories Public	Depending upon requirements, Wall hung or Self-rimming, vitreous china. Refer to architectural floor plans for areas with wall hung units and counter mounted units.	Faucets will be hot and cold mixing type, sensor operated, hard wired	0.5 gpm flow control
Lavatories	Wall hung or Self-rimming, vitreous china. Refer to architectural floor plans for areas with	Faucets will be hot and cold mixing type, sensor operated, hard wired	0.5 gpm flow control

Plumbing Fixtures			
Fixture	**Type**	**Operation**	**Flow Rate**
	wall hung units and counter mounted units.		
Sinks	Countertop mounted stainless steel	Faucets will be hot and cold mixing type. Sinks in break rooms will be fitted with garbage disposals.	1.5 gpm flow control
Laboratory Sinks	Integral with casework. Faucets will be furnished with the casework and installed by the Division 22 contractor	Faucets will be hot and cold mixing type, wrist blade handles	1.5gpm flow control
Electric Water Coolers	Wall mounted, recessed self-contained, dual level	Manual push button operated, with stainless steel cabinets and disposable activated carbon water filters	1.5 gpm flow control
Janitor Sinks	Flush mounted with vacuum breaker and loose key operator Floor mounted, precast terrazzo, with stainless steel splash wall panels	Manual Faucets will be hot and cold mixing type with hose connections and integral spout, vacuum breaker	-
Exterior Hose Bibbs	Recessed mounted freeze resistant with vacuum breaker and loose key operator	Manual	-
Mechanical Room Hose Bibbs	Surface mounted with in-line vacuum breakers	Manual	-

High Purity Water

System Description

A system will be provided to produce, distribute and recirculate water meeting the quality requirements of ASTM Type II as outlined below.

Water Quality								
Design Standard	Resistivity	Silica	Sodium	pH	Chlorides	TOC	Bacteria	Endotoxin
ASTM Type II	≥1 MΩ-cm @25°C	≤3µg/L	≤5µg/L	No Limit	≤5µg/L	≤50µg/L	1000 cfu/100 ml Limit	No Limit

This system will not be validated.

Pure water will be continuously circulated in a closed loop to users throughout the building's Environmental Engineering Laboratories.

Point of use polishing units will be provided for use points that require a higher level of quality water.

The system will be automatically monitored and controlled by a dedicated PLC based control system that will send a discrete alarm signal to the Building Automation System in the event of deviations.

Design Criteria

The system design will be based on performing sanitation using peracetic acid solutions.

The capacity of the production equipment and the storage tank will be based on the programmed use points and the following consumption estimates:

Use Point Type	Peak Flow Rate	Daily Usage
Laboratory Sink	1 gpm	15 gallons
Water Polisher	0.5 gpm	10 gallons
Glasswasher	2 gpm	50 gallons

The production equipment shall be sized to produce the total estimated consumption in 16 hours of operation. The capacity of the production system is estimated at 1 gpm.

The storage tank will be sized to provide storage for 24 hours of estimated usage. The size of the storage tank is estimated to be 200 gallons.

The distribution system will be designed to maintain the temperature of the water under 80°F.

The distribution system will be designed to continuously circulate water at a minimum velocity of 3 feet per second. The maximum demand for the distribution system shall be based on the previous peak flow rates with 80% diversity factor.

Equipment and Material

The production equipment is anticipated to consist of a prefilter, multimedia filter, carbon filter, water softener, single pass RO unit, two-bed deionization exchange cylinders, mixed bed deionization exchange cylinders, a one micron post filter, a 185 nm ultraviolet light, and a 0.2 micron final filter.

The distribution system equipment will include centrifugal pump(s) to provide circulation and 254 nm UV lights followed by 0.2 micron filters to control bacterial growth.

Materials in contact with pure water will be:

- Equipment: 316L stainless steel polished to 25 Ra
- Storage tank: vinyl ester,
- Piping: low-extractable PVC
- Elastomers: Viton EPDM

Distribution

The distribution system will be comprised of one loop through which water will be continuously circulated. The distribution loop will employ a series loop layout. The loops will drop to each use point location and a zero static tee diaphragm valve will be provided.

High purity water system distribution system shall be:

Low-extractable PVC or PP-R piping will be used for the distribution system. Joints will be made by solvent socket welding. Sanitary unions will be used where breakable connections are required. Piping will be continuously supported.

All tee connections shall be installed to minimize the dead leg. The distance from the sealing point on the branch to the inside of the main line wall shall be less than six (6) branch line diameters.

Piping will be installed so that it is completely free draining. A minimum slope of 1/8 inch per foot will be maintained.

Sink use points shall be a use point valve over the sink. Pipe loop drops within the room will be enclosed.

The quality of the water in the distribution system will be monitored by the PLC that will send a discrete alarm signal to the Building Management System in the event of deviations.

Pure Water System Materials		
Size	**Outside of Return Air Plenum**	**Within Return Air Plenum**
3" and smaller	Low-extractable PVC, virgin material, Schedule 80, with cell classification per ASTM D1784, One-step solvent cement	Plenum rated PVDF piping will be used for the distribution system. Joints will be made by IR butt fusion

Special Gases-Laboratory System

System Description

Special gas cylinders, manifolds/regulators and distribution piping shall be provided to all points of use as required by the Owner. Special gases shall include but not be limited to: helium, argon, nitrogen, oxygen and carbon dioxide.

Each Environmental Engineering Lab and Experiential Lab shall have an independent specialty gas distribution system.

Laboratory Compressed Air

System Description

Laboratory grade compressed air will be provided to all laboratory areas at a pressure of 125 psig and a dewpoint of -40°F. A lower pressure (50 PSI) laboratory grade compressed air system will be

provided off the 125 PSI system with separate pressure regulators at the entrance to each laboratory. Compressed air will be provided as required by the Owner. Grade shall be ISO8573.1 2001 1.2.0 oil free.

Design Criteria

Compressed air piping system will be sized based on 1 scfm per outlet plus any flow required for individual pieces of equipment. Diversity factors will be applied to laboratory outlets as indicated below:

Table 2
Compressed Air System Diversity Factors

Number of Outlets	Diversity Factor	Minimum Flow (scfm)	Empirical Formula for Flowrate (scfm)
1-5	1.00	0	No. of Outlets*1
6-12	0.80	5	5+(No. of Outlets-5)*5/7
13-33	0.60	10	10+(No. of Outlets-12)*10/21
34-80	0.50	20	20+(No. of Outlets-33)*20/47
81-150	0.40	40	40+(No. of Outlets-80)*20/70
151-315	0.35	60	60+(No. of Outlets-150)*50/165
316-565	0.30	110	110+(No. of Outlets-315)*60/250
566 and up	0.25	170	170+(No. of Outlets-565)*80/435

The compressors will be controlled by pressure switches in receiver. Each compressor will be sized for 50 % of the maximum total demand. The compressors will be controlled on lead/lag/alternate basis.

Equipment and Material

Laboratory grade compressed air will be produced by scroll oil-free type compressor system.

Compressors will be base mounted. Air will be treated with coalescing filters, charcoal filters and particulate filters and dried with heatless desiccant air dryers. Compressed air will be stored in an ASME rated horizontal receiver with outlet pressure regulator.

Distribution

Compressed air piping system will be ASTM B-280 Type L, oxygen cleaned copper piping with brazed joints.

Industrial Compressed Air

System Description

Industrial grade compressed air will be provided to the Automotive Shop/Vehicle Lab area at a pressure of 100 psig and a dewpoint of 40°F. Compressed air will be provided as required by the Owner.

Design Criteria

Compressed air piping system will be sized based on 1 scfm per outlet plus any flow required for individual pieces of equipment. Diversity factors will be applied to laboratory outlets as indicated below:

Table 2 Compressed Air System Diversity Factors			
Number of Outlets	Diversity Factor	Minimum Flow (scfm)	Empirical Formula for Flowrate (scfm)
1-5	1.00	0	No. of Outlets*1
6-12	0.80	5	5+(No. of Outlets-5)*5/7
13-33	0.60	10	10+(No. of Outlets-12)*10/21
34-80	0.50	20	20+(No. of Outlets-33)*20/47
81-150	0.40	40	40+(No. of Outlets-80)*20/70
151-315	0.35	60	60+(No. of Outlets-150)*50/165
316-565	0.30	110	110+(No. of Outlets-315)*60/250
566 and up	0.25	170	170+(No. of Outlets-565)*80/435

The compressors will be controlled by pressure switches in receiver set to operate between 100 and 115 psig. Each compressor will be sized for 50% of the maximum total demand. The compressors will be controlled on lead/lag/alternate basis.

Equipment and Material

Instrument grade compressed air will be produced by oil-less scroll air compressors. Compressors will be base mounted. Air will be treated with particulate filters and dried with refrigerated air dryers. Compressed air will be stored in an ASME rated vertical receiver with outlet pressure regulator.

Distribution

Compressed air piping system will be ASTM B-280 Type L, oxygen cleaned copper piping with brazed joints.

Laboratory Vacuum

System Description

Laboratory vacuum air will be provided to each Environmental Engineering Laboratory area as programmed using an independent local vacuum network for each lab such as Vacuu-Lan or equal. All components will come from single manufacturer. Vacuum will terminate at laboratory outlets or equipment connections as required.

Design Criteria

Laboratory vacuum piping system will be sized based on 0.5 scfm per outlet plus any flow required for individual pieces of equipment. Diversity factors will be applied to laboratory outlets as indicated below:

Table 2 Laboratory Vacuum System Diversity Factors			
Number of Inlets	Diversity Factor	Minimum Flow (scfm)	Empirical Formula for Flowrate (scfm)
1-5	1.00	0	No. of Inlets*0.5
6-12	0.80	2.5	(5+(No. of Inlets-5)*5/7)*0.5

Equipment and Material

Laboratory vacuum will be produced by oil-free diaphragm vacuum pumps. Pumps will be mounted inside casework or base of fume hood.

Distribution

Laboratory vacuum piping will be 10mm OD PTFE tubing and PVDF compression fittings.

Natural Gas

System Description

Natural gas is anticipated to be piped to equipment (ex: boilers, water heaters) as required to meet building needs. Gas pressure will be determined based on equipment requirements. Natural gas is anticipated to be a centrally piped and distributed system to serve lab and fume hood gas outlets food service equipment. Natural gas will be extended to the building from the gas company's natural gas main in the street. It is anticipated that the gas meter(s) will be located at grade at the service entrance to the building.

Design Criteria

All design and installation will be in accordance with the applicable codes.

Natural gas will be supplied at a pressure of 2 psig. Piping will be sized to limit the pressure drop across the system to 10% of the supply pressure.

Natural gas shutoff valves, where required, will be located in ceiling spaces. In classrooms a recessed wall valve box at 4'-6" above finished floor will provide access to a shutoff valve. .

Natural gas piping system will be sized based on 5 cfh per outlet plus any flow required for individual pieces of equipment. Diversity factors will be applied to laboratory outlets as indicated below:

Table 2 Natural Gas System Diversity Factors			
Number of Inlets	Diversity Factor	Minimum Flow (cfh)	Empirical Formula for Flowrate (cfh)
1-5	1.00	0	No. of Inlets*5
6-12	0.80	5	(5+(No. of Inlets-5)*5/7)*5
13-33	0.60	50	(10+(No. of Inlets-12)*10/21)*5
34-80	0.50	100	(20+(No. of Inlets-33)*20/47)*5
81-150	0.40	200	(40+(No. of Inlets-80)*20/70)*5

Table 2 Natural Gas System Diversity Factors			
Number of Inlets	Diversity Factor	Minimum Flow (cfh)	Empirical Formula for Flowrate (cfh)
151-315	0.35	300	(60+(No. of Inlets-150)*50/165)*5

Equipment and Material

Natural gas meter and building pressure regulating valves will be provided by and in accordance with gas utility company requirements.

Where shutoff valves are installed in valve boxes, the valve boxes will be steel frames with steel doors, piano hinges and level latches. All pipe penetrations through the box walls will be sealed.

Point of use pressure regulators will be self-operated spring-loaded constant pressure valves with internal relief capability.

Distribution

Natural gas piping will be Schedule 40 black steel pipe with malleable iron threaded fittings.

Natural gas valves 2-1/2" and smaller will be two-piece ball valves with bronze bodies and stainless steel balls. Valves 3" and larger will be plug valves with cast iron bodies.

All natural gas piping located within a return air plenum shall have welded joints in lieu of threaded joints as noted previously.

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