PURPOSE OF THIS DOCUMENT

The intent of this document is to disseminate the San Francisco International Airport’s (SFO’s or Airport’s) expectations regarding the information presented to designers, engineers, general contractors and other industry specialists. The material provided in the following sections includes the minimal requirements, general information, design criteria, guide specifications and details for plumbing installed at SFO. While this document addresses major areas of concern to SFO, it is not an all-inclusive document.

HOW TO USE THIS DOCUMENT

This document should be used as a resource for the development of project specific design documents including drawings, details and specifications. It is the responsibility of the design, engineering and construction professionals to adhere to all codes and regulations related to the content presented.

SCOPE

This section contains the Standards and Criteria for Plumbing. Any questions or concerns regarding the items or equals specified must be submitted to the Standards Committee in writing. All final decisions regarding products shall be made at the Airport’s discretion. If the Engineer of Record presents items that are not specified or named equals, they must be brought to the Standards Committee for evaluation of those products.

Please refer to Chapter 7 of Appendix A: SFO Mechanical Design Requirements for the Airport’s General Plumbing Design Guidelines and Standards.

DRAWING REQUIREMENTS

A. Provide enlarged detailed plumbing plans for restroom and concession areas.

B. Provide pipe elevations including invert elevations and slopes on all drainage piping.

C. Reference related civil utility drawings for continuation of piping connecting to drainage stub-outs connecting to site utility mains.

D. Provide a pipe size and drainage fixture unit table or piping diagrams indicating pipe sizes and drainage fixture unit loading for the sanitary soil, waste and vent system(s).

E. Provide piping diagrams indicating pipe sizes and water supply fixture unit loading for the domestic cold water, domestic hot water and recycled water systems.

F. Provide natural gas piping diagram showing pipe sizes, developed lengths of pipe lengths and gas loads in (BTUH/CFH) for each equipment connection, pipe main and branch lines. Diagram to include all meters, gas valves, regulators, gas vent pipes and related equipment.

G. All design disciplines including the architectural/engineering sub-consultants and the trade bid package subcontractors shall prepare documents using Revit in the current version utilized by the Airport in compliance with the Airport’s Building Information Modeling (BIM) Requirements as described in Document 00 73 87: BIM Requirements, unless waived by the Chief Development Officer.

H. When Revit models may not be applicable, (for example, tasks with underground infrastructure beyond a building footprint), Civil 3D may be used to model utilities and applicable infrastructure if approved by the Chief Development Officer.
I. Refer to technical specifications for As-Built requirements.

J. Documents and plans submitted to SFO shall be searchable using PDFs with live text. This includes, but is not limited to, text and symbols. The document shall also provide the capability to turn layers on and off. Any project using legacy documents which may be composed image files shall be converted to live text via Optical Character Recognition (OCR).

**STORM DRAINAGE SYSTEM**

A. Storm sewer piping system shall consist of roof drains, overflow drains, area drains, and storm sewer building mains and branch lines for roof drains/overflow drains discharging into a gravity drainage piping system, settlement joints, and connection to the existing pipes and site sewer mains.

B. Horizontal storm drain and overflow drain lines including roof drain bowl shall be wrapped with 0.5” thick fiberglass insulation to prevent condensation. Exception, pipes located above the vehicle service roads.

C. Storm water pipe sizing shall be per the CPC with the rainfall intensity based on a 1.5 per hour rainfall intensity. For combined roof and overflow lines, double the rainfall intensity and use a 3” per hour rainfall intensity.

D. A minimum slope of 1/8” per foot or 1% for gravity storm drainage shall be used.

E. Due to ground settlement, all underground storm drain piping shall be supported from the underside of the floor slab and or the vertical faces of the pile caps using Type 316 stainless steel hangers.

**SANITARY SOIL WASTE AND VENT SYSTEM**

A. Sanitary sewer system shall consist of sanitary soil, waste and vent connections to plumbing fixtures with gravity drainage piping system for the plumbing fixtures, stub-outs for future tenants including connections to existing pipes, pipe settlement joints, pipe supports, seismic bracings, and connections to site sewer.

B. Underground piping shall be wrapped with 8 mil polyethylene tube encasement in accordance with AWWA C105.

C. A minimum slope of 1/4” per foot or 2% for gravity sanitary sewer lines shall be used where possible. Administrative Authority to approve use of 1% slope if the depth if the available gravity sewer mains are inadequate or the arrangement of the building or structural conditions prohibit the use of a 2% slope.

D. Due to ground settlement, all underground soil, waste and vent piping shall be supported from the underside of the floor slab using Type 316 stainless steel hangers, supports and anchors.

**GREASE WASTE SYSTEM**

A. Provide 4” grease waste line stub-outs for food concession tenants located below the footprint of each food concession space. Provide grease waste piping from the stub-out to the location of future above ground grease interceptor. Provide 4” sanitary waste and 4” vent stub-outs for future grease interceptor installation.

B. Provide grease interceptor for the Airside Loading Dock floor drains including H20 rated manholes. Grease interceptor shall be supported from the floor slab with type 316 stainless steel supports.

C. Due to ground settlement, all underground grease waste drain piping shall be supported from the

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underside of the floor slab and/or the vertical faces of the pile caps using Type 316 stainless steel hangers, supports and anchors. Underground piping shall be wrapped with 8 mil polyethylene tube encasement in accordance with AWWA C105.

DOMESTIC COLD WATER SYSTEM

A. Water Pressure: The available water pressure is in the range of 120-125 psi. Domestic water system pressure shall be limited to 65 PSI through an existing pressure reducing station on the existing incoming cold water main. Existing pressure reducing station to remain as is.

B. Water flow velocity: To avoid any erosion, corrosion and excessive noise generation, the domestic cold water piping shall be sized for a maximum flow velocity of 4’ per second (FPS) for pipes 2” and smaller; and 6’ per second (FPS) for larger pipes.

C. System Sizing and Estimated Loads: The domestic water main shall be sized to accommodate the water loads serving fixtures with potable water connections. Plumbing fixtures requiring potable water connections are sinks, lavatories, janitor sinks, hose bibbs, trap primers, drinking fountains and bottle fillers, water heaters, and emergency showers/eyewashes, passenger boarding bridges’ cabinets, and concession plumbing fixtures/equipment. Refer to paragraph for recycled water system. Allowances shall be provided in the domestic water main pipe sizing to accommodate for mechanical make-up water, concession areas and jet bridges.

D. Plumbing fixtures to include sinks, lavatories, drinking fountains and bottle fillers. Refer to paragraph for recycled water system. Allowance shall be provided in the domestic water main pipe sizing to accommodate for mechanical make-up water, concession areas and jet bridges.

1. Toilet Rooms, Janitor Closets, Drinking Fountains and Break Rooms: Allowance shall be provided in the domestic water main pipe sizing to accommodate for public toilet rooms, janitor closets, break rooms, drinking fountains and bottle fillers.

2. Concession Areas: Allowance shall be provided to accommodate future concession areas. Domestic cold water for each future concession tenant shall be metered.

3. Jet Bridges: Allowance shall be provided to accommodate a water supply for jet bridges. Each jet bridge shall be provided with a 1.5” cold water supply line, water meter, combination emergency shower/eyewash, and a 1” water line with a backflow preventer for the water cabinet.

4. Mechanical make-up water: Allowance shall be provided to accommodate mechanical make-up water supply for chilled water and heating hot water systems.

5. Provide isolation valve for each battery of water closets, urinals, lavatories; each group of fixtures and for each isolated fixture. Valves shall be located in the plumbing chase and in accessible locations. Valves must be accessed from outside of the rest rooms. Provide 18” by 18” access panels were required. A minimum of required clearance must be maintained in front of the valve for maintenance access.

DOMESTIC HOT WATER SYSTEM

A. General: Domestic hot water for the restrooms, janitor sinks and break room sink shall be provided by an electric water heater located in a janitor room adjacent to the restrooms. Plumbing fixtures shall be supplied with hot water from a pumped re-circulating hot water supply line.

B. Domestic hot water supply and return lines shall be insulated in accordance with Title 24.

C. Temperature: Hot water shall be produced and stored at a minimum of 140 °F to prevent the growth of
Leginollia. The hot water shall be tempered down to 120 °F by use of an ASSE 1017 thermostatic mixing valve installed adjacent to the water heater. Hot water distribution shall be provided with a re-circulating line and pump to provide on-demand hot water to the lavatory faucets. Circulating lines shall be piped close to the hot water supply line to the lavatories, maximum distance shall be 2'-0" from the angle supply stops. Provide balancing valve for each circulating loop.

D. Lavatories: Water supply to lavatories shall be supplied with tepid water. Plumbing code required point of use ASSE 1070 thermostatic mixing valve shall be used to temper the water. Specified faucet is furnished with an ASSE 1070 device.

E. Flow velocity: To avoid any erosion, corrosion and excessive noise generation, the domestic hot water piping system shall be sized for a maximum flow velocity of 4’ per second (FPS) for pipes 2’” and smaller; and 5’ per second (FPS) for larger pipes. 5 FPS is the code maximum per CPC.

EXPANSION SETTLEMENT JOINTS

A. Expansion settlement joints for incoming and outgoing underground building utility mains shall be provided. Flexible connections shall be provided to accommodate a minimum of 12” of differential settlement and accompanying lateral movement for pipes entering or leaving the building and at other transition conditions where differential settlement may occur.

B. Expansion settlement joints shall be wrapped with 8 mil polyethylene tube encasement in accordance with AWWA C105. All necessary supports, hangers and anchors shall be Type 316 stainless steel.

RECYCLED WATER SYSTEM

A. General: A recycled water piping system shall be provided for flushing of water closets, and urinals. Currently there is no on-site recycled water supply but a recycled water system will be provided by SFO in the future. The recycled water piping system shall be temporarily connected to the existing domestic water main downstream of the existing water meter assemblies. A reduced pressure backflow preventer shall be provided at the point of connection to the domestic water system to prevent a cross connection between the recycled water system and the domestic water system.

B. Recycled water piping located above finished ceilings shall be wrapped with 0.5” thick fiberglass insulation to prevent condensation/freezing where exposed to atmosphere. Exception pipes located in the basement.

C. Recycled water signage, pipe identification and valve identification tags shall be provided in accordance with the CPC.

D. System Sizing and Estimated Loads: The recycled water main shall be sized to accommodate the water closet and urinal fixture loads.

E. Flow velocity: To avoid any erosion, corrosion and excessive noise generation, the recycled water piping system shall be sized for a maximum flow velocity of 4’ per second (FPS) for pipes 2’” and smaller; and 6’ per second (FPS) for larger pipes.

CONDENSATE DRAINAGE SYSTEM

A. Mechanical AC Units: Condensate drain lines from Mechanical AC units to approved indirect waste receptors such as floor sinks or funnel drains shall be provided. Condensate drain lines shall be wrapped with 0.5” thick insulation to prevent condensation.

B. Provide pumped condensate drainage system and 1” stub-outs for each Passenger Boarding Bridges including condensate lines terminated at floor sinks.
SOAP DISPENSING SYSTEM

A. A soap dispensing system(s) shall be provided for public and staff use lavatories. The soap dispensing system shall consist of soap fill tanks, soap reservoirs with soap dispensing pumps (one per three lavatories), soap distribution piping, and battery powered sensor operated soap dispensers (one for each lavatory).

B. The soap tank, reservoirs with dispensing pumps, AC power adapter and connecting tubing shall be located in an accessible plumbing chase behind the lavatories. Connecting tubing not to exceed 16’ 5”. Battery powered sensor operated soap dispensers to be mounted on the countertop adjacent to each lavatory. Soap dispenser shall be chrome plated and style shall match the lavatory faucet.

PLUMBING FIXTURES

A. General: Plumbing fixtures shall be commercial grade and water conservation type. Vitreous china fixtures, flushometer valves, lavatory sensor faucets and soap dispensing system shall be TOTO, or equal. High efficiency low consumption plumbing fixtures shall be provided for the restrooms. Lavatory and break room sink faucets and electric water coolers shall conform to lead free law and water efficiency standards. ADA compliant fixtures shall be provided at accessible locations.

B. Accessible Plumbing Chase: An accessible plumbing chase shall be provided for maintenance access to the plumbing behind a battery of water closets, urinals and lavatories. A minimum or 36” inside clearance shall be provided and an access door shall be provided to enter the chase.

C. Water-closets: High efficiency 1.28 gallons per flush water closets shall be provided. Fixture shall be wall mounted white vitreous china commercial grade type water closets with white elongated open front seats with concealed sensor operated (hydropower self-generating) piston type flushometers. (20% below CAL Green Baseline of 1.6 gpf).

D. Urinals: High efficiency 0.5 gallon per flush urinals shall be provided. Fixture shall be wall mounted white vitreous china commercial grade type with concealed sensor operated (hydropower self-generating) piston type flushometers. (50% below CAL Green Baseline of 1.0 gpf).

E. Lavatories: Lavatories shall be white vitreous china under counter mounted commercial grade type. Wall mounted at single toilet rooms. Lavatory faucets shall be chrome plated sensor operated (hydropower self-generating) metering faucets. Maximum discharge of 0.09 gallons per 10 second cycle. (64% below CAL Green Baseline of 0.25 gallons/cycle). Grid drains shall be provided for and p-trap and water supplies shall be wrapped with preformed insulation. Locate lavatory sensor faucet controller in the plumbing chase directly behind each lavatory.

F. Janitor Sinks: Janitor mop sinks shall be 24” x 24” x 12” high floor mounted square terrazzo type with stainless steel caps on all sides. Faucet shall be a wall mounted service sink faucet with vacuum breaker spout with pail hook and wall brace.

G. Electric Water Cooler with Bottle Filler: Electric water coolers with bottle filler shall be provided and located adjacent public/staff toilet rooms and as indicated on architectural floor plans. ADA compliant dual height units shall be provided.

H. Break Room Sinks: Break room sinks shall be a under counter mounted single compartment sink, type 304 stainless steel with satin finish. Sink shall be furnished with a single lever faucet and a 0.75 HP food waste disposal. Flow on sink faucet shall be limited to 1.5 gpm. (30% below CAL Green Baseline of 2.2 gpm).
I. Emergency Safety Fixtures: Emergency safety fixtures shall be provided as follows:

1. Janitor Closets: Provide emergency eyewash/drench hose unit in each janitor closet.
2. Jet Bridges: Provide emergency safety station (Combination emergency shower with eye/face wash at each jet bridge for ground personal use.

J. Floor Drains: Floor drains with a trap priming device shall be provided for the following areas:

1. Toilet rooms containing two or more water closets or a combination of one water closet and one urinal.
2. Janitor rooms.
3. Mechanical rooms.
4. Loading docks.
5. Trash rooms.
6. Other areas as needed

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<th>Publish Date</th>
<th>Revisions</th>
<th>Reviewed By</th>
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<td>March 2018</td>
<td>The March 2018 version was uploaded to SFOConstruction.com in November 2018</td>
<td>BIM language updated, Josephine Pofsky, N. King</td>
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<td>3.0</td>
<td>December 2017</td>
<td>Formatting</td>
<td>N. King</td>
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<td>Appendix A Updated</td>
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<td>June 2015</td>
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SECTION 22 05 50 – BASIC PLUMBING MATERIALS AND METHODS

PART 1 – GENERAL

1.1 CODES AND STANDARDS:

Provide products conforming to the requirements of the following:

A. American National Standards Institute (ANSI):
   1. B16.1 - Cast Iron Pipe Flanges and Flanged Fittings Class 25, 125, 250, 800
   2. B16.3 - Malleable Iron Threaded Fittings Classes 150 and 300
   3. B16.4 - Cast Iron Threaded Fittings Classes 125 and 250
   4. B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings
   5. B16.22 - Wrought Copper Alloy Solder Joint Pressure Fittings
   6. B16.24 - Bronze Pipe Flanges and Flanged Fittings Class 150 and 300

B. American Society of Testing and Materials (ASTM):
   1. A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded Seamless
   5. B88 - Standard Specification for Seamless Copper Water Tube
   7. D2000 - Standard Classification System for Rubber Products

C. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS):
   1. SP25 - Standard Marking System for Valves, Fittings, Flanges and Unions

D. National Electrical Manufacturers Association (NEMA)

E. CEC - California Electrical Code

1.2 SUBMITTALS

A. Prior to construction, submit for approval all materials and equipment in accordance with Division 01 requirements.

B. Product Data: Submit manufacturer’s standard technical Product data indicating conformance to the stipulated reference specifications, construction materials, construction details, and test and operating pressures. Submit manufacturer’s Product data on the following:
   1. Piping, fittings and valves
   2. Pipe specialties
   3. Supports, anchors, hangers, and seismic restraints

C. Construction and Shop Drawings: Provide layout drawings, drawn to a scale of not less than 0.25" to
1’ showing the proposed layout of pipe systems including fittings, hangers, elevations and grading.

PART 2 – PRODUCTS

2.1 GENERAL

A. Furnish and install all new material, equipment, and apparatus hereinafter specified unless specifically noted otherwise. All material, equipment, and apparatus shall be identified by the manufacturer’s name, nameplate, and pertinent data.

B. All materials, equipment, and apparatus are mentioned as standards unless noted otherwise. The words “or approved equal” shall be considered to be subsequent to all manufacturers’ names used herein, unless specifically noted that substitutes are not allowed.

2.2 SUPPORTS AND ANCHORS

A. General: Comply with applicable codes pertaining to Product materials and installation of supports and anchors, including, but not limited to, the following:

1. UL and FM Water heaters shall be instantaneous, point of use type. Provide products which are UL listed and FM approved.
2. Provide products which are ICC ESR approved.
3. MSS Standard Compliance: Manufacturer’s Standardization Society (MSS).
4. Manufacturer: B-Line, Grinnell, Superstrut, or approved equal.

B. Hanger-Rod Attachments: provide factory-fabricated hanger-rod attachments of one of the following MSS types listed:

2. Steel Clevises or J-hangers: MSS Type 14. B-Line 3201 MSS-SP-69

C. Building Attachments: Provide factory-fabricated building attachments of one of the following MSS types listed:

1. Steel Brackets: One of the following for indicated loading:
2. Anchor Bolts: Heavy duty, drilled-in concrete expansion wedge anchor bolts; Hilti #HSL #TZ.

D. Saddles and Shields: Provide saddles or shields under piping hangers and supports, factory-fabricated, for all insulated piping. Size saddles and shields for exact fit to mate with pipe insulation.

1. Pipe Covering Protection Saddles: MSS Type 39; fill interior voids with segments of insulation matching adjoining insulation.
2. Insulation Protection Shields: MSS Type 40, of 18” minimum or the length recommended by manufacturer to prevent crushing of insulation. High-density insulation insert lengths shall
match or exceed shield length.

2.3 SEISMIC RESTRAINT REQUIREMENTS


B. The manufacturers of the seismic restraints shall submit shop drawings for review prior to installation. The shop drawings shall indicate the location and loading of each restraint. Manufacturer: B-Line, Grinnell, Kin Line, Superstrut, Mason or approved equal.

C. Anchor bolt and restraint calculations stamped and signed by a Civil or Structural Engineer licensed in California, shall be submitted showing adequacy of the bolt sizing and type.

D. Restraint of rigidly mounted pipes conforming to preapproved details in referenced Seismic Restraint Manuals need not submit structural calculations for restraint systems strictly conforming to those guidelines.

E. Submittals:
   1. The seismic restraint manufacturer shall determine the number, size, and type of anchor bolts, cable restraints, etc., for each pipe and/or groups of pipes.
   2. Complete engineering calculations and details, stamped and signed by a Civil or Structural Engineer licensed in California, for all seismic restraints.
   3. Clearly outlined procedures for installing seismic bracing.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Coordinate the work between the various Mechanical Sections and with the work specified under other Divisions of the work or contracts. If any cooperative work must be altered due to lack of proper supervision or failure to make proper provisions in time, then the work hereunder shall include all expenses of such changes as are necessary in the work under other contracts, and such changes shall be directly supervised by and made to the satisfaction of the Airport Representative.

B. Inspect all material, equipment, and apparatus upon delivery and do not install any that may be subject to rejection as a result of damage or other defects. Protect equipment and piping delivered to and stored at the site.

3.2 SUPPORTS AND HANGERS

A. Installation of Building Attachments: Install building attachments at required locations for proper pipe support. Install additional building attachments at changes in direction of pipes.

B. Install hangers, supports, clamps, and attachments to support pipes properly from building structure. Hangers shall be located within 1’-0” of every change in Pipes direction, and end of pipe run. Arrange for grouping of parallel runs of horizontal pipes to be supported together on trapeze type hangers.
where possible. Where pipes of various sizes is to be supported together by trapeze hangers, space hangers for smallest Pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support pipes, and do not support pipes from other pipes.

C. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

D. Prevent electrolysis in support of copper tubing by use of hangers and supports which are copper plated, or by other recognized industry methods.

E. Hanger Spacing in accordance with following minimum schedules (other spacings and rod sizes may be used in accordance with the SMACNA Seismic Restraint Manual using a safety factor of five):

<table>
<thead>
<tr>
<th>Steel Pipe (Water Filled):</th>
<th>Pipe Size</th>
<th>Max. Hanger Spacing</th>
<th>Rod Size</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.5&quot; to 1.25&quot;</td>
<td>5’</td>
<td>3/8&quot;</td>
</tr>
<tr>
<td></td>
<td>1.5&quot; to 2&quot;</td>
<td>7’</td>
<td>3/8&quot;</td>
</tr>
<tr>
<td></td>
<td>2.5&quot; to 3&quot;</td>
<td>10’</td>
<td>0.5&quot;</td>
</tr>
<tr>
<td></td>
<td>4&quot; and larger</td>
<td>12’</td>
<td>5/8&quot;</td>
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<table>
<thead>
<tr>
<th>Steel Pipe (Gas/Air Filled):</th>
<th>Pipe Size</th>
<th>Max. Hanger Spacing</th>
<th>Rod Size</th>
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<tbody>
<tr>
<td></td>
<td>1.5&quot; to 1.25&quot;</td>
<td>6’</td>
<td>3/8&quot;</td>
</tr>
<tr>
<td></td>
<td>1.5&quot; and larger</td>
<td>10’</td>
<td>0.5&quot;</td>
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<table>
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<th>Max. Hanger Spacing</th>
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<td>0.5&quot; to 2&quot;</td>
<td>6’</td>
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<td></td>
<td>2.5&quot; and larger</td>
<td>8’</td>
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</table>

F. Sloping, Air Venting, and Draining:

1. Slope all piping as specified and as indicated, true to line and grade, and free of traps and air pockets. Unless indicated otherwise, slope piping in the direction of flow as follows:

<table>
<thead>
<tr>
<th>Service</th>
<th>Inclination</th>
<th>Slope</th>
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</thead>
<tbody>
<tr>
<td>Soil and Waste</td>
<td>Down</td>
<td>0.25” per foot (1/8” per foot where allowed by Code)</td>
</tr>
<tr>
<td>Sanitary Vent</td>
<td>Up (towards terminal)</td>
<td>0.25” per foot (1/8” per foot where allowed by Code)</td>
</tr>
</tbody>
</table>

3.3 PIPE INSPECTIONS

A. Inspection - Above Grade: All pipes installed above grade shall be inspected prior to finish of walls and ceilings by the Airport’s Inspector. Subcontractor shall follow the SFO procedures for inspection request for notice prior to inspection time. Should the pipes be hidden within the structure prior to inspection the subcontractor may be requested to uncover the pipes at no delay to the project and at no additional cost to SFO.

3.4 PAINTING – Not Used
3.5 TESTING

A. Provide all tests specified hereinafter and as otherwise required. Provide all test equipment, including test pumps, gauges, instruments, and other equipment required. Provide typed reports at completion of testing to certify to the Design Builder’s and Airport Commission’s Inspector of Record that the specified tests have been performed and that the installation complies with the specified requirements, and provide a report of the test observations signed by the Inspector of Record.

B. Pipework Specialties: Test for leaks and ensure that they are operable.

END OF SECTION 22 05 50
SECTION 22 07 00 – PLUMBING INSULATION

PART 1 – GENERAL

1.1 APPLICABLE REQUIREMENTS

A. All work to be furnished and installed under this Section shall comply with all the requirements of General Conditions and Division 01 - General Requirements.

1.2 SCOPE

A. Work to be furnished and installed under this section shall include, but not necessarily be limited to, providing insulation for the following:

1. Domestic hot water supply piping.
2. Domestic cold water supply piping exposed to outdoor conditions.
3. Exposed waste and hot water piping below accessible lavatories per ADA.
4. Repair or replacement of existing pipe insulation removed or damaged for installation of new work.
5. Roof drain and overflow drain bodies and horizontal rain water leader piping.

B. Types of mechanical insulation specified in this Section include the following:

1. Fiberglass pipe insulation.
2. Insulation jackets.
3. Insulation accessories.

1.3 CODES AND STANDARDS

A. Codes and Standards: Provide products conforming to the requirements of the following:

1. SFO Airport Building Regulations and A&E Standards
2. California Plumbing Code
3. American Society for Testing and Materials (ASTM): Manufacture and test insulation in accordance with the ASTM standards, including:
   h. C303 – Test Method for Density of Preformed Block-Type Thermal Insulation.
   i. C305 – Test for Thermal Conductivity of Pipe Insulation.
j. C356 – Test for Linear Shrinkage of Preformed High-Temperature Thermal Insulation.
m. C533 – Specification for Calcium Silicate Block and Pipe Thermal Insulation.
o. C547 – Specification for Mineral Fiber Preformed Pipe Insulation
q. C553 – Specification for Mineral Fiber Blanket-Type Pipe Insulation (Industrial Type).
r. C592 – Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered).

4. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE): Provide and install pipe and duct insulation in accordance with the following ASHRAE standard:
   b. National Fire Protection Association (NFPA): Manufacture insulation in accordance with the following NFPA standards:

B. Do not provide materials with flame proofing treatments subject to deterioration due to the effects of moisture or high humidity.

C. Flame/Smoke Rating: Provide composite insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less, and smoke-developed index of 50 or less, as tested by ASTM E84 (NFPA 255) method. In addition, the products, when tested, shall not drip flame particles, and flame shall not be progressive. Provide Underwriters Laboratories, Inc., label or listing, or satisfactory certified test report from an approved testing laboratory to prove the fire hazard ratings for materials proposed for use do not exceed those specified.

D. Products Containing Prohibited Chemicals:
   1. Products containing the following prohibited chemicals for use as flame retardants or for other purposes will not be acceptable when present in quantities greater than 0.1% by mass:
      a. Pentabrominated diphenyl ether (CAS#32534-81-9)
      b. Octabrominated diphenyl ether (CAS#32536-52-0)
      c. Decabrominated diphenyl ether (CAS#1163-19-50)

E. Insulation thickness shall be the greater of that specified here or the State energy conservation requirements.
1.4 SUBMITTALS

A. Product Data: Submit manufacturer’s technical product data and installation instructions for each type of insulation. Submit schedule showing manufacturer’s product number, K-value, thickness, and furnished accessories for each system requiring insulation. Also furnish necessary test data certified by an independent testing laboratory.

B. Maintenance Data: Submit maintenance data and replacement material lists for each type of insulation. Include this data and product in maintenance manual.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver insulation, coverings, cements, adhesives, and coating to the site in containers with manufacturer’s stamp or label affixed showing fire hazard indexes of products.

B. Protect insulation against dirt, water, chemical, and mechanical damage. Do not install damaged or wet insulation; remove from project site.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Schuller, Owens-Corning, Knauf, Armstrong, Certainteed, Johns Manville or equal. Manufacturer and insulation types listed below indicate a minimum acceptable level of quality required for each classification.

2.2 PIPE INSULATIONS

A. Glass Fiber: Schuller Micro-Lok meeting ASTM C547; rigid molded noncombustible.
   1. "K" Value: 0.23 at 75oF.
   2. Maximum Service Temperature: 850oF.
   3. Vapor Retarder Jacket: AP-T PLUS white kraft paper reinforced with glass fiber yarn and bonded to aluminum foil, secure with self-sealing longitudinal laps and butt strips or AP jacket with outward clinch expanding staples or vapor barrier mastic as needed.

B. Flexible Fiberglass Blanket: Schuller Microlite Type 75 meeting ASTM C553, Type 1, Class B-2; flexible blanket or equal.
   1. "K" Value: 0.27 at 75oF installed.
   2. Density: 0.75 lb/cu ft.
   3. Vapor Barrier Jacket: FSK, aluminum foil reinforced with fiberglass yarn and laminated to fire-resistant kraft, secured with UL listed pressure sensitive tape and/or outward clinched expanded staples and vapor barrier mastic as needed.

C. Field Applied Jackets:
   2. All longitudinal seams shall be located on bottom of pipes.

D. Removable Covers:
1. Provide removable covers on valves, fittings, flanges, strainers, traps, etc. where periodic maintenance or removal is required.
2. Use of pre-molded fittings with PVC covers is acceptable.

PART 3 – EXECUTION

3.1 EXAMINATION AND PREPARATION

A. Verify that piping has been tested for leakage in accordance with specifications before applying insulation materials. All piping shall be inspected by the Airport Commission Inspector prior to installation of insulation. Any insulation applied prior to inspection shall be removed and new insulation applied at no additional cost to the Airport. Notify the Design-Builder five (5) working days prior to insulation installation.

B. Verify that all surfaces are clean, dry and free of foreign material.

3.2 INSTALLATION

A. Install materials in accordance with manufacturer’s recommendations, building codes and industry standards.

B. Continue insulation and vapor barrier through penetrations except where prohibited by code.

C. Piping Insulation:
   1. Locate insulation and cover seams in least visible locations.
   2. Neatly finish insulation at supports, protrusions, and interruptions.
   3. Provide insulated dual temperature pipes or cold pipes conveying fluids below ambient temperature with vapor retardant jackets with self-sealing laps. Insulate complete system.
   4. For insulated pipes conveying fluids above ambient temperature, secure jackets with self-sealing lap or outward clinched, expanded staples. Bevel and seal ends of insulation at equipment, flanges, and unions.
   5. Provide insert between support shield and piping on piping 1.5” diameter or larger. Fabricate of Schuller Thermo-12 or other heavy density insulating material suitable for temperature. Insulation inserts shall not be less than the following lengths:

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5” to 2.5” pipe</td>
<td>10”</td>
</tr>
<tr>
<td>3” to 6” pipe size</td>
<td>12”</td>
</tr>
<tr>
<td>8” to 10” pipe size</td>
<td>16”</td>
</tr>
<tr>
<td>12” and over</td>
<td>22”</td>
</tr>
</tbody>
</table>

   6. Use of metal saddles is acceptable as specified in Section 22 05 50. Fill interior voids with segments of insulation matching adjoining pipe insulation.

   7. Where valves, strainers, etc., with insulation require periodic opening for maintenance, repair, or cleaning, install insulation in such a manner that it can be easily removed and replaced without damage. Use of pre-molded covers is acceptable.

3.3 PIPING INSULATION SCHEDULE
A. All insulation thicknesses shall meet or exceed state energy code requirements as noted below. Increase thickness 0.5” if exposed to ambient air. Minimum thermal resistance in range of 4.0 to 4.6 per inch of thickness.

B. Fiberglass Insulation

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>Insulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic hot water, cold water exposed to outdoor conditions:</td>
<td></td>
</tr>
<tr>
<td>Up to 2”</td>
<td>1”</td>
</tr>
<tr>
<td>2.5” and over</td>
<td>1.5”</td>
</tr>
<tr>
<td>Exposed hot water pipes, stop valves, and drains below handicapped accessible sinks:</td>
<td></td>
</tr>
<tr>
<td>All sizes</td>
<td>1/4”</td>
</tr>
</tbody>
</table>

C. Flexible Fiberglass Blanket:

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>Insulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interior Rain Water Leader and Overflow</td>
<td>3/4” (horizontal portion from roof drain body to first vertical drop)</td>
</tr>
</tbody>
</table>

END OF SECTION 22 07 00
SECTION 22 11 23 – PLUMBING EQUIPMENT

PART 1 – GENERAL

1.1 APPLICABLE REQUIREMENTS

A. All work to be furnished and installed under this section shall comply with all the requirements of General Conditions, Supplemental Conditions, Division 01 - General Requirements, and Section 22 05 50 - Basic Materials and Methods, and other Sections in Division 22 specified herein.

1.2 SCOPE

A. All work to be furnished and installed under this section shall include but not necessarily be limited to the following:

   1. Water heaters
   2. Expansion Tank
   3. Water meters

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Section 22 05 50 – Basic Materials and Methods
B. Section 22 40 00 – Plumbing Fixtures

1.4 SUBMITTALS

A. Prior to construction submit for approval all materials and equipment in accordance with Division 01. Submit manufacturer’s data, colors, installation instructions, and maintenance and operating instructions for all components of this section including, but not limited to, the following:

   1. Water heaters
   2. Expansion tank
   3. Water meters

B. Electrical Work: Refer to Division 22 – Section 22 05 50 for requirements.

C. Shop Drawings: Submit rough-in drawings. Detail dimensions, rough-in requirements, required clearances, and methods of assembly of components and anchorages.

D. Wiring Diagrams: Submit manufacturer’s electrical requirements for electrical power supply wiring. Submit manufacturer’s ladder-type wiring diagrams for interlock and control wiring required for final installation. Differentiate between portions of wiring that are factory installed and portions that are to be field installed.

E. Maintenance Data: Submit maintenance data and parts lists for each type and size of water heater, control, and accessory, including “trouble-shooting” maintenance guide. Include this data, product data, shop drawings, and wiring diagrams in maintenance manual, in accordance with requirements of Division 01.

F. Certificates: Submit appropriate Certificates of Shop Inspection and Data Report as required by
provisions of ASME Boiler and Pressure Vessel Code.

G. Start-up: Provide written report on start-up in accordance with Section 22 05 50.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver units to the site in containers with manufacturer’s stamp or label affixed.

B. Store and protect products against dirt, water, chemical, and mechanical damage. Do not install damaged products – remove from project site.

1.6 WARRANTY

A. Provide a 2-year warranty. The warranty shall include parts, labor, travel costs, and living expenses to repair or replace products or systems.

PART 2 – PRODUCTS

2.1 DOMESTIC WATER HEATER – ELECTRIC (STORAGE TYPE)

A. Water heater shall be a glass-lined commercial electric water heater as scheduled on the drawings, or equal. Heater should be rated at capacities indicated on contract documents and constructed in accordance with ASME code shall bear appropriate symbol and listed with the National Board as required. Heater shall be listed with Underwriters’ Laboratories and approved by National Sanitation Foundation.

B. All internal surfaces of the tank shall be glass-lined with an alkaline borosilicate composition that has been fused-to-steel by firing at a temperature of 1600 °F. Tank shall be cathodically protected with adequate extruded magnesium anode. The entire vessel is to be enclosed in a round steel enclosure with baked enamel finish.

C. Control compartment to be hinged and shall house 120 volt control circuit transformer, transformer fusing, magnetic contactor(s), immersion style operating thermostat(s), element fusing per NEC, and commercial grade incoloy sheathed flange mounted elements with pre- wired thermal leads. Temperature controls include limiting switch which will require resetting manually in the event the temperature reaches 190 °F.

D. Foam insulation (R-16) shall exceed latest requirements of ASHRAE (currently 90A-1980) for heat loss efficiency.

E. Heater shall include ASME T & P relief valve and drain valve.

F. Warranty: Two (2) years, professional start-up to be included.

G. Acceptable Manufacturers Equals: A. O. Smith, Bradford-White, Lochinvar, or RECO.

2.2 DOMESTIC WATER HEATER – ELECTRIC (POINT-OF-USE TYPE)

A. Water heaters shall be instantaneous, point of use type as scheduled on the drawings. Construction: Solid copper, storage tank, polystyrene insulated with steel jacket; Chromalox Cartridge type screw in element, 1500 watt, 120 volt, single phase; on-off switch; 42” cord with grounded plug.

B. Warranty: Two (2) years.
C. Acceptable Manufacturer: Eemax, Chronomite, Bradford-White or In-Sink-Erator.

2.3 RELIEF VALVES

A. Relief Valve: Watts vacuum relief valve, bronze body, silicone disc, threaded ends, installed on C.W. supply line only, refer to H.W. Heater Detail on contract drawings.

B. Temperature and Pressure Relief Valve: Watts, bronze body construction, thermostat and test lever, temperature relief set at 210 °F, and pressure relief set at 125 psi.

C. Acceptable manufacturers: Watts, Kunkle, Keckley or Cash Acme.

2.4 EXPANSION TANK

A. Furnish and install where required for domestic hot water system.

B. ASME stamped and constructed vessel with the following:
   1. Tanks rated for 125 psi maximum working pressure.
   2. Black steel construction painted with standard finish
   3. Tank supports.
   4. Butyl diaphragm bonded to polypropylene liner.
   5. Pre-charged air chamber permanently sealed.
   6. Air valve.

C. Manufacturer: Amtrol AST, Adamson, RECO, Watts or equal.

2.5 WATER METERS

A. Provide Tenant water meters installed complete with gate valve on each side of meter and full line size bypass around meter.

B. Water meters shall have a mechanical drive with hermetically sealed registers; meter shall be equal to or exceed AWWA Standards and shall have an all bronze case.

C. Provide flanges on valves and support stands or wall brackets as required for meter support.

D. Manufacturers: Hersey Products Inc #MHD, Niagra, or Rockwell or equal.

PART 3 – EXECUTION

3.1 GENERAL

A. Examine areas and conditions under which equipment is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

B. Install equipment in accordance with manufacturer’s installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer’s recommended clearances.

C. Orient so controls and devices needing service and maintenance have adequate access.
D. Connect water piping to units with shutoff valves and unions as indicated.

E. Start-Up: Start-up, test, and adjust equipment in accordance with manufacturer’s start-up instructions. Check and calibrate controls. Start-up to be by authorized manufacturer’s representative or agent.

3.2 OPERATION MANUALS, START-UP SERVICE, WARRANTIES, ACCEPTANCE AND GUARANTEES

A. General: Refer to relevant Division 01 and Division 22 sections.

END OF SECTION 22 11 23
SECTION 22 21 13 – PLUMBING PIPING, VALVES AND SPECIALTIES

PART 1 – GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe and Fittings
   a. Sanitary waste and vent
   b. Storm drain and overflow
   c. Cold water
   d. Hot water
   e. Fuel gas

2. Valves
   a. Water valves
   b. Backwater valves
   c. Natural gas valves
   d. Balancing valves
   e. Backflow prevention valves
   f. Pressure reducing valves
   g. Gas pressure regulator valves
   h. Thermostatic mixing valves
   i. Solenoid valves
   j. Thermometers and gauges

3. Piping specialties
   a. Pipe escutcheons
   b. Strainers
   c. Drip pans
   d. Air vent
   e. Dielectric Unions
   f. Flanges
   g. Pipe sleeves
   h. Sleeve seals
   i. Pipe coating
   j. Gas connectors

1.2 REFERENCES

A. General: Comply with Appropriate Standards Methods

1. All work shall be in full accordance with all applicable codes, ordinances and code rulings.
2. Perform all tests required by governing authorities and as required under all Division 22 Sections. Provide written reports on all tests.
3. Electrical devices and wiring shall confirm to the latest standards of NEC; all devices shall be UL listed and so identified.
4. All plumbing work shall comply with the Americans with Disabilities Act (ADA).
5. All excavation work must comply with all provisions of state laws including notification to all owners of underground utilities at least 48 business day hours, but not more than 10 business days, before commencing an excavation.
6. The Contractor shall furnish without any extra charge the labor and material required for compliance to codes.

1.3 QUALITY ASSURANCE

A. Manufacturers Qualifications:
   1. Manufactured items furnished shall be the current, cataloged product of the manufacturer.
   2. Replacement parts shall be readily available and stocked in the USA.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer’s technical product data for all piping, valves and specialties indicating dimensions, valve CV, tolerances etc.

B. Shop Drawings: Submit shop drawings indicating underground piping installation showing all fittings with inverts. Indicate all footings and grade beams.

C. Maintenance Data: Submit maintenance instructions on accordance with requirements of Division 01 sections.

PART 2 – PRODUCTS

2.1 GENERAL

A. Furnish and install all new material, equipment, and apparatus hereinafter specified unless specifically noted otherwise. All material, equipment, and apparatus shall be identified by the manufacturer’s name, nameplate, and pertinent data.

B. Type M copper piping is not acceptable for any pressure water piping unless specifically noted otherwise.

C. All materials, equipment, and apparatus are mentioned as standards unless noted otherwise. The words “or approved equal” shall be considered to be subsequent to all manufacturer’s names used herein, unless specifically noted that substitutes are not allowed.
2.2 STANDARD PIPE AND FITTING

A. Natural Gas Pipe & Fittings (Above Grade)
      b. Joints: 2” and smaller, threaded (except in the case of piping located in shafts which must be welded); all piping inside the building 2.5” and larger, ANSI B16.25 bevel weld, ANSI B16.5 flanges, or ANSI B16.11 socket weld.
   2. Flexible Pipe: Corrugated stainless steel tubing (CSST) equal to Gastite corrugated stainless steel tubing manufactured from ASTM A240, type 304 stainless steel with a minimum nominal wall thickness of 0.010”. System shall comply with ANSI LC-1 “Standard for Fuel Gas Piping Using Corrugated Stainless Steel Tubing (CSST), and carrying listings by CSA International (Certification Number 1009875), ICC Evaluation Services (Report Number ESR-1031) and IAPMO Research & Testing (Certificate of Listing Number 3250). System to be fire-rated for installation in plenum applications.
      a. Fittings and joints: Corrugated stainless steel tube fittings and joints equal to Gastite mechanical tube fittings manufactured from ASTM B16 type 360 brass whose design incorporates a double wall flare for gas-tight seal with Jacket Lock, mechanical capture of the jacket for enhanced tubing protection.

B. Trap Primer Piping:
   2. Fittings: No joints below ground. For pipes below grade double wrap with Scotch Wrap #51 or PASCO Wrap, with 50% overlap.

C. Condensate and indirect drains:
   1. Pipe: ASTM B88, Type M, hard drawn copper water tube.
   4. Insulate condensate drain pipes with minimum 0.5” insulation to prevent moisture dripping from pipe.

D. Domestic Hot and Cold Water and Reclaimed Water (RW) Pipe & Fittings (Above Grade):
   1. Pipe: ASTM B88, Type L, hard drawn copper water tube.
   2. Fittings: ANSI B16.22, wrought copper, 95%-5% tin-antimony solder joints.
   3. Alternative Domestic Water Pipe Fitting: Copper press fittings shall conform to the material and sizing requirements of ASME B16.22. O-rings for copper press fittings shall be EPDM, Viega/Ridgid or approved equal.

E. Reclaimed Cold Water Pipe & Fittings (Above Grade):
   1. Pipe: ASTM B88, Type L, hard drawn copper water tube.
2. Fittings: ANSI B16.22, wrought copper, 95%-5% tin-antimony solder joints.

3. Alternative Domestic Water Pipe Fitting: Copper press fittings shall conform to the material and sizing requirements of ASME B16.22. O-rings for copper press fittings shall be EPDM. Viega/Ridgid or approved equal.

4. All reclaimed water shall be clearly labeled with purple background and black lettering per Table 6-1 of the 2010 C.P.C. The colored identification band shall be indicated every 20 feet but at least once per room and shall be visible from floor level.

F. Sanitary Sewer, Vent, Rainwater Pipe & Fittings:

1. Pipe: Tyler or AB&I or Charlotte Pipe and Foundry, ASTM A-74, ASTM A-888 cast iron, bituminous coated, “No-Hub.” Pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute and manufactured by AB &I, Charlotte or Tyler.

2. Fittings: No-hub, ASTM A-888.

3. Couplings Below Grade: Heavy Duty Type 304 stainless steel couplings conforming to FM 1680 with neoprene sealing sleeve conforming to ASTM C-1540 having minimum shield thickness of 28 gauge. Husky SD-4000 or Clamp All 125 only.

4. Couplings Above Grade: Type 304 stainless steel couplings conforming to ASTM C-1540 and neoprene sealing sleeve, having minimum shield thickness of 34 gauge. Anaco or Ideal.

5. Couplings Above Grade: Band type stainless steel couplings conforming to ASTM C-1540 having a minimum thickness of 31 gauge with neoprene sealing sleeve conforming to ASTM C-564. Husky 2000 or Clamp All 80 only.

G. Sanitary Sewer, Vent, Rainwater Pipe & Fittings-Alternative:

1. Pipe: Charlotte Pipe and Foundry, ASTM F 628, ASTM D 3965, NSF Standard 14, ABS (acrylonitrile-butadiene-styrene) compound with Cell Class 42222. Use in non-pressure applications where operating temperature will not exceed 160 °F.

2. Fittings: ASTM D 2661, ASTM D 2235, ABS DWV Fittings shall be by a single manufacturer and to be installed in accordance with manufacturer’s recommendations. Solvent cement joints.

H. Vent Piping (Above Grade) (Contractor’s Option):

1. Pipe: ASTM B306, DWV class, copper tube.

2. Fittings: Elkhart, ANSI B16.23 cast bronze or ANSI B16.29 wrought copper, sweat solder no lead joint.

2.3 VALVES: GENERAL

A. General: Valve ratings shall exceed respective system operating pressures by 50% (minimum). All valves shall be line size unless otherwise noted.

B. Product Data: Submit manufacturer’s technical product data, including installation instructions for each type of valve. Include pressure drop curve or chart for each type and size of valve. Submit valve schedule showing manufacturer’s figure number, size, location, and valve features for each required valve.

C. Shop Drawings: Submit manufacturer’s assembly-type (exploded view) shop drawings for each type
of valve, indicating dimensions, weights, materials, and methods of assembly of components.

D. Acceptable manufacturers (manufacturer and model number listed for individual valves indicates minimum acceptable by all manufacturers):

1. Gate, Ball, Check or Butterfly: Apollo, Hammond, Nibco (commercial grade, US manufacturer only), Milwaukee, Victaulic or Watts.
2. Lubricated Plug Valves: Homestead, Resun, or Rockwell.
5. Solenoid Valves: ASCO, Automatic or Magnatrol.

E. Valve Identification: Provide valves with manufacturer’s name (or trademark) and pressure rating clearly marked on the valve body.

F. Operators: Provide handwheels, fastened to valve stem, for valves other than quarter-turn. Provide lever handle for quarter-turn valves, other than plug valves. Provide one wrench for every 10 plug valves, and one in each size. Provide extended levers/stems for valves on insulated lines. For manual valves 2.5" and larger located 8’ above the floor in mechanical rooms provide chain operator to permit operating the valve from 4’ above floor.

G. Valve Features:

1. General: Provide valves with features indicated and, where not otherwise indicated, provide proper valve features. Comply with ASME B31.9 for building services piping, and ASME B31.1 for power piping.
2. Drain: Comply with MSS SP-45, and provide threaded pipe plugs.
6. Flangeless: Valve bodies manufactured to fit between flanges complying with ANSI B16.1 (cast iron), ANSI B16.5 (steel), or ANSI B16.24 (bronze).

2.4 DOMESTIC PLUMBING SERVICE VALVES

A. Gate Valves:

1. Two inches (2") and Smaller: Class 125, MSS SP-80, ASTM B62 cast bronze body, soldered ends, bronze bonnet, bronze wedge, rising stem, brass packing gland, non-asbestos packing and aluminum hand-wheel.
2. Two-and-a-half inches (2.5") and Larger: Class 125, MSS SP-70, ASTM A126 Grade B cast iron body, flanged ends, cast iron bonnet, cast iron wedge, bronze trim, rising stem, brass packing gland, non-asbestos packing and cast iron hand-wheel.
B. Butterfly Valves:
   1. Three inches (3”) and Larger: MSS SP-67, lug wafer, ductile iron body, stainless steel disc, stainless steel stem, EPDM seat, memory stop control, lever handle thru 5” size and worm gear operator for 6” and larger. Mount stem in horizontal position. Hammond 6100 series.

C. Ball Valves:
   1. 2.5” and Smaller: 600 psi, 2 piece, bronze body, soldered ends for copper pipe and threaded ends for iron pipe, chrome plated brass ball, Teflon seat, brass stem, steel handle, full port. Equal to Nibco 585 series Apollo 7-200 series

D. Check Valves:
   1. Two inches (2”) and Smaller: Class 125, MSS SP-80, ASTM B62 and ASTM B16, cast bronze body, soldered ends for copper pipe, screwed cap, swing type, Teflon bronze disc.
   2. Two-and-a-half inches (2.5”) and Larger: Class 125, MSS SP-71, ASTM A126 class B cast iron body, bolted bonnet flanged ends, bolted cap, swing type, cast iron disc with bronze face rings.
   3. Vertical or High Flow: Class 125, cast bronze, high-flow body, TFE seat, brass check, stainless steel guide and spring. Watt #6015.

2.5 NATURAL GAS VALVES

A. Ball Valves:
   1. Half an inch (0.5") and 0.75": Brass body, U.L. listed, CSA approved for pressure of system, bronze ball valve, 175 WOG, with integral lever handle. Apollo 64 series or Watts #FBV-1.
   2. One inch (1") thru 1.5": 175 psi working pressure, CSA and UL approved, bronze body, welded ends, stainless steel ball, stainless steel stem, steel handle with memory stop tab, conventional port.
   3. Lubricated Plug Valve, 2” and Larger: Class 125, MSS SP-78, 200 PSI, UL listed, CSA approved for pressure of system, lubricated plug type, semi-steel body, loose wrench operated, straight way pattern round port, combination button head fitting and lubricant screw, Teflon seal and discs.

2.6 BALANCING VALVES: MAXIMUM 125 PSIG SYSTEM WORKING WATER PRESSURE

A. Pressure Dependent Water Flow:
   1. Half an inch (0.5") and Larger: Construction and attachment style as required by piping system. Ball or globe valve design with memory stop. Valves shall be field adjustable.

2.7 BACKFLOW PREVENTION VALVES

A. General: All backflow prevention valves shall be State approved and listed and lead free.

B. Reduced Pressure Zone Backflow Preventer for High Hazard Applications:
   1. Two inches (2") and Smaller: Assembly shall consist of shutoff ball valves in inlet and outlet, and strainer on inlet. Assemblies shall include test cocks and pressure-differential relief valve located between two positive seating check valves and shall comply with requirements of ASSE Standard 1013 and AWWA C506. Bronze construction, threaded ends, stainless steel internal parts, and air
gap fitting. Route pipe from air gap fitting to approved waste receptor. Watts #909-QT-S-HW valve with #909AG air gap fitting.

2. Two-and-a-half inches (2.5”) and Larger: Assembly shall consist of shutoff OS&Y gate valves in inlet and outlet, and strainer on inlet. Assemblies shall include test cocks and pressure-differential relief valve located between two positive seating check valves and shall comply with requirements of ASSE Standard 1015 and AWWA C506. Epoxy coated cast iron body construction, flanged ends, stainless steel internal parts, bronze seats, and air gap fitting. Route pipe from air gap fitting to approved waste receptor. Watts #909-S-OSY valve with #909AG air gap fitting.

C. Double Check Valve for Low Hazard Applications:

1. Two inches (2”) and Smaller: Assembly shall consist of shutoff ball valves in inlet and outlet, strainer on inlet. Assemblies shall include test cocks and two positive seating check valves and shall comply with requirements of ASSE Standard 1015 and AWWA C510. Bronze construction, threaded ends, and stainless steel internal parts. Watts #007-QT-S.

2. Two-and-a-half inches (2.5”) and Larger: Assembly shall consist of shutoff OS&Y gate valves in inlet and outlet, and strainer on inlet. Assemblies shall include test cocks and two positive seating check valves and shall comply with requirements of ASSE Standard 1015 and AWWA C506. Epoxy coated cast iron body construction, flanged ends, and stainless steel internal parts. Watts #709-S-OSY.

D. Atmospheric Vacuum Breaker: Assembly shall consist of a bronze vacuum breaker body with silicone disc, and full size orifice. Device shall be IAPMO listed, meet ASSE std. 1001, and ANSI std. A113.1.1 Chrome plated in finish areas.

E. Pressure Vacuum Breaker: Assembly shall consist of a one piece bronze or stainless steel body, with stainless steel spring loaded check, rubber diaphragm, and atmospheric vent, breakaway set screw. Provide chrome plated in finish areas.

2.8 PRESSURE REDUCING VALVES

A. Single seated, direct operated type; high capacity, having bronze body with strainer, by-pass feature, pressure gauge tappings and complying with requirements of ASSE Standard 1003. Select proper size for maximum flow rate and fail-off at inlet and outlet pressure indicated. Watts #US series or equal.

B. Single-seated, pilot-operated globe valve type having ductile iron body with FDA approved epoxy coating inside and out, with Y strainer, stainless steel seat, FDA approved diaphragm, copper control tubing, pressure gauge tappings and complying with requirements of ANSI Standard A112.26.2. Select proper size for maximum flow rate and fall-off at inlet and outlet pressure indicated. Watts 115 series or equal.

2.9 PRESSURE RELIEF VALVES

A. Pressure Relief Valves: Constructed in accordance with ASME, 125-pound setting, and so stamped. Size as required. Watts #740 series or equal.

B. Temperature and Pressure Relief Valve: Constructed in accordance with ASME, 125-pound setting, and so stamped. Size as required. Watts #100XL, 40XL, 140, N240, or 340 series or equal.

2.10 GAS PRESSURE REGULATOR VALVES
A. Diaphragm operated, steel construction of size and capacity as indicated on drawings. Regulators shall be approved serving gas supplier, CSA and UL listed. Fisher, Sherwood, or approved equal.

2.11 THERMOSTATIC MIXING VALVES

A. General: Thermostatic valve constructed of brass and stainless steel, with screwdriver locking temp. regulator and adjustable check stops. Provide access door with cylinder lock. Finish as selected by Architect. Powers E480 or Leonard #210 SB.

B. Master: High-low master thermostatic assembly of size and capacity as indicated on drawings. Bi-metal motor, adjustable check stops, inlet and outlet pressure gauges, thermometer with full port outlet ball valves shutoffs, locking temperature regulator and surface mount stainless steel cabinet as specified. Powers 1432-RC-E-Q or Leonard type TM186-PRV-RF-LTR-STSTL.

2.12 SOLENOID VALVES

A. UL listed, globe pattern bronze valve with threaded ends, stainless steel pilot, bronze piston, malleable iron solenoid assembly with 0.5” tapped conduit connections and Class “A” coil, 120 Volt, 60 Hertz. Solenoid valve shall be wired to the Fire Alarm System. The valve shall close instantly on application of current and open when de-energized.

2.13 THERMOMETERS AND GAUGES

A. General:

1. Certification: Provide meters and gauges whose accuracies, under specified operating conditions, are certified by manufacturer.

2. No mercury shall be used in thermometers due to hazardous material classification.


B. Thermometers:

1. Bi-Metal Type: Provide bi-metal glass thermometers of materials, capacities, and ranges indicated, designed and constructed in service indicated. Accuracy shall be 1% +/- full scale with adjustable recalibration.
   a. Case: Type 300 series stainless steel, hermetically sealed, glass window, 3” diameter dial, with adjustable angle.
   b. Adjustable Joint: Die cast aluminum, finished to match case, 180° adjustment in vertical plane, 360° adjustment in horizontal plane, with locking device.
   c. Scale: Satin-faced, non-reflective aluminum, permanently etched markings.
   d. Stem: Stainless steel, adjustable angle socket, length to suit installation.

2. Glass Thermometer: Provide adjustable angle 9” thermometer of materials, capacities and ranges as appropriate to medium being measured and designed and constructed for service indicated. Accuracy to be 1% +/- of full scale.
   a. Case: Aluminum or Valox.
   c. Scale: Aluminum painted white with black markings.
   d. Connection: 0.5” NPT with thermowell, 1.25” UNF swivel nut without thermowell.
3. Photovoltaic Cell Powered LCD Thermometer
   a. Case: ABS Plastic
   b. Accuracy: 1% of full scale.
   c. Display: 16 LUX rating LCD display. Switchable Fahrenheit and Celsius.
   d. Connection: 0.75” NPT with thermowell 1.24” UNF swivel nut without thermowell.

4. Range: Conform to the following:
   a. Hot Water: 20°F to 240 °F with 2 °F scale divisions.
   b. Cold Water: -40°F to 160 °F with 2 °F scale divisions.

C. Thermometer Test Wells:
   1. Provide thermometer test wells as indicated, constructed of brass or stainless steel, pressure rated to match piping system design pressure. Provide 2” extension for insulated piping. Provide cap nut with chain fastened permanently to thermometer well.

D. Temperature Gauge Connector Plugs:
   1. Provide temperature gauge connector plugs pressure rated for 500 psi and 200 °F (93 °C). Construct of brass and finish in nickel-plate, equip with 0.5” NPS fitting, with self-sealing valve core type neoprene gasketed orifice suitable for inserting 1/8” O.D. probe assembly from dial type insertion thermometer. Equip orifice with gasketed screw cap and chain. Provide extension, length equal to insulation thickness, for insulated piping.

E. Pressure Gauges:
   1. General: Provide pressure gauges of materials, capacities, and ranges indicated, designed and constructed for use in service indicated.
   2. Type: General use, 1% accuracy ANSI B40.1 grade A, phosphor bronze bourbon type, bottom connection.
   3. Case: Drawn steel or brass, glass lens, 4.5” diameter.
   4. Connector: Brass with 0.25” male NPT.
   5. Scale: White coated aluminum, with permanently etched markings.
   6. Pressure differential range shall be 100 psig minimum for the appropriate application with maximum one (1) psig divisions.

F. Pressure Gauge Cocks:
   1. General: Provide pressure gauge cocks between pressure gauges and gauge tees on piping systems. Gauge cock constructed of brass with 0.25” female NPT on each end, and “T” handle brass plug.
   2. Syphon: 0.25” straight coil constructed of brass tubing with 0.25” male NPT on each end.
   3. Snubber: 0.25” brass bushing with corrosion resistant porous metal disc, through which pressure fluid is filtered. Select disc material for fluid served and pressure rating.

G. Pressure Gauge Connector Test Plugs:
   1. Provide pressure gauge connector plugs pressure rated for 500 psi and 200°F (93 °C).
Constructed of brass and finish in nickel-plate, equip with 0.5” NPS fitting, with self-sealing valve core type neoprene gasketed orifice suitable for inserting 1/8” O.D. probe assembly from dial type insertion pressure gauge. Equip orifice with gasketed screw cap and chain. Provide extension, length equal to insulation thickness, for insulated piping.

### 2.14 PIPING SPECIALTIES

**A. General:**
1. Provide factory-fabricated piping specialties recommended by manufacturer for use in service indicated. Provide piping specialties of types and pressure ratings indicated for each service, or provide proper selection to comply with installation requirements. Provide sizes as indicated, and connections, which properly mate with pipe, tube, and equipment connections. Where more than one type is indicated, selection is installer’s option.

**B. Pipe Escutcheons:**
1. Provide pipe escutcheons as specified herein with inside diameter closely fitting pipe outside diameter, or outside of pipe insulation where pipe is insulated. Select outside diameter of escutcheon to completely cover pipe penetration hole in floors, walls, or ceilings; and pipe sleeve extension, if any. Furnish pipe escutcheons with nickel or chrome finish for occupied areas, prime zinc base paint finish for unoccupied areas.
2. Pipe Escutcheons for Moist Areas: For waterproof floors, and areas where water and condensation can be expected to accumulate, provide stainless steel, cast brass or sheet brass escutcheons, solid or split hinged.
3. Pipe Escutcheons for Dry Areas: Provide stainless steel escutcheons, solid or split hinged.

**C. Drip Pans:**
1. Provide drip pans fabricated from 16-gauge galvanized sheet metal with watertight joints, and with edges turned up 2.5”. Reinforce top by structural angles. Provide hole, gasket, and flange at low point for watertight joint and one inch (1”) copper drain line connection. Extend one inch (1”) drain to nearest approved receptor.

**D. Air Vent with Valves:**
1. Install in all closed and open loop water systems at high points of systems and at any other point necessary to free system of air. A shut-off valve shall be provided in riser to each automatic vent valve to facilitate servicing. A 3/8” type “L” copper tubing drain line shall be run to drain receptor to carry away water that valve discharges. Manual type vent may be used in lieu of automatic type, where specifically shown on the Drawings. Hoffman #79 or Dole.

**E. Dissimilar Metals:**
1. Provide brass unions and nipples per SFO standards to effectively isolate ferrous from non-ferrous piping (electrical conductance), prevent galvanic action, and stop corrosion.
2. Dielectric Flanges: Provide dielectric flanges for flanged transitions between dissimilar metal piping. Watts Series 3100 or approved equal.

**F. Unions:**
1. Unions shall be of type specified in following schedule:
a. Black Steel, 2" and smaller: 250 lb. screwed malleable iron, ground joint, brass to iron seat.
b. Black Steel, 2.5" and larger: 150 lb. cast iron screwed flanged, flat faced, full faced gasket.
c. Soldered Copper or Brass Pipe, 2" and smaller: 150 lb. cast bronze or copper, ground joint, non-ferrous seat with soldered ends.
d. Screwed Copper or Brass Pipe, 2" and smaller: 150 lb. cast brass, ground joint, brass to brass seat, with threaded ends.
e. Flanged Copper or Brass Pipe, 2.5" and larger: two (2) 150 lb. cast bronze flanges.
f. Manufacturer: EPCO, Mueller, Stanley G. Flagg or Watts.

G. Flanges:
   1. Provide flanges at flanged connections to equipment, tanks and valves. Faces of flanges being connected shall be alike in all cases. Connection of raised-face flange to flat-faced flange not permitted.
   2. Use ASTM A307, Grade B, bolts and nuts for cast iron flanges and ASTM A193 for steel flanges. Regular square head unfinished bolts with heavy semi-finished hex nuts ASTM A194. Cadmium plated where exposed to weather. Rating: 150 lb. or 300 lb. in high pressure portions.
   3. Type of pipe and corresponding flanges as follows:
   5. Welded Steel Pipe, 150 lb. black forges steel welding flanges, 1/16” raised fact ASTM A181 Grade I. Use flat face when connected to flat faced companion flange.

H. Pipe Sleeves:
   1. Provide fire proof sleeve assemblies utilizing UL rated sealant systems at all fire rated penetrations. For non-rated sleeve penetrations pack the annular space between the pipe and sleeve with fiberglass and/or mastic.
   2. Sleeves shall provide a minimum 0.5” annular clearance around pipe.
   3. Sheet metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate from the following gauges: 3” and smaller, 20 gauge; 4” to 6”, 16 gauge; over 6”, 14 gauge.
   4. Steel pipe: Fabricate from Schedule 40 galvanized steel pipe; remove burrs.
   5. Iron pipe: Fabricate from cast iron or ductile-iron pipe; remove burrs.
   6. Plastic and copper pipe: Fabricate from Schedule 80 PVC plastic pipe; remove burrs.
   7. Sleeves through interior concrete walls and floors: Telescopic, submerged, adjustable sleeves by Adjust-to-Crete, AMI or Shamrock. Floor sleeves to extend a minimum of 1” above finished floor.
   8. Through exterior walls and floor on grade: 150-pound class cast-iron pipe sleeve. Where waterproof membranes are used, provide membrane clamps. For insulated piping, sleeve diameter shall not be less than diameter of insulated pipe.

I. Sleeve Seals:
   1. All sleeves shall be sealed to prevent intrusion of moisture, dust or insects.
2. Underground: For sleeves passing through exterior or foundation walls, provide mechanical link seal assembly.

3. Aboveground: For sleeves passing through walls or floors provide a non-toxic 3-hour rated fire resistant silicone foam sealant with a Flame Spread Rating of 20. Sealant to be tested and approved under UL 263, ASTM E119, and NFPA 251 Standards. All fire rated penetrations shall be sealed with approved UL System.

4. Local Approvals: All seals to be provided shall be in accordance with the regulations of all governing agencies of the city, county, and State Fire Marshal's Office.

2.15 PIPE COATING

A. All underground steel and copper pipe fittings, and all uninsulated above ground steel and copper pipe and fittings exposed to outdoor environments shall be covered with one of the following methods:

1. Twice Wrap 20 Mil. Scotch Wrap PVC No. 51, 50% overlap.

2. Prefabricated extruded plastic cover with joints sealed with two coats of 20 Mil. Scotch Wrap No. 51 or Pasco Wrap 20 mil weight.

2.16 GAS CONNECTORS

A. General Areas: CSA rated, UL listed, braided stainless steel gas hose of size and capacity to meet appliance input requirements.

B. Food Service Equipment: CSA rated, UL listed, plastic coated braided stainless steel gas hose with quick disconnect, swivel fitting and coiled restraining device. Dormont #1675BPQS or approved equal.

C. Gas connectors for outdoor applications shall be listed for exterior use.

2.17 EXPANSION COMPENSATORS

A. General: Pipe expansion, in general, is to be absorbed in bends, swing joints, expansion loops, and offsets. All piping mains, branches and runouts shall be installed to allow for free expansion and contraction without developing leaks or undue stressing of pipe. Stresses shall be within allowable limits of ASME B31.9 for pressure piping. Vertical piping for domestic hot water, chilled water, heating water, steam and steam condensate shall be provided with expansion joints at each floor. Expansion products to conform to the standards of the Expansion Joint Manufacturer's Association. Expansion joints shall not require packing. Installer shall select materials and pressure/temperature ratings to suit intended service. Select packless expansion joints to provide 150% absorption capacity of calculated maximum piping expansion between anchors. All connections shall have ends to match piping system application.

B. Expansion Compensators (Pipe Compression and Extension): Multiple stainless steel bellows and stainless steel liner with shroud and end fittings. Keflex #311 series or approved equal.

C. Flexible Expansion Joint/Seismic Connector for Steel Pipe: Stainless steel hose and braid, 180° return, CSA approved, and end fittings. Metraflex #Metraloop or approved equal.

D. Flexible Connection for Steel Pipe (Piping and Equipment Located Outside the Building): Stainless steel hose and braid, with threaded or flanged ends. Metraflex #SST or approved equal.
E. Flexible Connection for Copper Pipe: Bronze hose and braid, copper tube ends. Metraflex #BBS or approved equal.

1. For non-critical pump connections. Furnish with fluorelastomer tube and cover to ASTM D2000 Grade 1HK710. The body shall be reinforced with rectangular body rings and six bias plies of fiberglass/kevlar fabric rated 190#/26” vacuum at 250°F. Provide galvanized flat (not L shaped) back up rings and control rods to limit maximum axial extension. Garlock #206 EZ-FLO or approved equal.

2. Flexible Ball Pipe Joints: Provide flexible ball pipe joints where required for piping systems, with materials and pressure/temperature ratings selected by installer to suit intended service. Design joints for 360° rotation, and with minimum of 50° angular flexing movement for sizes 0.25” to 4”. Provide two composition gaskets for each joint. Barco or approved equal.

F. Pipe Alignment Guides: Provide pipe alignment guides on both sides of expansion joints, and elsewhere as required indicated on drawings. Guide shall be of carbon steel construction with split guiding cylinder and integral anchor base and internal four finger two-piece spider. Cylinder wall thickness shall be equal to schedule 40 wall thickness of pipe being guided. Spider shall be capable of clamping directly to pipe and moving only in an axial direction while inside cylinder. Anchoring directly to building substrate. Metraflex #Style IV or approved equal.

G. Expansion Loops: Provide field fabricated pipe expansion loops as detailed on the drawings or in place of mechanical expansion joints.

PART 3 – EXECUTION

3.1 GENERAL

A. Workmanship shall be performed by licensed journeymen or master mechanics and shall result in an installation consistent with the best practices of trades.

B. Install work uniform, level and plumb, in relationship to lines of building. Do not install any diagonal, or otherwise irregular work unless so indicated on Drawings or approved by Airport’s representative.

3.2 MANUFACTURER’S DIRECTIONS

A. Follow manufacturers’ directions and recommendations in all cases where the manufacturers of articles used on this Contract furnish directions covering points not shown on the Drawings or covered in these Specifications.

3.3 INSTALLATION

A. Coordinate the work between the various Plumbing Sections and with the work specified under other Divisions of the work or contracts toward rapid completion of the entire project. If any cooperative work must be altered due to lack of proper supervision or failure to make proper provisions in time, then the work hereunder shall include all expenses of such changes as are necessary in the work under other contracts, and such changes shall be directly supervised by and made to the satisfaction of the Engineer.

B. The cooperative work not included in the Plumbing Division related to the general construction work is as follows:

1. All formed concrete work.
2. Framed openings in masonry and other Architectural and Structural elements.
3. Wood grounds and nailing strips in masonry and concrete.
4. Sloping of floors to drains and floor sinks.
5. Sloping of roof-to-roof drains and overflow drains.

C. Inspect all material, equipment, and apparatus upon delivery and do not install any that may be subject to rejection as a result of damage or other defects. Provide tarps and visqueen cover to protect equipment and piping delivered to and stored at the site.

3.4 WORKING PRESSURES

A. All fittings, valves, pipe, specialties equipment shall be rated for the working pressure subjected in the installed locations.

B. The rating of the equipment and material shall not be less than that of the system pressures.

3.5 PIPES SIZES TO EQUIPMENT

A. General: Pipe sizes indicated shall be carried full size to equipment served. Any change of size to match equipment connection shall be made within one foot of equipment.

B. At temperature control valves with sizes smaller than connected lines, reduction shall be made immediately adjacent to valve.

3.6 PIPING INSTALLATION

A. General: Install pipes and pipe fittings in accordance with recognized industry practices which will achieve permanently leak-proof piping systems, capable of performing each indicated service without piping failure. Install each run with minimum joints or couplings, but with adequate and accessible unions for disassembly and maintenance or replacement of valves and equipment. Reduce sizes (where indicated) by use of reducing fittings. Align piping accurately at connections, within 1/16” misalignment tolerance. Comply with ASME B31.9 Code for Pressure Piping.

B. Locate piping runs, except as otherwise indicated, vertically and horizontally (pitched to drain) and avoid diagonal runs wherever possible. Orient horizontal runs parallel with walls and column lines. Locate runs as shown or described by diagrams, details, and notations or, if not otherwise indicated, run piping in shortest route which does not obstruct space or block access for servicing building and its equipment. Hold piping close to walls, overhead construction, and other structural and permanent-enclosure elements of building. Limit clearance to 1/2” where furring is shown for enclosure or concealment of piping, but allow for insulation thickness, if any. Where possible, locate insulated piping for 1” clearance outside insulation. Whenever possible in finished and occupied spaces, conceal piping from view, by locating in column enclosures, in hollow wall construction, or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as indicated.

C. Elevator Machine Rooms, Switchgear, Generator, SSR/Telecommunications, and Electrical Equipment Spaces: Do not run piping through transformer vaults and other electrical or electronic equipment spaces and enclosures unless unavoidable. Install drip pan under piping that must be run through electrical spaces. Route drip pan drain piping to floor drain, floor sink or other approved receptor.

3.7 WELDING

A. Qualifications of Welders: Welders performing work under this Contract shall be certified and qualified
in accordance with tests prescribed by the National Certified Welding Bureau (NCWB) or by other
approved test procedures using methodology and procedures covered in the ASME Boiler and
Pressure Vessel Code, Section IX, “Qualification Standard for Welding and Brazing Procedures,
Welders, Brazers, and Welding and Brazing Operators.” Installation shall conform to ANSI 31.9.

1. Submit for approval the names, identification, and welder’s assigned number, letter or symbol
   of welders assigned to this project.
2. The assigned identification symbol shall be used to identify the work of each welder and shall be
   indelibly stamped immediately upon completion of each weld.
3. Welders shall be tested and certified for all positions.
4. Submit identifying stenciled test coupons made by each operator.
5. Any or all welders may be required to retake welding certification tests without additional
   expense.
6. When so requested, a welder shall not be permitted to work as a welder on this project until he
   has been recertified in accordance with NCWB.
7. Recertification of the welder shall be made after the welder has taken and passed the required
   tests.
8. Where piping 1.5” and smaller is butt or socket welded, submit 3 samples of test welds for
   approval.

3.8 PIPING SYSTEM JOINTS

A. All piping shall be cut squarely, free of rough edges and reamed to full bore. Piping shall be
   mechanically cleaned prior to make-up of joints and fully inserted into fittings.

B. Provide joints of type indicated in each piping system.

C. Thread pipe in accordance with ANSI B2.1. Cut threads full and clean using sharp dies. Ream threaded
   ends to remove burrs and restore full inside diameter. Remove excess cutting oil from piping prior to
   assembly. Apply pipe joint compound, or pipe joint tape (Teflon) where recommended by pipe/fitting
   manufacturer, on male threads at each joint and tighten joint to leave not more than 3 threads
   exposed.

D. Solder copper tube and fitting joints with lead free nickel/silver bearing solder meeting ASTM B-32,
   in accordance with IAPMO IS 3-93, ASTM B-828 and Copper Development Association recommended
   procedures. Joints shall be cleaned by other than chemical means prior to assembly. “Shock” cooling
   is prohibited. Fluxes shall be applied liberally to the outside of the pipe and the solder cup of the
   fitting. Fluxes shall be water soluble for copper and brass potable water applications, and shall meet
   CDA standard test method 1.0 and ASTM B813-91. Solder shall be applied until a full fillet is present
   around the joint. Solder and flux shall not be applied in such excessive quantities as to run down
   interior of pipe. Lead solder or corrosive flux shall not be present at the jobsite.

   1. Manufacturers:
      a. Solder: JW Harris “Bridgit” or Englehard “Silvabrite 100.”

E. Braze copper tube and fitting socket or extrude joints (T-drill) with BCUP series filler metal without
   flux. Listed brazing flux shall be used for joining of copper tube to brass or bronze fittings and shall
   meet AWS FB3A or FB3C. Medical gas system brazing shall be as specified in pertinent Division 22
   sections. “Shock” cooling is prohibited. A continuous fillet shall be visible around the completed joint.
After cooling, flux residue shall be thoroughly removed with warm water and a brush prior to testing. Do not use BCUP filler on copper alloys containing over 10% nickel.

F. Corrugated stainless steel tube (CSST) fittings joints: Gastite mechanical tube fittings manufactured from ASTM B16 type 360 brass whose design incorporates a double wall flare for gas-tight seal with Jacket Lock, mechanical capture of the jacket for enhanced tubing protection.

G. Alternative domestic water piping mechanical press type connections: Copper press fittings shall be made in accordance with the manufacturer's installation instructions. The tubing shall be fully inserted into the fitting and the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to assure the tubing is fully engaged (inserted) in the fitting. The joints shall be pressed using the tool approved by the manufacturer. Copper press fittings shall conform to the material and sizing requirements of ASME B16.22. O-rings for copper press fittings shall be EPDM. Viega/Ridgid or approved equal.

H. Piping shall be capped during construction to prevent entry of foreign material.

I. Weld pipe joints in accordance with recognized industry practice and as follows:
   1. Weld pipe joints only when ambient temperature is above 0 °F.
   2. Bevel pipe ends at a 37.5° angle where possible, smooth rough cuts, and clean to remove slag, metal particles, and dirt.
   3. Use pipe clamps or tack-weld joints with 1" long welds, 4 welds for pipe sizes to 10", 8 welds for pipe sizes 12" to 20".
   4. Build up welds with stringer-bead pass, followed by hot pass, followed by cover or filler pass. Eliminate valleys at center and at edges of each weld. Weld by procedures which will ensure elimination of unsound or unfused metal, cracks, oxidation, blow-holes, and non-metallic inclusions.
   5. Do not weld out piping system imperfections by tack-welding procedures. Refabricate to comply with requirements.
   6. At Installer’s option, install forged branch-connection fittings whenever branch pipe is indicated, or install regular T-fitting.

J. Flanged Joints: Match flanges within piping system, and at connections with valves and equipment. Clean flange faces and install gaskets. Tighten bolts to provide uniform compression of gaskets.


3.9 VALVES

A. General: Except as otherwise indicated, comply with the following requirements:
   1. Install valves where required for proper operation of piping and equipment, including valves in branch lines where necessary to isolate sections of piping. Locate valves so as to be accessible and so that separate support can be provided as necessary.
   2. Install valves on all services connected to kitchen equipment.
   3. Install valves, except butterfly valves, with stems pointed up, in vertical position where possible, but in no case with stems pointed downward from horizontal plane without prior written
approval. Install valve drains with hose-end adapter for each valve that must be installed with stem below horizontal plane.

4. Install butterfly valves with stems mounted horizontally.

5. All valves mounted higher than 7’ above floor in mechanical rooms and where indicated shall be installed with stem horizontal and equipped with chain wheels and chains extending to 6’ above floor.

B. Insulation: Where insulation is indicated, install extended-stem valves, arranged in proper manner to receive insulation.

C. Selection of Valve Ends (Pipe Connections): Except as otherwise indicated, select and install valves with the following ends of types of pipe/tube connections:

1. Copper Pipe, 2.5” and Smaller: Soldered-joint valves.
2. Steel Pipe, 2” and Smaller: Threaded joint valves.
3. Larger Pipe Sizes: One of the following, at installer’s option:
   a. Flanged valves.
   b. Lug valves.

D. Non-Metallic Disc: Limit selection and installation of valves with non-metallic discs to locations indicated and where foreign material in piping system can be expected to prevent tight shutoff of metal seated valves.

E. Renewable Seats: Select and install valves with renewable seats, except where otherwise indicated.

F. Fluid Control: Except as otherwise indicated, install gate, ball, plug, circuit setter, globe, and butterfly valves to comply with ASME B31.9.

G. Swing Check Valves: Install in horizontal position with hinge pin horizontally perpendicular to center line of pipe. Install for proper direction of flow.

H. Wafer Check: Install between 2 flanges in horizontal or vertical position.

I. Ball Valve: Ball valve used on gas systems shall be UL listed, CSA approved for pressure of system, no exception.

J. Valve Adjustment: After piping systems have been tested and put into service, but before final testing, adjusting, and balancing, inspect each valve for possible leaks. Adjust or replace packing to stop leaks, replace valve if leak persists.

K. Valve Identification: Tag each valve in accordance with “Mechanical Identification” section.

L. Cleaning: Clean factory-finished surfaces. Repair marred or scratched surfaces with manufacturer’s touch-up paint.

3.10 TEMPERATURE GAUGES

A. General: Install temperature gauges in vertical upright position, and tilted so as to be easily read by observer standing on floor without supplemental illumination. All gages to be installed with snubbers
to absorb system shock.

B. Install in the following locations, and elsewhere as indicated:
   1. At outlet of storage type water heaters.
   2. At inlet and outlet of solar hot water tanks.

3.11 MECHANICAL SLEEVE SEALS

A. Loosely assemble rubber links around pipe with bolts and pressure plates located under each bolt head and nut. Push into sleeve and center. Tighten bolts until links have expanded to form a watertight seal.

B. Fire Barrier Penetration Seals: Fill entire opening with sealing compound in compliance approved and listed UL system number. Adhere to manufacturer’s installation instructions.

3.12 SUPPORTS AND HANGERS (Refer to 22 05 50)

3.13 EQUIPMENT RAILS AND PIPE PORTALS

A. Install per manufacturer’s instructions.

B. Coordinate with other trades so units are installed when roofing is being installed.

C. Verify roof insulation thickness and adjust raise of cant to match.

3.14 VIBRATION CONTROL ISOLATORS

A. Comply with manufacturer’s instructions for installation and load application to vibration control materials and units.

B. Flexible Pipe Connectors: Install on equipment side of shutoff valves.

C. Upon completion of vibration control work, prepare report showing measured equipment deflections for each major item of equipment as indicated.

D. Clean each vibration control unit, and verify that each is working freely, and that there is no dirt or debris in immediate vicinity of unit that could possibly short-circuit unit isolation.

3.15 EXPANSION LOOPS

A. Expansion Loops: Fabricate expansion loops as indicated, in locations indicated, and elsewhere as determined by installer for adequate expansion of installed piping system. Subject loop to cold spring which will absorb 50% of total expansion between hot and cold conditions. Provide pipe anchors and pipe alignment guides as indicated, and elsewhere as determined by installer to properly anchor piping in relationship to expansion loops.

B. Expansion Compensation for Risers and Terminals: Install connection between piping mains and risers with at least 5 pipe fittings including tee in main. Install connections between piping risers and terminal units with at least four pipe fittings including tee in riser.

3.16 EXPANSION COMPENSATORS
A. Install as noted on plans. Where plans do not indicate spacing of guides or other pertinent information, install per manufacturer’s recommendations.

3.17 EXCAVATION AND BACKFILL

A. Underground piping shall be installed in stable, open trench work. Trench excavations shall be a minimum of 16” wide, true to line and grade. Contractor shall exercise all due shoring and safety procedures. No stones larger than 1” may be present in the trench to a minimum depth of 4” below the trench bottom. The trench shall be free of job site debris, and free of corrosive media. Pipe crown shall be not less than 3 feet (36 inches) below the finished ground surface for metallic pipe, and 30” for non-metallic pipe, unless otherwise indicated on the drawings or directed by the Airport’s representative. Trenches shall be kept free of excess moisture, and shall be kept open for only a short time as necessary for installation, testing and inspection. Off haul and Dispose of surplus excavation and seepage water as directed by the Airport’s representative.

B. Piping shall be properly bedded and backfilled over stable trench bottom to a level of at least 12” above the pipe crown with thin layers of unwashed sand, dampened but not puddle, and free of organic or corrosive materials and excessive moisture. Backfill shall be placed in thin layers not to exceed 6” and tamped by mechanical tampers to a minimum 90% Modified Proctor Density, in accordance with ASTM D-1557-58T. Trenches shall be backfilled to a minimum depth of 36” prior to being wheel loaded. Replace to their original condition all turf, plants, concrete, asphalt, or other improvements which constitute landscaping, traffic areas or other improved areas which become disturbed by excavation. In graded and undeveloped areas, in addition to procedures specified above, backfill trenches with crown 8” above the surrounding surface.

3.18 PIPE INSPECTIONS

A. It is the intent of the Contract Documents that systems be inspected at completion of each phase while under tests required for administrative authorities, and prior to concealment, i.e., “Rough-in” “top-out” and final. All piping shall be inspected by Airport plumbing inspector.

B. Inspection – Below Grade: All piping installed below grade shall be inspected prior to burial by the Airport’s Plumbing Inspector Representative or the Engineer. Contractor must notify Airport’s representative no less than 24 working hours prior to inspection time. Should the piping be buried prior to inspection the contractor may be requested to uncover the piping at no delay to the project and at no additional cost to the Airport.

C. Inspection – Above Grade: All piping installed above grade shall be made available for inspection upon completion and prior to finish of walls and ceilings. Notify the Airport’s Plumbing Inspector representative, the Owner’s Representative or the Engineer. Contractor must notify Airport’s representative no less than 72 working hours prior to the desired inspection time. Should the piping be hidden within the structure prior to inspection the contractor may be requested to uncover the piping at no delay to the project and at no additional cost to the Owner.

3.19 CLEANING, FLushing, DISINFECTING

A. General: Clean exterior surfaces of installed piping systems of superfluous materials, and prepare for application of specified coatings (if any).

B. Flush out piping systems per AWWA standards with clean water before proceeding with required tests. Inspect each run of each system for completion of joints, supports, and accessory items. Minimum pipe velocity for flushing shall be 3 fps.
C. Inspect pressure piping in accordance with procedures of ASME B31.

D. Disinfect water mains and water service piping in accordance with AWWA standards.

3.20 TESTING

A. Provide all tests specified hereinafter and as otherwise required. Provide all test equipment, including test pumps, gauges, instruments, and other equipment required. Test all rotational equipment for proper direction of rotation. All piping shall be inspected by SFO Plumbing Inspector prior to testing. Upon completion of testing, certify to the Airport’s representative, in writing, that the specified tests have been performed and that the installation complies with the specified requirements and provide a report of the test observations signed by qualified inspector.

B. Piping: Remove from the system, during testing, all equipment which would be damaged by test pressure. Replace removed equipment when testing has been accomplished. The system may be tested in sections as the work progresses; however, any previously tested portion shall become a part of any latter test of a composite system. Correct leaks by remaking joints with new material.

C. Test time will be accrued only while full test pressure is on the system, unless indicated otherwise. “Tolerance” shall be no pressure drop, except that due to temperature change in a 24- hour period. Inspect and test all work prior to burying or concealing. Test pressure shall be one and one-half times the system operating pressure or the listed test pressure below, whichever is greater:

<table>
<thead>
<tr>
<th>System</th>
<th>Test Medium</th>
<th>Test Pressure</th>
<th>Tolerance-Test Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic Water</td>
<td>Water</td>
<td>200 psig</td>
<td>None – 24 hours</td>
</tr>
<tr>
<td>Soil and Waste</td>
<td>Water</td>
<td>10 ft head, 5 psi</td>
<td>No leaks – 8 hours</td>
</tr>
<tr>
<td>Reclaimed Water</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vent</td>
<td>Water</td>
<td>Top of Vent</td>
<td>No leaks – 8 hours</td>
</tr>
<tr>
<td>Storm</td>
<td>Water</td>
<td>Top of Roof Drain</td>
<td>No leaks – 1 hour</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>Air or Nitrogen</td>
<td>100 psig</td>
<td>None – 2 hour</td>
</tr>
</tbody>
</table>

D. Backflow Preventers: Each testable backflow prevention device shall be tested and approved by certified testers after installation. Submit test results.

E. Valves: Test all valve bonnets for tightness. Test operate all valves at least once from closed-to open-to-closed position while valve is under test pressure. Test all automatic valves, including solenoid valves, and temperature and pressure relief valves, safety valves, and temperature and pressure relief valves not less than 3 times.

F. Piping Specialties: Test all pressure gauges, and water meters for accurate indication; trap primers, and vacuum breakers for proper performance.

END OF SECTION 22 21 13
SECTION 22 40 00 – PLUMBING FIXTURES AND SPECIALTIES

PART 1 – GENERAL

1.1 SUMMARY

A. Section includes:
   1. Plumbing fixtures and trim
   2. Plumbing specialties
   3. Water closets
   4. Urinals
   5. Lavatories
   6. Sinks
   7. Service sinks
   8. Electric water coolers
   9. Water fountains/Hydration stations

1.2 REFERENCES

A. General: comply with all required standards, including but not limited to the following:
   1. NSF Standard 61, Section 9 for Residential/Drinking Faucets.

1.3 SUBMITTALS

A. Prior to construction, submit for approval all materials and equipment in accordance with Division 01.
B. Submit manufacturer’s data and installation instructions
C. Submit maintenance and operating instructions for all components of this section
D. Other submittals as required by the Division 01 sections

1.4 WARRANTY

A. Provide 2 years (24 months). The warranty shall include parts, labor, travel costs, and living expenses to repair or replace products or systems, and shall start on date of acceptance by the Airport Commission.

1.5 QUALITY CONTROL

A. All faucets and drinking fountains shall contain no more than two tenths of one percent (0.2%) lead and shall comply with NSF Standard 61, Section 9 for Residential/Drinking Faucets.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the site in containers with manufacturer’s stamp or label affixed.
B. Protect products against dirt, water, chemical, and mechanical damage. Do not install damaged
components – remove from project site.

PART 2 – PRODUCTS

2.1 Faucets:
A. American-Standard.
B. Kohler.
C. Toto.
D. Delta.
E. Chicago.
F. Symmons.
G. Leonard.
H. Powers.
I. Equal.

2.2 FIXTURES AND TRIM
A. Provide fixtures and appurtenances as specified on the drawings. Manufacturer listed on drawings are for reference only. Substitute manufacturers must comply with all aspects of specified fixtures. Acceptable manufacturers include:
   2. Type 304 Stainless steel fixtures: Elkay, Halsey Taylor, Haws, Just, Intersan, Acorn, Bradley, Metcraft, or equal.
   4. Flush valves: Sloan, Delaney, Toto, or Zurn.
   5. P-traps, supplies and stops: Brass Craft, Dearborn, Eastman, McQuire, Sanitary Dash, or Teldyne Ansonia.
   6. Toilet seats: Beneke, Bemis, Church, Olsonite, or Sperzel.
B. General: Provide complete fixture assembly, including all trim and appurtenances for proper operation and neat, finished appearance. Procure all rough-in data from manufacturers, and rough-in and connect to fixtures as required. All toilets, lavatory faucets and shower heads shall be of the low-flow type. All vitreous china fixtures shall be white, unless otherwise specified.
C. All fixtures shall comply with federal, state and local codes for water flow requirements.
D. All fixtures shall comply with handicap accessibility requirements of the American with Disabilities Act (ADA), and applicable state and local codes. Waste and water piping below handicap accessible lavatories shall be insulated.
E. Trim:
1. All exposed trim, including tubing, traps, and waste pieces, shall be polished chrome plated.

2. Provide separate control stops for each fixture, polished chrome plated, with loose key.

3. Provide screwdriver stop and vacuum breaker with each flush valve assembly.

4. P-Traps: Chrome plated 17 gauge trap, adjustable, 1.5” inlet, 1.5” outlet, with cleanout plug for lavatories, 1.5” by 1.5” for sinks except as noted. Provide tap for condensate drains where required.

5. Gasket floor mounted fixtures and grout with non-hardening Tile-Fix.

6. Provide stainless steel rims, as applicable, for all counter mounted fixtures.

F. Vitreous chinaware fixtures shall be white and of a quality known commercially as “twice-fired” vitreous china. Enamelware shall be cast iron with acid resistant enamel. Include china bolt caps.

2.3 WATER HAMMER ARRESTORS

A. Provide Water Hammer Arrestors

1. Piston Type, Hard drawn copper construction, mirror finished internal surfaces; machine finished brass piston, air charged, 250 psi rated, tested and certified per PDI WH-201 and ASSE 101; Precision Plumbing series SC, Watts Series 15, Sioux Chief, or approved equal.

2. Provide access panel. Access panel shall be at least 6” x 6” and located so as to be able to inspect and repair Water Hammer Arrestor as needed.

2.4 HOSE BIBBS

A. Provide hose bibbs as follows:

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<tr>
<th>Location</th>
<th>Diameter</th>
<th>Accessory</th>
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<tbody>
<tr>
<td>Toilet Rooms</td>
<td>0.5”</td>
<td>With vacuum breaker hose adapter outlet, loose key</td>
</tr>
<tr>
<td>Exterior</td>
<td>0.75”</td>
<td>With vacuum breaker hose adapter outlet, loose key</td>
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B. Manufacturers: Acorn, Chicago, or equal.

PART 3 – EXECUTION

3.1 GENERAL

A. This system to be installed by an experienced firm a C-36 Plumbing Contractor regularly engaged in the installation of plumbing systems as specified by the requirements of the Specifications.

B. Install all items specified in this section of the Specification under the full purview of local and state governing agencies.

3.2 PERFORMANCE OF WORK

A. Examine areas, physical conditions and phasing requirements under which materials are to be installed. Layout the system to suit the different types of construction and equipment as indicated on the drawings.

B. Verify all existing and new pipe locations, elevations, and points of connections prior to start of
construction. Notify Design-Builder of any potential problems prior to construction.

C. Coordinate with other trades as necessary to properly interface components of the plumbing system.

D. Follow manufacturer’s directions and recommendations in all cases where the manufacturers of articles used on this Contract furnish directions covering points not shown on the drawings or covered in these Specifications.

3.3 FIXTURES

A. Verify exact locations and mounting heights of all fixtures and trim with Architectural Drawings.

B. All fixtures shall be installed straight and level. Each wall hung fixture shall be secured against down movement when the weight of 150 300 pounds is applied to the front top edge of the unit. Gaskets shall be tightly and neatly caulked into position for all floor mounted fixtures.

C. There shall be no vertical up movement when 50 pounds pull is applied to the underside of the front edge of the fixture. All pipe located in piping chase shall be anchored so there will be no movement of supply lines extending through the chase walls. Flush valves, faucets, shower head arms, wall hydrants, hose bibbs, lavatory P-traps shall be installed so that there will be no movement in any direction when fixture is finally installed.

D. Grouting between wall or floor fixture or in wall around fixture supply lines shall not be used for purpose of anchorage.

E. Fixtures will be checked on final inspection for spacing, level installation, soundness and stability, all parts will be checked for proper operation. Only fixtures meeting the above requirements will be accepted.

3.4 CLEANING

A. All fixtures, including those on which only connection is made, shall be cleaned. The Subcontractor shall be responsible to see that fixtures and trim are not damaged during cleaning by use of acids, industrial cleaners or strong solvents.

END OF SECTION 22 40 00
San Francisco International Airport

Mechanical Design Standards

Rev. 11/15/2017
# Mechanical Design Standards

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CHAPTER 1
GENERAL

SECTION 101 - GENERAL

101.1 INTENT
The Mechanical systems consist of HVAC, Plumbing, and Automatic Controls located in the Terminal Building, Concourses and Auxiliary Buildings. The goals and objectives are to develop a Mechanical design to achieve an efficient, economical, maintainable and reliable installation consistent with the long term goals and objectives of the San Francisco International Airport (SFIA). This is not intended to be a code review or master specification.

The space environment shall be designed to be controllable within acceptable year around comfort and health levels. The Design Engineer shall utilize the latest state-of-the-art, energy conservative, readily available equipment and components based on proven design techniques.

The design guide is intended to supplement California Building Codes, City and County of San Francisco (CCSF) regulatory requirements, Net Zero Energy Standards and Objectives, and design specifications. It is not intended to override or void any codes, regulatory or design. The standards are intended to provide basis of design and design criteria to support programming, planning and establish general design objectives. This is not to simply the design process but rather to establish a baseline for design evaluation, system assessment, value engineering, and overall challenge points to achieve exceptional design.

Deviation from the design criteria must be submitted for review. Design options, value engineering, and alternative systems must be submitted with engineering justification.

101.2 GENERAL
The designer shall prepare the design, construction documents, drawing and specifications for HVAC equipment, ductwork and piping, exhaust equipment, controls, insulation, structural, plumbing, fire protection, automatic control systems and operational services such as aircraft and vehicle fuel and glycol systems. The designer shall coordinate the Mechanical design with the applicable sections of the Architectural, Electrical, Structural, Civil and SFIA standards and criteria.

Mechanical systems must be coordinated and integrated with all other building systems and features. Mechanical systems shall be adapted to support all performance objectives, typically involving sustainability, workplace performance (productivity and efficiency), fire safety, security, historic preservation, and improved operations and maintenance.

All Construction Documents shall be developed by the designer and reflect a complete engineered design. The installing contractor may perform certain engineering tasks, such as the Fire Protection, but the designer is responsibility for the total overall design.

101.3 SFIA MECHANICAL ENGINEER
All references in this document to the “SFIA MECHANICAL ENGINEER” refer to the individual listed below. For questions, updates or requests for deviations to this document contact:

John Chinn, PE  
Senior Mechanical Engineer  
P.O. Box 8097  
San Francisco, CA 94128  
Email: john.chinn@flysfo.com  
Phone: (605)821-7807  
Cell: (650)821-7838

101.4 REGULATORY REQUIREMENTS
Specify that work shall be per Underwriters, Public Utility, Local, State and Federal Codes, Ordinances and applicable regulations. Work shall also comply with latest editions of all applicable codes, ordinances and regulations in effect as of the date of the Contract Documents. If discrepancies occur between the Contract Documents and any applicable codes, ordinances, acts, or standards, the most stringent requirements shall apply.

Drawings will be reviewed for code compliance and permitted through SFIA Building Inspection and Code Enforcement (BICE).
102.1 SYSTEM CRITERIA
The mechanical systems for all facilities at the San Francisco International Airport are to be based on straight-forward, proven design techniques utilizing the latest state-of-the-art development in readily available equipment and hardware. The overriding criteria for the use of systems and equipment shall be safety, sustainability, reliability, life cycle cost, and the comfort of the traveling public.

It is most important that the systems installed serve the public well, are readily serviceable and maintainable, are stable, reliable, and direct in their operation, and provide flexibility for future change and development. All equipment, appurtenances, and hardware shall be accessible for adjustment and maintenance. Suitable access is required to permit removal and replacement of equipment items. Provisions are to be made for centralization of operating and maintenance diagnostics, controls, measuring, monitoring, alarms, and trending analytics.

It is anticipated that there will be changes and development in many areas of the airport facilities and the mechanical systems will have to be revised or expanded to accommodate these changes. In addition, development in state-of-the-art technology may suggest updating systems and system components in the future. All designs of mechanical systems must include built-in flexibility in keeping with the nature of change that is ever present for air transportation facilities.

In addition, energy conservation and cost savings will also be guiding criteria in the design of mechanical systems. All facilities must meet the energy conservation requirements included in these standards. Both initial system and equipment costs and life cycle owning and operating costs are to be important considerations in concept design efforts and these considerations must be carried through final design and construction. Life-cycle cost analysis requires a minimum of 2 options for comparison. All new central systems must be justified with a life-cycle analysis. Modifications of existing systems do not require life-cycle analysis.

102.2 MECHANICAL DESIGN CRITERIA - FLEXIBILITY
Special provisions are to be made in determining terminal and concourse building heating and air conditioning load requirements to properly allow for the dynamic nature of the application of these loads. During normal operation these loads can vary dramatically from zone to zone and the peak load can fluctuate significantly within each zone. This is due to the rapid mass movement of people within the building, as well as, the shifting solar load on glass walls, infiltration loads associated with people and baggage movement in and out of the building, and outside air ventilation requirements.

Heating and air conditioning system controls must provide system flexibility so as to be able to deal with the shifting internal cooling loads as well as coordinating for future interconnection with planned development of existing systems. The HVAC system must be able to handle varying perimeter loads during heating and cooling seasons while the internal and other loads fluctuate between no load and peak conditions. In addition, appropriate air quality conditions must be maintained in the spaces while the natural ambient (outside) conditions are very often of less than ideal quality.

102.3 DESIGN PARAMETERS
A. Indoor Design Temperatures: It is intended that the mechanical systems (in general) maintain indoor design conditions in all occupied spaces normally accessible to the public as follows (unless specified otherwise):
1. Summer: 72 degrees F, 50% percent maximum relative humidity
2. Winter: 68 degrees F

B. Outdoor Design Temperatures: Outdoor design conditions to be used for system designs are as follows:
1. Summer: 83 degrees F dry bulb/ 64 degrees F wet bulb.
2. Winter: 35 degrees F

These design criteria conditions are based on the recommended conditions listed for San Francisco in the ASHRAE Fundamentals Handbook at the 0.5% summer condition and the 99.8% winter condition. That is, based on historical data, the outdoor temperatures can be expected to exceed the summer design conditions 0.5% of the time and exceed the winter design conditions 0.2% of the time. The more stringent design condition is required for winter criteria due to inherent outdoor infiltration condition present in most airport situations. The standards establish only baseline criteria for equipment sizing.
Net Zero Energy goals and operational goals should be evaluated as part of the Energy Model to achieve Sustainability goals. See Standards & Criteria for Thermal Comfort Modeling in the SFO Net Zero Energy Standards for alternative design parameters.

102.4 VENTILATION STANDARDS

Ventilation Standards for occupied spaces are to be based upon the latest revision of ASHRAE Standard 62, "Ventilation for Acceptable Indoor Air Quality." The minimum required ventilation rate of outdoor air per person is to be 15 CFM per person, with several special use areas in the buildings having significantly higher requirements.

Design engineer shall investigate increasing outdoor air ventilation rates to all occupied spaces by at least 30% above the minimum rates for LEED Indoor Environmental Quality credits.

102.5 ENERGY EFFICIENCY REQUIREMENTS

Energy efficiency is an important consideration in the design of the mechanical systems for all SFO International Airport facilities. Heating, ventilating and air conditioning systems are to be designed to exceed the requirements of the latest revision of ASHRAE Standard 90.1 - "Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings," and the San Francisco Building Code. Refer to the latest SFO Sustainability Design Guide. All new facilities must be certified as LEED Gold at a minimum. All Commercial Interior renovations over 5,000SF must be certified as LEED Gold at a minimum and reach Net Zero Energy objectives.

Equipment selections must be specified to meet or exceed these standards. The equipment and systems described herein must be selected to obtain the optimum in conserving owning and operating costs considering energy efficiency, initial costs, maintainability, and comfort. Energy use budgets and criteria are described in detail in this section of the Mechanical Design Standards.

102.7 NOISE CRITERIA

The mechanical (HVAC) system shall be designed to minimize noise in the occupied space. The system and components shall be designed so as not to transmit or generate sound above a specified noise level in the space. Sound attenuators, duct liner, lower duct velocities and appropriate ductwork fittings and components shall be utilized as required to attain acceptable sound levels. Vibration isolation shall also be evaluated and utilized. Sound attenuators shall be isolated from the building structure.

Sound tests shall be conducted in accordance with accepted procedural standards in and around all major sound producing equipment to either confirm adequate attenuation or to identify problem areas requiring additional modifications as required by the Project Manager.

Maximum noise levels in the occupied space produced by HVAC equipment shall be in accordance with the following NC (noise criteria) curves.

A. Offices NC-30
B. Terminals & Concourses NC-40
C. Maintenance Facilities NC-40
D. Mechanical Equipment Rooms NC-50
E. Museum NC-25
F. Exercise Rooms NC-30
G. Conference Rooms NC-30
H. Lobbies, Corridors and Waiting Areas NC-40
I. Quiet Rooms and Meditation Rooms NC-25

Where mechanical noise is to be utilized for sound masking, RC (room criteria) curves shall be utilized as described in the ASHRAE Handbook, "Fundamentals."

Equipment and ductwork noise levels to permit attaining sound pressure levels in all 8 octave bands in Tenant occupied spaces shall conform to noise criteria NC-35 curves. Motor drives for pumps or any equipment shall operate with noise levels not exceeding OSHA 8 hour 90dBA Time Weighted Average (TWA). Noise levels shall be determined in accordance with IEEE Standard #85 Test "procedure for Air-Borne Noise Measurements on Rotating Electric Equipment."
SFIA Mechanical Design Standards

Engineering Firms will be required to submit sound attenuation analysis.

102.8 SUPPORTS AND PENETRATIONS
All supports for mechanical and plumbing equipment shall be designed, detailed and specified by a California licensed Structural Engineer. Penetrations and reinforcement of penetrations through structural floors and/or walls shall be designed, detailed and specified by a California licensed Structural Engineer.

102.9 HVAC COMPUTER BASED LOAD ANALYSIS
The HVAC loads calculations shall be performed with a computer-based program using the latest ASHRAE Handbook of Fundamentals Heat Balance Method (HB), Radiant time Series (RTS) Method, or Transfer Function Method (TFM), developed for the hourly analysis of heating and cooling loads in commercial buildings. Preferred program is Carrier HAP. All projects are required to submit load calculations.

The program shall be capable of calculating each zone’s peak heating and cooling load as well as the whole-building “block” loads. The program shall, at a minimum, calculate: solar gains through fenestration, internal gains from occupants including latent heat for cooling purposes, internal gains from lighting and equipment, outside air loads (sensible and latent) from ventilation and infiltration, and heat gains or losses through fenestration, walls, floors and roofs. The heating load calculations must be done without credit for occupants and internal gains.

The HVAC loads calculations report shall include all input and output used in the heating and cooling calculation program, and shall include zone peak heating and cooling loads results, and whole building “block” loads, air-handling unit coil selections, and psychrometric process charts.

102.10 PREDICTIVE ENERGY MODELING
A building energy analysis shall be performed to demonstrate that the building design meets or exceeds the energy performance goals established for the project. Predictive Energy Modeling will be required to support Net Zero Energy objectives. Iteration process to support design collaboration, engineering, life cycle cost, and integrated design across all aspect of the new space will be required. See Chapter 8 for Energy Analysis.

The building energy analysis shall be performed using the ASHRAE Standard 90.1 Energy Cost Budget methodology, and must demonstrate compliance with the latest editions of ASHRAE Standard 90.1. The analysis shall be included in each design submission. Predictive Energy Modeling program shall be Integrated Environmental Solutions – Virtual Environment (IES VE).

The analysis shall evaluate the energy performance of the building design including the proposed building envelope, HVAC systems and components, the lighting systems, and domestic hot water systems, as well as the proposed control strategies for these building systems. The analysis shall be based on actual parameters and values found in the proposed building design and not simply on defaults assigned by the simulation program. The analysis shall be performed using a simulation program. The simulation program shall be a computer-based program for the analysis of energy in buildings. Simulation programs must be capable of simulating: 8,760-hours per year, hourly variations in occupancy, lighting power, miscellaneous equipment power, thermostat setpoints, and HVAC system operation defined separately for each day of the week and holidays, thermal mass effects, the number of required HVAC zones, part-load performance curves for mechanical equipment, capacity and efficiency correction curves for mechanical equipment, air-side and water-side economizers, and temperature controls. Public domain or commercial software shall utilize the IES VE modeling software. Alternative simulation programs, meeting the above stated requirements, may be used with prior approval. The building energy analysis report shall include all input and output used in the simulation programs, including: established energy goals for the project, detailed descriptions of the budget and proposed building models, actual local utility rates, descriptions of any and all energy conservation measures, an analysis of results with final conclusions and recommendations.

102.11 MAINTENANCE SERVICE
A. Service Access. Space shall be provided around all HVAC system equipment as recommended by the manufacturer and in compliance with local code requirements for routine maintenance. Access doors or panels shall be provided in ventilation equipment, ductwork and plenums as required for in-site inspection and cleaning. Equipment access doors or panels shall be readily operable and sized to allow full access. Large central equipment shall be situated to facilitate its replacement. The HVAC design engineer shall be cognizant of the necessity to provide for the replacement of major
equipment over the life of the building and shall insure that provisions are made to remove and replace, without damage to the structure, the largest and heaviest component that cannot be further broken down.

In addition, adequate methods of access shall be included for items such as: chillers, boilers, air-handling units, heat exchangers, cooling towers, reheat coils, VAV terminals, pumps, water heaters and all devices that have maintenance service requirements.

To facilitate equipment access, maintenance, removal and replacement, a freight elevator stop shall be provided to serve each floor housing HVAC systems and equipment.

Where stairs are required, they must allow for safe transport of equipment and components. Ship’s ladders are not permitted for access and maintenance of any equipment.

B. Vertical Clearances. Mechanical equipment rooms shall have clear ceiling heights of not less than 12 feet. Catwalks with stairways shall be provided for all equipment that cannot be maintained from floor level. Where maintenance requires the lifting of heavy parts (100 lbs. or more), hoists and hatchways shall be installed.

C. Horizontal Clearances. Mechanical rooms shall be configured with clear circulation aisles and adequate access to all equipment. The arrangement shall consider the future removal and replacement of all equipment. The mechanical rooms shall have adequate doorways or areaways and staging areas to permit the replacement and removal of equipment without the need to demolish walls or relocate other equipment. Sufficient space areas (noted by outlining manufacturer’s recommendations) for maintenance and removal of coils, filters, motors, and similar devices shall be provided. Air-handling units require a minimum clearance of 2'-6" in on all sides, except the sides that filters and coils are accessed, where clearance shall be equal to the length of the coils plus 2'-0".

1. Housekeeping Pads. Housekeeping pads shall be at least 6 inches wider on all sides than the equipment they support and shall be 6 inches thick.

2. Mechanical Rooms. All mechanical rooms must be mechanically ventilated to maintain room space conditions as indicated in ASHRAE 62 and ASHRAE 15. Water lines shall not be located above motor control centers or disconnect switches and shall comply with requirements of NFPA 70. Mechanical rooms shall have floor drains in proximity to the equipment they serve to reduce water streaks or drain lines extending into aisles. Mechanical rooms shall not be used as return air, outdoor air, or mixing plenums. Mechanical equipment rooms must be designed in accordance with the requirements of ASHRAE Guideline15: Safety Code for Mechanical Refrigeration.

3. Electrical Equipment Rooms. No water lines are permitted in electrical rooms, except for fire sprinkler piping. Avoid placing restrooms, kitchens or utility rooms above Electrical Equipment Rooms.

4. Communications Closets. Communications closets must be cooled in accordance with the requirements of EIA/TIA Standard 569. Closets which house critical communications components shall be provided with dedicated air-conditioning systems that shall be connected to the emergency power distribution system.

5. Elevator Machine Rooms. A dedicated heating and/or cooling system must be provided to maintain room mechanical conditions required by equipment specifications. In the event the building is equipped throughout with automatic sprinklers, hoist way venting is not required.

6. Emergency Generator Rooms. The environmental systems shall meet the requirements of NFPA Standard 110: Emergency and Standby Power Systems and meet the combustion air requirements of the equipment. Rooms must be ventilated sufficiently to remove heat gain from equipment operation. The supply and exhaust louvers shall be located to prevent short circuiting. Generator exhaust shall be carried up to roof level in a flue or exhausted by way of compliance with the generator manufacturer’s installation standards. Horizontal exhaust through the building wall shall be avoided.

SECTION 103 - SUBMITTALS

103.1 DESIGN SUBMITTALS

Regardless of requirements outlined by the Design Analysis Report, or lack of, the Designer shall submit the following at the 100% phase of the project to the SFIA Mechanical Engineer:

1. Space load calculations shall be modeled.

2. Ventilation calculations defined by ASHRAE 62.
3. Equipment sizing and selection (AHU, FCU, Pump, Expansion tank, water heater, etc.)
4. Duct sizing and static pressure analysis
5. Hydronic piping sizing and static pressure analysis
6. Plumbing sizing and code analysis
7. Building pressurization analysis
8. Smoke Control Analysis
9. REVIT Building Model
10. Energy Analysis, Building Performance Energy Model
11. Life cycle cost analysis
12. Displacement Ventilation Air Flow, Computational Fluid Dynamics
13. Building Air Flow Modeling, Computational Fluid Dynamics
15. Additional calculations as requested by the SFIA Engineering Group

Each item shall be included as a single, book-marked PDF file. No paper copies are required or will be accepted. All equipment shall be labeled as identified on the contract drawings. Each filename should include the contract number.

103.2 AS-BUILT SUBMITTALS
The Engineer shall submit the information outlined, with corrections made due to field changes in Construction.
CHAPTER 2
HVAC SYSTEMS

SECTION 201 – HVAC SYSTEM DESCRIPTION
This Chapter outlines basic HVAC system parameters and options. All sustainability based system upgrades or alternative solutions shall be evaluated to best achieve Net Zero Energy program objectives. It is the responsibility of design professionals to provide a collaborative solution with all aspects of building and system design.

201.1 AIR HANDLING SYSTEMS
The most appropriate designs for an airport terminal necessitate that the space conditioning system be flexible and responsive to wide swings in thermal loads. Factors include constantly changing people loads, high people door usage, air infiltration, shifting passenger densities, shifting solar loads, and baggage handling transfers in and out of the building. These items change in timing and intensity depending on changes in aircraft schedules and special peak passenger periods.

The air handling unit selection must consider the primary system design. For the San Francisco International Airport, the air handling units will utilize hot and chilled water from a four-pipe distribution system. Separate cooling and heating coils shall be required. The heating coils shall be selected for a minimum 20 degrees F temperature differential (180 degrees F to 160 degrees F). The cooling coils shall be selected for an approximate 10 degrees F temperature differential (42 degrees F to 52 degrees F) or as required by the psychometrics of the specific system design. This criterion shall be coordinated with the Central Plant.

Packaged air handling units should be used for applications below 25,000 CFM. Customized, built-up air handling units may be used in applications above 25,000 CFM.

Cooling and heating coils are to be sized and arranged for water velocities in the 6 fps range. Air cooling coils shall be designed to have a maximum air face velocity of 600 fpm. Air heating coils shall have a maximum air face velocity not to exceed 800 fpm. Fin spacing shall be as wide as possible to provide the specified leaving coil conditions. Condensate traps shall be 1 inch deeper than suction pressure. Drain pans shall be sloped to center.

DX cooling coils shall be row split (in lieu of face split) where multiple coil sections are required. All supply air handling units shall be draw-through, built-up systems except in instances where sound control would favor the application of blow-through units. Each unit shall consist of a non-overloading supply air fan with selected for maximum efficiency. Fan selection shall be based on noise criteria requirements. Fan walls are the preferred system type, however, other fan type may be considered if economy, efficiency and noise criteria parameters can be assured. Fan static pressure shall be based on final filters at end of life and pre-filters at midlife. Fan walls shall be provided with variable frequency drive (VFD) and redundant back-up VFD.

In addition, each air handling unit system shall contain separate cooling and heating coils (includes cooling only units), a final filter section, a throwaway filter section, a photo catalytic oxidation (PCO) filter, an air blender section to eliminate air stratification, a mixed air plenum for outside air and return air duct damper connections, and a sound attenuation section if required. Integral face and bypass dampers shall be considered for pre-heat coils in appropriate areas. Each air handling unit section shall be provided with an access door and non-breakable plenum light (coordinate with corresponding electrical designs). Heating coils shall be located upstream of the cooling coils, with space in between the two coil sections to facilitate access for maintenance and inspection. Air-tight shutoff type dampers shall be provided for the outside air damper.

The following air handling systems may be used for various applications at the San Francisco International Airport terminal and concourse areas. These include single-zone systems, Multi-zone systems, variable volume systems, heat pump systems, and roof-top HVAC systems.

All equipment visible from public line of sight shall be reviewed by the SFIA Architectural review committee. Non-standard equipment color and finishes may require additional screening.

201.2 DESIGN SUBMITTAL REQUIREMENTS
A. Provide load calculations or building performance model
B. Provide performance data sheets and air handler shop drawings
C. Provide selection fan curves
D. Sound spectrum for air handler inlet and outlet conditions
201.3 SINGLE-ZONE SYSTEMS
Single-zone type air handling systems will effectively handle any particular local area (zone) of a facility. However, a multitude of different temperature zones may necessitate a high number of single-zone air handling units. The disadvantages of such a design would be the requirement for more mechanical room space, higher maintenance costs, and increased capital cost due to the number of individual units that would be required. The use of single-zone air handling units on a large scale is not economical. A multitude of single zone units serving large, main spaces would also reduce the flexibility required to accommodate future space modifications.

Single-zone air handling units do have suitable application, however, to serve certain perimeter zones of the terminal building and concourses. They also have application in many areas in the various support facilities, where their use would prove to be the most suitable solution.

201.4 HEAT-PUMP SYSTEMS
Heat-pumps are a viable alternative for decentralized buildings.

201.5 ROOF-MOUNTED HVAC SYSTEMS
Another alternative, viable in many building applications, is the decentralized, roof mounted, packaged HVAC system. Rooftop HVAC equipment shall not be incorporated into the designs for the San Francisco International Airport terminals. This equipment does have application however, for some of the support facilities. Whenever a roof-top unit is utilized in the mechanical design of a building, the following concerns should be addressed in detail:

A. Maintenance - is the equipment readily accessible?
B. Energy Efficiency - select equipment to be energy efficient.
C. Noise and Vibration - proper vibration isolation is usually not provided unless special requirements are specified.
D. Aesthetics - this equipment can have a negative impact on the appearance of a building, depending on the elevation of other buildings or facilities in the vicinity. An architectural enclosure shall be provided around roof-mounted mechanical equipment.

201.6 VARIABLE AIR VOLUME SYSTEMS
In a variable air volume (VAV) system, the air volume supplied to the conditioned space is modulated to maintain the space temperature utilizing a constant supply air temperature. This system can offer the best approach to meet two major goals; energy efficiency and moderate initial capital costs.

The VAV system shall contain the air-handling system components described above for air handling systems, plus fan inlet vane controls or variable frequency fan motor drives. The air distribution system shall be of a single design. The appropriate variable volume terminal boxes shall then be provided to control the airflow to the space.

It is important with VAV systems that proper outside air ventilation rates be maintained, as well as building pressurization. Additional HVAC equipment or controls may be required with VAV systems to control pressurization. This issue will be addressed in the temperature control system requirements. The advantages of VAV systems both in flexibility and energy efficiency outweigh the additional control requirements.

Variable air volume systems are recommended for a number of areas in the San Francisco International Airport terminal buildings and in office areas, concourses and many other interior zone applications.

Systems shall be designed to deliver a minimum 0.5" WC at the most remote VAV box

201.7 PERIMETER SYSTEMS
Any expanse of exterior glass wall area, in the Terminal, Concourses, or other areas will require a perimeter thermal conditioning system. These systems are to be designed to handle at least the conduction and infiltration loads of the perimeter walls plus potentially some radiant solar and internal loads near the perimeter, depending on the application.

There are three suitable methods to handle the perimeter loads.

A. A perimeter finned-tube hot water radiation system.
B. Radiant slab system.
C. A forced air system at the perimeter. Air circulation at the perimeter reduces pockets of stagnant hot or cold air.

If a perimeter forced air system is to be provided it should be a constant volume system in order to provide the necessary "throw" at the sill diffusers during mild weather. The perimeter system is preferably located at the sill rather than overhead to counteract down-draft at the windows during the winter. Some perimeter areas with low ceilings (9 ft. or less above finished floor) may use ceiling supply for the perimeter system; in addition these areas could be VAV with reheat if the system supplies only the perimeter and can handle both heating and cooling peak load conditions.

Perimeter finned-tube hot water radiation systems can be used to meet the perimeter loads. Ensure that the perimeter radiation system and forced air distribution systems don't work against each other causing them both to constantly cycle. Caution should be used in providing sill system components so that they do not easily collect trash.

201.8 HVAC FOR UNFINISHED (TENANT) AREAS

HVAC systems for unfinished future tenant areas shall be designed to provide for heating and cooling. The interior space(s), (defined as that space 12 +/- feet from the exterior wall) shall be designed for VAV with only cooling primary air ductwork routed to the terminal units. The VAV units shall be sized to deliver approximately 1.25 CFM of supply air per square foot. Prior to setting air flows the anticipated use of tenant areas shall be reviewed for functions that may require airflow rates above this amount (i.e. kitchens, bars, etc.). Additional CFM shall then be built into the air handling system design to easily handle these special areas. Controls will be connected to the VAV terminal unit only if some cooling or ventilation is required in the space.

The exterior glass walls shall utilize a perimeter forced air system as described previously. The perimeter system shall be complete in the unfinished area. The interior system shall be complete only to the VAV terminal system components.

SECTION 202 – SPECIAL SYSTEMS

202.1 AIR CURTAINS

Air curtains, plastic curtains and rapid operation doors are to be considered for use at doors and openings at all maintenance type facilities and also at baggage doors and openings.

Overhead fan-coil units or fan powered terminal boxes may be used as a modified type of air curtain at each concourse jetway entrance. The fan-coil units shall be activated, if not already in operation, whenever the jetway door is opened utilizing a 30-second time delay, and the supply air temperature is to be controlled from a space thermostat.

Air curtain type units shall be used at all terminal entrance vestibules. These air curtain units are controlled by vestibule thermostats.

202.2 CATALYTIC AIR CLEANING SYSTEM

Air filtration is an important consideration in the design of HVAC systems to serve airport facilities. Provide a catalytic air cleaning system in all new air handling units, which consists of MERV 13 rated filters, Ultraviolet Germicidal Irradiation (UVGI) and Photocatalytic Oxidation (PCO).

Ultraviolet Germicidal Irradiation (UVGI) is used to damage or kill various organisms on surfaces on the evaporator coil and surface in the air handler. Photocatalytic Oxidation (PCO) render bacteria cells, mold spores, and viruses inactive and accelerates the breakdown most volatile organic compounds (VOCs).

The key benefits of this system are:

A. Significant reduction of microbiological elements (viruses, bacteria and fungi/mold).
B. The reduction of organic odors caused by VOCs, like engine exhaust fumes.
C. Highly efficient particle removal.

202.3 SPLIT DX SYSTEM

Provide an independent Split DX to serve Special System Rooms (SSR), Server Rooms and Elevator Machine Rooms. Systems shall be sized to serve the cooling load in the room.
SECTION 203 - VENTILATION SYSTEMS

203.1 OUTDOOR AIR REQUIREMENTS
Outside air shall be brought in through the air handling systems to satisfy minimum ventilation requirements plus provide building pressurization and minimize air infiltration at building entrance door areas.

Existing outdoor air requirements on air handling equipment in the terminals were designed around previous revisions of ASHRAE Standard 62. Minimum outside air ventilation amounts shall be provided in accordance with the latest revision to ASHRAE Standard 62 and California Mechanical Code, there may be a conflict in the required amount of outdoor air. The Engineer shall coordinate those requirements with the Building Inspection and Code Enforcement (BICE) Department and provide electronic copies of correspondence and documentation of final design direction to the Project Manager. It is the responsibility of the Engineer to provide documentation that the existing equipment can comply with any modifications in outdoor air.

Outside air intakes shall be located high and away from landside vehicle traffic and airside jet exhaust to the greatest extent possible, a minimum of seven feet above grade. Most ventilation air will be brought in through air intakes in the mechanical penthouses. Computerize Fluid Dynamics modelling shall be utilized to validate intake air locations. All effort shall be made to provide distance and dilution as primary air quality solutions. See 202.2 and 203.5 for air quality controls and filtration.

203.2 CO2 MONITORING
Monitor CO2 concentrations within all densely occupied spaces. CO2 monitors must be between 3 and 6 feet above the floor. CO2 monitors must have an audible or visual indicator or alert the building automation system if the sensed CO2 concentration exceeds the setpoint by more than 10%. Calculate appropriate CO2 setpoints using methods in ASHRAE 62.1–2010, Appendix C.

For spaces where air contaminants are likely, evaluate potential sources of additional air contaminants besides CO2. Develop and implement a materials-handling plan to reduce the likelihood of contaminant release. Install monitoring systems with sensors designed to detect the specific contaminants. An alarm must indicate any unusual or unsafe conditions.

203.3 RETURN AIR \ TRANSFER AIR
Return air from the conditioned space back to the air handling unit should be via ductwork and ceiling plenums. The pressure drop in the return air system shall be minimized in the design. Return air fans should not be required in most cases. Maximum velocity shall be 500 fpm over net free area for general return and transfer air and 200 fpm over net free area for smoke control areas.

Eggcrate grilles shall be used in return air plenums that are used for smoke control. Perforated face grilles shall not be used.

203.4 VENTILATION RATES
As described earlier in this document, the outside air ventilation rate shall be as recommended in the latest edition of ASHRAE Standard 62. Careful consideration shall be given to these new recommended rates, particularly considering recent attention in the HVAC industry to indoor air quality. A summary of the applicable rates published in ASHRAE Standard 62, as applicable to airport building spaces, is presented below:
Outside air requirements, unless otherwise specified, shall be as follows for "normal" occupancy levels.

The occupancy load in many public areas of the airport (i.e., concourses, hold rooms, ticketing areas, baggage claim, etc.) is highly variable. As an alternate to the ventilation air flows indicated as based on "normal" occupancy levels, it is acceptable to calculate the minimum ventilation rate on 10 CFM per person, based on peak load occupancy; unless exhaust requirements override this amount.

203.5 FILTRATION
Air filtration is an important consideration in the design of HVAC systems to serve airport facilities. Air should be brought in at the roof or penthouse level wherever possible in an attempt to use the highest quality air available. As a minimum, outside air is to be filtered by the use of 2” dry type pre-filter sections having a minimum rating of Minimum Efficiency Reporting Value, MERV 8 (30% - 35% efficient with a maximum allowable particle size of 10.0 micron), 12” dry type filter section having a minimum rating of MERV 13 (89% - 90% efficient with a maximum particle size of 1.0 micron), ultraviolet germicidal irradiation (UVGI) and photocatalytic oxidation (PCO). Filters for small air-handling units serving maintenance or non-public areas should be provided with 4” dry type pre-filter section having a minimum rating of MERV 10 (50% - 55% efficient with a maximum particle size of 3.0 micron).

Ventilation shall be provided in all ground level spaces that may have occasional or full-time occupancy. This ventilation shall be such as to minimize any possibility of an accumulation of radon gas; however, shall not be less than one (1) air change per hour.

Unoccupied crawl spaces in contact with the ground, shall be ventilated likewise to eliminate radon gas hazards at a rate of one (1) air change per hour - on a time clock to run not less than four one-hour periods in each 24-hour day.

SECTION 204 - HEATING, VENTILATION, EXHAUST SYSTEMS

204.1 GENERAL
This section covers areas of the building that are primarily mechanically heated and/or ventilated only; no air conditioning to be included. Basically, ventilation rates, filtration etc., mentioned previously for HVAC systems will apply unless otherwise indicated. Special exhaust requirements are also discussed.

204.2 BAG MAKEUP AND TUG DRIVE AREA
A. Ventilation: These spaces shall be maintained under a negative pressure in relation to the main terminal (public space) area. This will be accomplished with the use of exhaust fans. The exhaust shall exceed the 100% O.A. make-up air quantities by approximately 10 percent in the bag make-up area. Ventilation rates shall be a minimum of 6 air changes per hour in the bag make-up area and 10 air changes per hour in the tug drive area, if internal combustion engines are utilized. If all electric vehicles are utilized, the air change rate may drop to 2.0 air changes per hour of makeup air.
B. Heating: The bag make-up area shall have a 100% outside air make-up unit filters and with heating coils or indirect gas-fired equipment. In addition hot water unit heaters or low intensity infrared heaters shall be strategically located throughout the area and near overhead doors to maintain space temperature. Consideration will be given to providing low intensity infrared heat in lieu of some unit heaters, depending on overhead door activity. This will be based on input from the individual airlines which will utilize this space. Consideration shall also be given to recover heat from the exhaust air stream.
C. The tug drive shall be tempered with low intensity infrared heaters placed at bag drop-off areas.

204.3 TRUCK DOCK VENTILATION
An exhaust system shall be provided to ventilate truck docks on the apron level. This exhaust system shall provide 10 air changes per hour in the truck dock area. This ventilation system will provide the added benefit of creating air movement and reducing carbon monoxide build up.
204.4 TOILET EXHAUST
The ventilation (exhaust) rate for all toilet room facilities shall be a minimum of 2.0 CFM/SF of floor space or 15 air changes per hour, whichever is the larger requirement. Toilets with extremely high traffic, such as those located in concourse areas, should have a minimum daytime exhaust rate of 2.5 CFM/SF or 19 air changes per hour, whichever is the larger requirement.

Under no circumstance shall a positively pressurized toilet exhaust duct run through a return air plenum or occupied space.

204.5 KITCHEN EXHAUST
All kitchens shall be air conditioned. The exhaust requirements shall be based on the number and size of the exhaust hoods installed within the facility. All ovens, fryers and grilles shall have dedicated exhaust hoods serving the equipment. Kitchen exhaust systems shall be designed in accordance with NFPA 96, “Standard for the Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors from Commercial Cooking Equipment.” Heat recovery from kitchen hood exhaust should be considered in the final design if grease build up or collection can be avoided. In addition, make-up air systems for large kitchens must be evaluated. Make-up air should be supplied at the kitchen hoods. Packaged, factory designed and NFPA approved kitchen exhaust hoods with make-up air systems are acceptable.

Under no circumstance shall a positively pressurized kitchen or hood exhaust duct run through a return air plenum or occupied space.

204.6 SERVICE LEVEL
A. Ventilation: Provide dampered air intakes and exhaust fans in all electrical and mechanical equipment rooms for adequate ventilation. Air intakes should be from the ramp or apron area. Compliance with applicable fire codes is essential.

B. Heating: Provide hot water or gas-fired unit heaters to heat the storage and equipment room areas where a heat loss is involved.

204.7 ATRIUM/HIGH-BAY AREAS
The atrium of the terminal building shall contain a relief air system in the high bay area which will relieve air to exterior due to pressure or temperature build up. A make-up air unit shall also serve the high bay area to provide ventilation air and pressurization when required. These systems shall also be incorporated into a smoke removal system as required by NFPA and the California Building Code for high rise structures.

204.8 DISPLACEMENT VENTILATION
Displacement ventilation (DV) is a means of providing cool supply air directly to the occupants in a space. The fresh air, supplied near the floor at a very low velocity, falls towards the floor due to gravity and spreads across the room until it comes into contact with heat sources. It is ideal for high-bay areas for cooling and ventilation only.

Diffusers shall be mounted near the floor level deliver 65°F supply air at less than 75 fpm velocity. Air flow causes a thermally stratified space and vertical air movement towards the return located high in the space.

A single air handling unit shall not be used for displacement ventilation and an overhead forced air system. They should have different supply air temperatures.

204.9 AIR INTAKE MINIMUM SEPARATION DISTANCES
Provide separation between exhaust outlet and outside air intakes. Minimum separation distances in Table 204.9.

<table>
<thead>
<tr>
<th>Exhaust Discharge</th>
<th>Distances to Nearest Outside Air Intake*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aircraft Jet Engine Exhaust</td>
<td>25</td>
</tr>
<tr>
<td>Cooling Tower</td>
<td>20</td>
</tr>
<tr>
<td>Fan Exhaust</td>
<td>15</td>
</tr>
<tr>
<td>Plumbing Vents</td>
<td>15</td>
</tr>
<tr>
<td>Kitchen Exhaust</td>
<td>25</td>
</tr>
<tr>
<td>Generator Stack</td>
<td>25</td>
</tr>
</tbody>
</table>

*Minimum separation between exhaust and outside air intake in feet.
SECTION 205 - EQUIPMENT IDENTIFICATION

205.1 GENERAL
All major air handling equipment shall have a unique equipment designation. Engineer shall obtain designation from the SFIA Mechanical Engineer (or the SFIA Mechanical Maintenance group).

SECTION 206 - PC AIR SYSTEMS

206.1 GENERAL
All gates shall be furnished with a stand-alone, DX PC Air unit. When replacement units are installed that are of larger capacity than the original, a hydronic and load analysis shall be performed by the Engineer to verify piping, pumping and chiller capacity. Design calculations and report shall be submitted to the SFIA Mechanical Engineer.

SECTION 207 - EQUIPMENT SUPPORTS

207.1 DESIGN
All equipment supports shall be manufactured systems or designed and detailed by a Professional Engineer licensed in the State of California. Supports shall be coordinated with Architectural and Structural disciplines. Under no circumstances shall the Construction Documents direct a Contractor to provide supports without detailed performance specifications outlining criteria and requirements of supports and their design and installation.

SECTION 208 - ENERGY SOLUTIONS & SYSTEM ALTERNATIVES

208.1 MECHANICAL SYSTEM ALTERNATIVES
As part of the Net Zero Energy program objectives, HVAC system and control alternatives must be evaluated against baseline systems. Such alternative systems shall include but is not limited to the following:

1. Slab hydronic heating and cooling systems
2. Stack natural ventilation and cooling systems
4. Local heat pump systems
5. Heat pump systems with geothermal condenser systems
6. Heat Recovery chillers and tank system storage systems
7. Chilled Beam systems
8. Radiant and convection heating
9. Ventilation alternatives for air quality control
10. Passive systems
11. Non-distributed systems
12. Heat recovery systems
13. Advanced control, technology, and sequencing systems

These systems are only examples of alternatives that should be evaluated as part of the Net Zero Energy program objectives. Coordinate with all disciplines in collaboration to determine the best value using Predictive Energy Modelling.
SECTION 301 - AIR DISTRIBUTION SYSTEMS

301.1 DUCTWORK DESIGN
Ductwork layout and sizing shall be done using the best practices to ensure minimum energy loss by thermal transfer and friction. Ductwork shall generally be designed for low pressure, i.e., 2.0 in. w.g or less. In no instance shall the pressure exceed 4.0 in. w.g. All medium pressure ductwork shall be sized based on the static regain method. All low pressure ductwork shall be sized using either the static regain method or the equal friction method. Existing main ductwork upstream of VAV boxes is considered medium pressure. All ductwork systems shall be designed to minimize noise transmission through the ductwork and avoid noise generation from components or fittings.

Ductwork air velocities shall not exceed the following limits:

A. Mains (equipment rooms and non-occupied spaces) 3000 fpm
B. Mains (occupied spaces) 2000 fpm
C. Branch (or mains w/diffuser connection) 1200 fpm
D. Branch with diffusers 1000 fpm
E. Aspect ratios shall not exceed 4:1 for mains.

Exceptions shall be submitted for review. Allowances can be acceptable depending on the design options and cost impact.

301.2 DUCTWORK REQUIREMENTS
Ductwork shall be either rectangular or round (spiral) as appropriate for the specific application. All designs shall be in accordance with SMACNA "HVAC Duct Construction Standards" and the technical criteria in this manual. All supply air distribution ductwork shall be galvanized sheet metal with flanges, seams, supports, etc., to match the appropriate duct classification as defined by SMACNA unless moisture in the system dictates the use of aluminum or stainless steel materials. Kitchen exhaust ductwork shall be welded stainless steel. Ductwork shall be designed in classification and maximum air velocities for all accordance with ASHRAE: Handbook of Fundamentals, ductwork. Duct Design Chapter, and constructed in accordance with the ASHRAE: HVAC Systems and Equipment Handbook, Ductwork construction shall be tested for leakage prior Duct Construction Chapter, and the SMACNA Design to installation.

Ductwork Classification - Static Pressure Air Velocity Duct Class:

- 250 Pa (1.0 in W.G.) < 10 m/s DN < (2000 FPM DN) Low Pressure
- 500 Pa (2.0 in W.G) < 10 m/s DN < (2000 FPM DN) Low Pressure
- 750 Pa (3.0 in W.G.) < 12.5 m/s DN < (2500 FPM DN) Medium Pressure
- 1000 Pa (+4.0 in W.G.) < 10 m/s DN > (2000 FPM UP) Medium Pressure

Although SMACNA allows spin-in fitting for medium pressure ductwork, the fact they are difficult to differentiate in field inspections from low pressure fitting, spin-in fittings are not allowed at SFIA. Spin-in fittings shall not be represented on plans or sketch for medium pressure systems. Spin-in fittings are allowed on low pressure systems.

All branch take-offs shall be with a 45 degree boot or tap.

Exposed ductwork used as an architectural feature shall be round and constructed of sufficient gage metal to prevent dings or dents. Ductwork material shall be either aluminum finish or suitable for painting. No external insulation shall be provided on architecturally exposed ductwork. Lined ductwork shall be used in exposed areas when radiated sound level exceeds that required.

All 90 degree elbows in both medium and low pressure ductwork shall contain double-walled, air foil type turning vanes, unless long radius elbows are used. Ductwork near air-handling units and outside air ductwork will be lined, as required for thermal performance, noise control and condensation control. The Design Consultant shall designate the calculated duct static pressure on the drawings to establish duct construction classification.
Flexible round duct shall be a maximum of 7 feet in length and be of a material acceptable by the San Francisco Building Code. Elbow into diffusers with flex is acceptable with a long radius turn. Crimping the flex duct at the elbow or under obstructions is prohibited. Aluminum flex duct is prohibited.

301.3 DAMPERS
All volume control dampers shall be opposed-blade type and isolation/shut-off dampers shall be parallel blade type. Outside air intake dampers shall have air-tight seals at both the edges and ends of the blades. The seals shall be of a material that will not disintegrate with exposure to jet exhaust fumes.

Control dampers shall be provided on all main branch take-offs and on the main ductwork downstream of a branch take-off.

All fire dampers shall be U.L. listed and conform to the standards and requirements of the California Building Code. Fire dampers shall be located at all fire zone penetrations and will have access doors provided for service and maintenance.

All combination fire-smoke dampers (FSD) shall be U.L. listed and conform to the standards and requirements of the California Building Code. Fire-smoke dampers shall be located were required by code and have access doors provided for service and maintenance. FSD shall feedback to building Fire Alarm System.

301.4 DIFFUSERS
Various types of diffusers are to be considered based on architectural input. Consideration shall be given to quality, durability, capacity, aesthetics, throw and noise level. Coordinate with the architect all diffuser types and locations. Linear slot diffusers shall be individual, 4-foot maximum sections with individual supply boots. Perforated face diffusers are not to be used.

Sidewall and perimeter diffusers shall be selected based on quality, durability, aesthetics, capacity, throw and noise level. Coordinate with architect all diffusers types and locations. Continuous linear slot diffusers shall be individual 4 (four) foot maximum sections with an individual supply boot. NC levels at the diffuser and at the neck connection should be consistent with design sound levels in rooms.

301.5 GRILLES
Standard core 1/2" x 1/2" x 1/2" eggcrate grilles shall be used in return air plenums/systems. Eggcrate grilles shall have a minimum free area of 90%. Perforated face, louvered-face or other face types shall not be used in return air systems in smoke control areas.

301.6 TRANSFER AIR
Transfer air openings are required in all walls to structure in return air plenums and smoke control zones. Transfer air openings shall be sized for a maximum velocity of 200 fpm in smoke zones and 500 fpm in return air plenums that are not used for smoke control. Sizing shall accommodate the entire return air/smoke control system to the point of installation.

301.7 VAV TERMINAL AIR UNITS
Designer shall ensure all components of VAV terminals are completely accessible for maintenance and no additional HVAC or Tenant equipment is required to be removed from operation in order to complete maintenance activities. Control modules shall have a minimum twenty-four (24) inches of clear space to allow for maintenance activities.

301.8 SECURITY GRATES
Security grates shall be installed on all ductwork and transfer air openings larger than 144 square inches between public spaces and private spaces. All roof penetrations larger than 144 square inches with a direct path of access to indoors shall be required to have a security gate.
CHAPTER 4
HYDRONIC SYSTEMS

SECTION 401 – OVERVIEW

401.1 EXISTING CAMPUS HEATING/COOLING SYSTEMS OPERATION
Chilled water and heating hot water for the HVAC systems in the Terminal buildings are supplied from the Central Plant.

SECTION 402 – EQUIPMENT

402.1 CHILLED WATER SYSTEM
The chilled water system shall be configured with multiple water circulation loops. The primary loop is the “chiller loop”, which uses chiller pumps in parallel and header to circulate water through the chillers which are piped in parallel.

The second circulation loop shall be a variable flow system. The secondary loop distributes the chilled water from the primary “chiller” loop to the terminal buildings. Pumps in parallel supply the distribution piping with chilled water. The pumps shall be staged on and off based on chilled water demand.

Variable chilled water flow is provided in response to signals from differential pressure controllers in the secondary loop circuit. The controllers shall cycle the secondary loop pumps to maintain sufficient pressure differences between the secondary supply and return mains to provide chilled water to the most remote tertiary sub-circuit.

The water service to the end use equipment is provided from the tertiary loop variable chilled water flow pumps which are provided at each tertiary equipment area. These systems to be equipped with differential pressure controllers and the tertiary pumps shall vary to provide adequate flow to the most remote sub-circuit.

Flow measuring devices will be required in each loop and sub-circuit.

402.2 HEATING SYSTEM
Heating in all building spaces shall be provided by high-temperature hot water from hot water generators (boilers) located in the Central Plant. The hot water system will consist of a primary “boiler” loop; a secondary high-temperature hot water distribution loop; heat exchangers and a tertiary distribution loop serving the Terminals. Hot water boiler pumps shall be equal in number to the boilers and shall circulate and maintain a constant temperature in the primary boiler loop (reset with outside temperature). The secondary loop will consist of pumps in parallel supplying a variable flow as required by demand and differential pressures. The tertiary loop pumps shall provide a variable flow sufficient to maintain a differential pressure between supply and return legs of the most remote unit on the tertiary loop.

402.3 HYDRONIC REQUIREMENTS
Chilled or Heating Water shall be sized for a maximum of 10 feet pressure drop per 100 feet of equivalent pipe for any run, but no more than an average of 4 feet pressure drop per 100 feet of equivalent pipe for the entire connected system. Circuit setters or balancing valves shall not be used for equipment isolation.

A. Hydronic design temperatures for Secondary Loops:
   1. Chilled Water Supply Temperature: 40°F
   2. Chilled Water Return Temperature: 60°F
   3. Heating Water Supply Temperature: 300°F
   4. Heating Water Return Temperature: 200°F

B. Hydronic design temperatures for Building Tertiary Loops:
   1. Chilled Water Supply Temperature: 40°F
   2. Chilled Water Return Temperature: 60°F
   3. Heating Water Supply Temperature: 180°F
   4. Heating Water Return Temperature: 140°F

402.4 PIPING AND VALVES
Piping for both the central plant and the distribution systems shall be designed to minimize pressure losses and maximize energy use efficiency. Valves to be specified for equipment servicing shall be selected to minimize losses while open, and have suitable pressure drop characteristics for intended use. The piping shall be designed to allow for central plant equipment expansions.

Control valves shall be sized for the correct and appropriate Cv value at the design flow rate. All valves shall be suitable for extended service operation without extensive requirements for lubrication or servicing. Control valves shall be Flow Control Industries Delta P valves.

Tees, valves and blind flanges shall be provided to allow for additions of equipment and piping to the central plant without interruption of services. Double block and bleed valves required for high pressure systems. Piping systems shall be sized for ultimate loads. Tees, valves and blind flanges shall be provided on distribution piping systems for expansion of distribution systems; sectional valves shall be provided in the distribution piping for piping system repairs and at key locations to provide isolation and servicing of equipment. On compressed air lines, quick disconnect connections shall be installed down stream of sectional valves to enable use of portable compressors in emergencies. The piping design and materials selection shall be in accordance with ANSI/ASME Standard B31.9 Building Services and ANSI/ASME Standard B31. Power Piping.

402.5 PUMPS

Pumps shall be selected for maximum operating efficiency, (i.e., slightly to the right of maximum efficiency point on the pump curve). The motor shall exceed BHP by a minimum of 10%. The preferred operating motor speed is 3500rpm.

Single pumps to be used in throttling applications without variable speed drives shall have relatively flat performance curves and be selected for operation on the pump performance curve to the right of the point of highest efficiency. Multiple pumps for parallel operation shall have relatively steep performance curves. Multiple pumps for series operation shall have relatively flat performance curves. Pumps for variable speed drive (VSD) applications shall have relatively steep performance curves. All pumps shall be specified with suction and discharge flange taps for pressure gauge connections. Provide all VSD pumps with matching VSD compatible motors. Pumps VSD shall be mounted close to pump motor.

The final selection of pump types and the application arrangement shall be made to maximize pump efficiency without excessive initial pump costs. All pumps that are selected for both current and future needs will be sized for the future requirements, where practical, and equipped with the necessary accessories. The lower initial performance requirement will be met by balancing valves or by the use of a trimmed impeller to provide energy efficient operation in start-up performance.

Standby pumps and accessories shall be provided for both heating and cooling systems. Pumps shall be arranged in a parallel configuration and header so as to maximize pumping flexibility.

Generally: Vertical turbine pumps shall be used for pumping cooling tower water. Hydronic water applications shall use end suction pumps for flow rates below 500 GPM. Horizontal split-case, double suction pumps shall be used for flow rates above 500 GPM.

Vertical split case, double suction pumps will be allowed for use with flow rates above 500 GPM, only in existing rooms when adequate space for horizontal arrangements does not exist.

Mount pumps to housekeeping pad with seismic isolation. Pump installation shall include inlet isolation valve, outlet isolation valve, suction diffusers, triple-duty valves with inlet strainer, inlet pressure gauge, outlet isolation gauge and temperature gauges. Double block and bleed valves required for high pressure systems. All valves shall be accessible and gauges shall be readable.

402.6 MOTORS

Electric motors shall conform to NEMA Standards. All 3-phase motors shall be high efficiency type. Motors shall not be selected for operation in the service factor range.

The minimum system installed power factor shall be 90% with a goal to attain a 95% system power factor. Motors larger than 15hp shall have power factor correction.

Motors shall be specified to be provided with adequate thermal protection, integral or external control and branch circuit protection, and starters suitable for use with the motors. Motor and starter types shall be selected to minimize voltage
fluctuations and current surges. Motors and starters shall be provided with auxiliary contacts for control and operation interface with the central Energy Management Control (EMC) system and any other control functions included.

402.7 WATER TREATMENT
Chemical treatment systems shall be provided at the Central Plant for the protection of the chilled water, condenser water and hot water systems from scale, corrosion, biological growths and suspended solids.

Any system connecting shall not have glycol or separate chemical treatment system. Any chilled water, condenser water and/or hot water systems not connected to the Central Plant hydronic distribution system shall have a chemical treatment system.

SECTION 403 - DESIGN CRITERIA

403.1 GENERAL REQUIREMENTS
The hydronic systems design shall be based upon the criteria following:

A. Piping shall be designed in accordance with the technical criteria in Section IV of this manual. Water pipe sizing shall be based on the stricter of the two following parameters:

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>Max. Velocity (fps)</th>
<th>Max. Pressure Drop** (ft per 100ft pipe)</th>
<th>Materials</th>
<th>Fittings</th>
<th>Isolation Valve</th>
</tr>
</thead>
<tbody>
<tr>
<td>½&quot; thru 2&quot;</td>
<td>4</td>
<td>8.5</td>
<td>Type K Copper</td>
<td>Soldered</td>
<td>3-Piece Ball Valve</td>
</tr>
<tr>
<td>2½&quot; thru 4&quot;</td>
<td>6</td>
<td>4.5</td>
<td>Type K Copper</td>
<td>Soldered</td>
<td>3-Piece Ball Valve</td>
</tr>
<tr>
<td>6&quot; thru 12&quot;</td>
<td>8.5</td>
<td>2.5</td>
<td>Sch 40 Steel</td>
<td>Welded/Flanged****</td>
<td>Lug Butterfly Valve</td>
</tr>
<tr>
<td>14&quot; thru 20&quot;</td>
<td>10.5 (14)***</td>
<td>2.5</td>
<td>Sch 40 Steel</td>
<td>Welded/Flanged****</td>
<td>Lug Butterfly Valve</td>
</tr>
<tr>
<td>24&quot; thru 42&quot;</td>
<td>11 (14)***</td>
<td>1.5</td>
<td>Sch 40 Steel</td>
<td>Welded/Flanged****</td>
<td>Lug Butterfly Valve</td>
</tr>
</tbody>
</table>

* Minimum ½" for coil connection only. Provide ¾" minimum for branch lines.
** Based on new, clean steel pipe
*** Number in parenthesis is velocity limit applicable to long straight runs where noise is not critical (such as pipe tunnels, etc.). Maximum pressure drop still applies.
**** Mechanical coupling is an option for CHW only in mechanical rooms.

B. Due to availability issues and relative cost, 5-inch piping and valves shall not be used.
C. Pressure drops in piping systems shall be calculated to allow for aging and corrosion of the interior surface. Therefore, all water piping systems shall be designed with the following friction factors ("C" values) based on the Hazen Williams Friction Factor formula.

<table>
<thead>
<tr>
<th>System Type</th>
<th>&quot;C&quot; Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Closed Water Systems</td>
<td>120</td>
</tr>
<tr>
<td>Closed, Treated Water Systems</td>
<td>130</td>
</tr>
<tr>
<td>Open Water Systems</td>
<td>100</td>
</tr>
<tr>
<td>(New clean steel pipe)</td>
<td>(140)</td>
</tr>
</tbody>
</table>

D. Hot and chilled water distribution systems should be designed for variable volume flow.
E. Hydronic systems should be designed for widest practical delta T and the closest possible approach of the return water temperature to the terminal equipment supply air temperature.
F. The terminal equipment must be selected not only for its full load capacity, but also for its performance over the full range of partial loads. Laminar fluid flow in the coils shall be avoided.
G. Integral face and bypass coils should be utilized with preheat coils.
H. The impact of the change in volume due to thermal expansion of the distribution system fluids during all operations must be addressed in the design process. Show anchorage points, pipe guides, flex joints and expansion loops.
I. Control valves in hydronic systems must not be oversized. The flow characteristics and pressure drops are to be selected for the appropriate Cv value corresponding to the design flow to be controlled.
J. Provide automatic air vents at all coils and at the high points of all piping. Provide drains at the low points of all piping. Vents shall be accessible and well-marked.
K. Provide isolation shut off valves at all equipment and branch lines. Double block and bleed valves required for high pressure systems. All isolation valves shall be accessible.
L. Hydronic systems controls shall be automatic and adjustable to optimize pumping and thermal efficiency.
1. When close control is essential, do not use three-way valves either for output control in constant-volume-flow systems or for blending control in any variable-volume-flow systems, since their characteristics are of the linear type. Provide equal-percentage valves.
2. When using three-way valves for throttling, avoid pressure under one port being significantly higher than under the other.
3. Use mixing three-way valves with caution for flow diversion or diverting valves for mixing since the valves have tendencies to slam shut at reduced flows.
4. Use two-way valves at terminal coils in variable flow systems.
5. Hot water coil valves shall fail to the open position.

403.2 EXPANSION REQUIREMENTS
In modular buildings that are designed for to be expanded as the Airport capacity increases (such as Concourses and the Terminal) all hydronic systems shall be sized for the maximum build out of the facility. Piping flow diagrams shall indicate all calculated flow rates of all general spaces anticipated for future construction.

403.3 CHILLED WATER SYSTEM
The chilled water system is configured with multiple water circulation loops. The primary loop is the "chiller loop", which uses chiller pumps in parallel and header to circulate water through the chillers which are piped in parallel.

The pumps are connected in parallel on suction and discharge headers with a 1-to-1 ratio of chiller pumps to coolers. Pumps provide a constant flow to each chiller.

The secondary circulation loop shall be a variable flow system. The secondary loop distributes the chilled water from the primary loop to the secondary loop which loops through the terminals and concourses. Pumps in parallel supply the distribution piping with chilled water. The pumps shall be staged on and off based on chilled water demand (based on differential pressure).

Variable chilled water flow in the secondary loop is provided in response to signal/signals from differential pressure controllers in the secondary loop circuit. The controllers shall cycle the secondary pumps to maintain sufficient pressure differences between the secondary supply and return mains.

The tertiary circulation loop shall be a variable flow system. The tertiary loop distributes the chilled water from the secondary loop to the terminal building, concourses and areas to be served with Central Plant cooling. Tertiary pumps are located in terminal mechanical rooms. Pumps in parallel supply the distribution piping with chilled water. The pumps shall be staged on and off based on chilled water demand.

Variable chilled water flow in the tertiary loop is provided in response to signal/signals from differential pressure controllers in the tertiary loop circuit. The controllers shall control the tertiary loop pumps to maintain sufficient pressure differences between the tertiary supply and return mains to provide chilled water to the most remote sub-circuit.

Flow measuring devices will be required in each loop and sub-circuit. For each new tertiary loop provide a BTU meter with data logging.

403.4 HEATING SYSTEM
Heating in all building spaces shall be provided by high-temperature hot water from boilers located in the Central Plant. The hot water system will consist of a boiler loop; a secondary high-temperature hot water distribution system loop and heat exchanger with tertiary distribution loop serving the terminal units. Hot water boiler pumps are equal in number to the boilers and circulate and maintain a constant temperature in the boiler loop. The secondary loop consists of pumps in parallel supplying a variable flow, as required by demand and differential pressures, to the secondary loop.

The water service to the end use equipment is provided from the tertiary loop variable hot water flow pumps which are provided at each tertiary equipment area. These pumps are to be controlled to maintain supply water temperature in the tertiary loop, with these systems to be equipped with differential pressure controllers to insure adequate flow to the most remote sub-circuit. Provide one stand-by pump for each loop system. Tertiary loops reduce the hot water temperature to 180/140 degrees F (supply/return) through heat exchangers.
Flow measuring devices will be required in each loop and sub-circuit. For each new tertiary loop provide a BTU meter with data logging.
SECTION 501 – GENERAL

501.1 GENERAL
A complete system of automatic controls shall be provided to maintain space conditions within allowable limits. When heating and cooling is incorporated in one system for personnel comfort, the automatic temperature controls shall not be capable of simultaneous heating and cooling and shall provide a "dead band."

The system shall consist of all necessary control devices, control valves, control dampers, damper motors, electric switches, relays, gages, panel boards, and fittings, including all necessary accessories required for a complete and operative control system. All control wiring and control system electric power is to be furnished to provide a complete of environmental control and central panel functions.

Control systems shall be electronic, digital systems controlling all HVAC equipment utilizing local microprocessor control panels located in the applicable adjacent equipment rooms. The field panels shall be capable of interfacing with central (EMCS) equipment provided by a different vendor.

The local field panels shall be tied to the master Energy Management Control System (EMCS) server, but capable of stand-alone operation.

501.2 EMCS LEVELS AND ARCHITECTURE
EMCS shall be Direct Digital Control (DDC) based system for providing lower operating costs and ease of operation. The BAS (Building Automation System) shall adjust building systems to optimize their performance and the performance with other systems in order to minimize overall power and fuel consumption of the facility.

BAS shall utilize ‘open’ communication protocols, such as BACnet, to minimize the costs of providing integration and to allow interoperability between building systems and control vendors. A/E to specify and include functional design manual, hardware manual, software manual, operation & maintenance manual, and as-built drawings with sequence of operations. BAS shall have energy management and monitoring software.

EMCS Architecture shall include standalone zone or terminal controls with local control panel (LCP) for centralize HVAC equipment. Building level controls (BLC) shall integrate all LCP in the building, Boarding Area, and Terminal. The all new projects shall provide full communication with the EMCS system. Projects must provide fiber, server, address, graphics, and programming to integrate new HVAC control systems with the existing EMCS system.

501.3 INTEGRATION:
All BLC systems shall be capable for standalone operation at the local level. And all BLC systems shall be coordinated and provided with full integration, control, communication, monitoring, and connectivity to the front end SFIA EMCS. Design and coordination shall be indicated in drawings and in control architectural diagrams. Details of IT network connections and server addresses must be specified with communication fiber routing as part of the BLC system design. Front end EMCS graphic upgrades and additions must be included as part of every new BLC. For all integration work, drawings and/or specifications shall clearly state responsibility of each contractor as follows:

Controls System 'A' will be the lead system for this integration. Controls System 'B' will need to be compatible with the protocol used by Controls System 'A'. Manufacturer of Controls System 'B' will be responsible for ensuring this compatibility.”

501.4 ENHANCED COMMISSIONING
Enhanced Commissioning is mandatory on all LEED projects. The intent of Enhanced Commissioning is to further support the design, construction, and eventual operation of a project that meets the owner’s project requirements for energy, water, indoor environmental quality, and durability.
As part of Enhanced Commissioning the following activities must be completed for mechanical, electrical, plumbing, and renewable energy systems and assemblies in accordance with the latest revisions of ASHRAE Guidelines for HVAC&R systems, as they relate to energy, water, indoor environmental quality, and durability.

A. Develop/Review Owner’s Project Requirements (OPR), Basis of Design (BOD), and project design.
B. Develop/Implement a Commissioning (Cx) Plan.
C. Confirm incorporation of Cx requirements into the construction documents.
D. Develop construction checklists.
E. Develop a system test procedure and verify system test execution.
F. Maintain an issues and benefits log throughout the Cx process.
G. Prepare a final Cx process report.
H. Review contractor submittals.
I. Verify systems manual updates and delivery.
J. Review building operations 10 months after substantial completion.
K. Develop an on-going commissioning plan.
L. Front End EMCS control and integration

501.5 MEASUREMENT AND VERIFICATION
Measurement and Verification (M&V) is mandatory on all LEED projects. The intent of M&V is to provide for the ongoing accountability of building energy consumption over time.

Develop and implement a Measurement and Verification (M&V) plan consistent with the International Performance Measurement & Verification Protocol (IPMVP). The M&V period must cover at least 1 year of post-construction occupancy. Provide a process for corrective action if the results of the M&V plan indicate that energy savings are not being achieved.

SECTION 502 - ENERGY MANAGEMENT CONTROL SYSTEM (EMCS)

502.1 ENERGY MANAGEMENT CONTROL SYSTEM (EMCS)
New EMCS systems shall be a direct digital controls system. New EMCS shall be open-communication protocol BACNET and be manufactured by commercial manufacturer. Each new control loop shall be a standalone system designed to be programmed and operated from a building PLC work station. All mechanical rooms will be equipped with local equipment level PLCs. All zone level controls shall be standalone loops and designed to communicate back to the equipment level PLCs.

Building PLCs shall communicate information, control functions, alarms, and monitoring data back to the Front End. EMCS Architecture and IT servicer interface must be integrated as part of the renovation or new building project. Cable, conduit, fiber, and switch, IT server, and address shall be provided as part of the new project. It is the responsibility of the of the new building or renovation project to provide the communication and integration back to the EMCS server. All work shall be provided such that new EMCS shall be monitored, controls, alarmed, and programmable from the master workstation. Provide all front end programming, graphics, and hardware to suit the new EMCS installed as part of the building renovation or new building design. For all integration work, drawings and/or specifications shall clearly state responsibility of each contractor as follows:

"Controls System ‘A’ will be the lead system for this integration. Controls System ‘B’ will need to be compatible with the protocol used by Control System ‘A’. Manufacturer of Control System ‘B’ will be responsible for ensuring this compatibility."

Additional requirements for the EMCS are detailed below in the following subsections.

502.2 EMCS NAMING STANDARD
All points within the EMCS shall comply with SFO Naming Convention. SFO Engineer shall provide the most current SFO Naming Convention to the Contractor. If Naming Convention for a system does not exist, Contractor shall provide a submittal of all points to SFO Engineering for review and approval prior to starting construction. Comply with latest SFO Information Infrastructure Management (IIM) standards.

502.3 EMCS GRAPHICS
Comply with latest Energy Management Control System (EMCS) specification.
502.4 SOFTWARE
The EMCS and all equipment under its control must follow ASHRAE Guideline 36P High Performance Sequence of Operation for HVAC Systems. The Design Consultant shall review the current stage in the development of universal protocol and make every practical effort to incorporate this into the temperature control automation system.

The software shall have, but are not limited to, the following capabilities:
A. Run Time
B. Optimum Start/Stop
C. Economizer Controls
D. Time of Day Scheduling
E. Chilled Water Outdoor Air Reset
F. Hot Water Outdoor Air Reset
G. Variable Condenser, Hot, and Chilled Water Pumping
H. Night Set Back
I. Status
J. Change of Status
K. Smoke Venting and Control
L. Ambient High/Low Alarms
M. Energy Totalizing
N. Electrical System Monitoring
O. Maintenance and Alarm Reports
P. Heating/Cooling Mode

502.5 TREND LOGGING AND GRAPHING
Trend logs and graphing capability shall be provided.

502.6 ALARM PRINTOUTS
All alarms shall be on the display monitor, providing information on the type of alarm, time and date of occurrence. Change of state alarms are to be programmed to be disabled or enabled at the option of the operator.

502.7 SYSTEM ACCESS CONTROL
Provide access control (passwords) for system operation.

502.8 REPORT CAPABILITY
The software shall be capable of being user programmed to generate custom user designed reports.

Basic Report Printouts required are as follows:
A. Alarm Summary
B. Run Time Summary
C. Maintenance Reports
D. Energy Usage Reports
E. Utility Consumption Reports

502.9 Automated Fault Detection and Diagnostics (AFDD)
The EMCS software and sequence of operations shall comply with all Automatic Fault Detection and Diagnostics (AFDD) requirements in ASHRAE Guideline 36P High Performance Sequence of Operations for HVAC Systems. The AFDD system must detect faults based on sensor inputs, as well as suggest likely cause(s) based on fault condition. The AFDD logic must send direct errors from the EMCS Front End to SFO Main Saver work order system for maintenance, troubleshooting and/or calibration.

SECTION 503 – CONTROL COMPONENTS

503.1 THERMOSTATS
Zone thermostats mounted in public areas shall be sensors only with controllers. Zone thermostats in private areas shall be programmable.
503.2 CARBON MONOXIDE AND NITROGEN DIOXIDE SENSORS
Carbon monoxide and nitrogen dioxide sensors shall be provided in the service drive or wherever internal combustion engine traffic is utilized in an enclosed space. Sensors shall increase air flow and/or alarm out-of-tolerance conditions.
CHAPTER 6
SPACE REQUIREMENTS AND MAINTAINABILITY

SECTION 601 – GENERAL

601.1 GENERAL
Mechanical equipment and layout shall be selected to maximize equipment performance; and minimize equipment servicing, repair and maintenance. Equipment selection shall also consider durability, reliability, maintainability and serviceability. Equipment arrangement and layout shall allow for safe and efficient accessibility for equipment removal, replacement, repair and maintenance. Provide sufficient service corridors, pathways, fall protection, and door access to deliver replacement equipment and parts.

During the design phase, coordination with other design disciplines is essential to provide for the necessary access to equipment. All otherwise inaccessible equipment and equipment components shall be provided with OSHA approved catwalks, platforms, or etc. to allow maintenance. The catwalks, platforms, and adequate lighting, etc. shall provide for maximum safety to both personnel and equipment while allowing access for equipment maintenance. Standardization of equipment and materials shall be used to the maximum extent possible. Standardization and interchangeability will minimize the space and expense of the maintenance spare parts inventories. Items for consideration for standardization shall include, but not be limited to: Air handling units and components, terminal units, control components, heat exchangers, pumps, valves, and fans.

SECTION 602 - DESIGN REQUIREMENTS

602.1 DESIGN
The design shall, in general, include equipment layouts with maintenance and repair clearances indicated. Special maintenance items or equipment, or necessary auxiliary equipment shall be specified to be provided and installed with the equipment it is to serve. Avoid locating equipment requiring frequent service or repair above ceilings or in occupied spaces. Hydronic systems and associated gauges check valves, and shutoff valves all need to be design for ease of access, inspection, and maintenance. Air side systems and components should also be designed and configured for ease of access inspection, and maintenance.

602.2 EQUIPMENT SELECTION
Equipment shall be selected for stable operation at both full and part-load conditions. Equipment selections shall be below maximum limits for capacity, speed, temperature and pressure. The equipment installation design and specification shall include sufficient instrumentation for measuring, indicating, monitoring, operating and servicing at full and part loads.

602.3 BEARINGS
Use permanently lubricated bearings on fans, if available. Equipment which cannot be furnished with permanently lubricated bearings shall have lubrication lines extended to the exterior of the unit.

602.4 CONSTRUCTION REQUIREMENTS
Require the contractor to include in the shop drawing submittals manufacturers recommended spare parts lists, maintenance and service clearances, special maintenance equipment or requirements and recommended maintenance schedules. Conflicts between equipment and maintenance requirements or clearances shall be submitted, along with contractors’ solutions to the conflicts, for approval. Approval of conflict resolution shall be required before equipment installation.

Require the contractor to revise all flow diagrams, control diagrams and additional information to reflect any revisions to designed systems and/or required performance capabilities to suit the actual equipment installed. Require the contractor to provide instruction for operating personnel on the operation, attendance and maintenance of equipment. Include all data necessary to establish an efficient and effective preventive maintenance program.

602.5 FAN HOUSING
All supply fan housings shall have ladder rungs mounted on the side of each unit next to the coil pipe connections to provide access to the top of each unit without stepping on insulated pipes.
602.6 ACCESS DOORS
All air handling units shall be equipped with access doors for each compartment (coils, filter, fan, etc.), with piano hinges, door handles, and a viewing window in each compartment access door. The doors should be sturdy enough to permit opening the door using one handle.

Provide in accessible locations access doors of adequate size at all fire damper locations for the purpose of inspection as well as for replacing fusible links.

For combination fire-smoke dampers (FSD) provide ceiling access doors and duct access doors. Access doors shall be properly located and size for adequate access to the FSDs. Duct access doors shall be properly labeled.

Labeling and service access shall be provided for all controllers and duct sensors.

SECTION 603 - SPACE REQUIREMENTS

603.1 MECHANICAL ROOMS
Mechanical room space requirements and dimensions shall be coordinated with the architect so that appropriate space is provided for the equipment and its service and maintenance.

603.2 MECHANICAL CHASES
Mechanical chase space requirements shall also be determined and coordinated, including space for supply and return air ductwork, outside ventilation air, exhaust air, hot and chilled water piping, domestic water piping, sanitary drainage, and roof drains, etc. All chases with plumbing equipment shall have a minimum one floor drain.

603.3 EQUIPMENT CLEARANCE
Provide a minimum of four feet (clear space) around all sides of boilers and chillers, plus tube pull space. Provide three feet (clearance space) around all sides of pumps, and air handling equipment. These are minimum design requirements, if manufacturers recommendations exceed these values, Design Consultant shall comply with the more stringent requirement.

All rooftop equipment shall be serviceable through existing roof access.

Drawings shall show minimum clearances for service and access to equipment.

603.4 CONVEYOR RIGHT OF WAY
In certain areas baggage conveyors will be routed through ceiling plenums. The space requirement for these conveyors will be approximately 4 feet deep by 4 feet wide per conveyor, plus the additional space needed for personnel cat walks (preferable 4 feet wide). Therefore, all ductwork must be routed to avoid conveyors and structural members. Physical space may prohibit ductwork crossing baggage conveyors. Careful coordination is required.

Design Consultant shall coordinate with all systems and disciplines throughout the design process to insure adequate space is available and to avoid interferences.
CHAPTER 7
PLUMBING REQUIREMENTS

SECTION 701 - PLUMBING SYSTEMS

701.1 GENERAL
This section applies to the systems used to receive, transport or discharge liquid waste or sewage; the systems used to receive and distribute potable water; the systems used to receive and distribute fuel gas; the systems used for the collection and transport of rain water and cooling coil condensate drains, etc.

701.2 DESIGN SUBMITTAL REQUIREMENTS
A. Provide enlarged detailed plumbing plans for restroom and concession areas.
B. Provide pipe elevations including invert elevations and slopes on all drainage piping.
C. Reference related civil utility drawings for continuation of piping connecting to drainage stub-outs connecting to site utility mains.
D. Provide a pipe size and drainage fixture unit table, calculation, and piping diagrams indicating pipe sizes and drainage fixture unit loading for the sanitary soil, waste and vent system(s).
E. Provide existing system load analysis to validate tie-in connections and existing system capacity to support new work and new loads.
F. Provide piping diagrams indicating pipe sizes and water supply fixture unit loading for the domestic cold water, domestic hot water and recycled water systems.
G. Provide natural gas piping diagram showing pipe sizes, developed lengths of pipe lengths and gas loads in (BTUH/CFH) for each equipment connection, pipe main and branch lines. Diagram to include all meters, gas valves, regulators, gas vent pipes and related equipment.
H. All data such as ultimate water and gas service demand, sanitary and storm analysis report shall be submitted for review.

701.3 SYSTEM REQUIREMENTS
A. Facilities for the physically handicapped shall be provided in all public building restrooms.
B. Provision shall be made within the terminal building and each of the concourses for future expansion of the plumbing systems at such time that the complex is expanded to meet increased usage.
C. Buildings, in the Terminals and Concourse areas, shall be provided with roof drains and a drainage collection system. The roof drainage system shall be connected to the exterior storm sewer system. Overflow roof drain system shall be piped separately and terminated at grade level.
D. An industrial waste sewer shall be provided for all liquid wastes that would be detrimental to the public sewer system or detrimental to the operation of a sewage treatment plant. Industrial waste shall be collected, treated and disposed of as required by the authority having jurisdiction.
E. Reclaim water system shall be provide for all new restroom facilities.
F. Plumbing systems are defined to be within the building up to 5 feet from the building perimeter. All systems beyond this point shall comply with utilities design guides and specifications.

SECTION 702 - PLUMBING DESIGN PARAMETERS

702.1 GENERAL
All plumbing systems shall conform to the requirements of the codes and standards.

702.2 FIXTURE COUNT
To determine the minimum number of fixtures required for the terminal and concourse areas a plumbing fixture count method shall be used. The plumbing fixture method is a method of adjusting the numbers of people on which the number of fixtures are determined in setting the design for the plumbing facilities. After the numbers of people are appropriately adjusted, the fixture per persons for the type of building or occupancy from the uniform plumbing code shall be used for determining the minimum plumbing facilities.

The plumbing fixture method typically allows for additional fixtures for peak loads not adequately accounted for by the codes. The basis for the plumbing fixture count method is based on historical airport experience and the following criteria:
SFIA Mechanical Design Standards

A. Projected Peak Occupancy (per area).
B. Thirty-three percent of passengers and 15 percent of visitors will use concourse facilities. (Departures and arrivals levels.)
C. Fifteen percent of visitors and fifteen percent of passengers will use terminal building facilities.
D. The percentage of men and women of total occupancy is estimated at 50 percent male/50 percent female.
E. Each level and area shall be sub-divided into terminal public space, restaurant, office and retail to determine fixture count for each particular occupancy.
F. Urinals shall be utilized in lieu of water closets in men’s toilets to the maximum ratio allowed by code.

Fixture counts and/or flow rates shall be shown on all isometric drawings.

702.3 CALCULATIONS
Design calculations shall be based on ASPE Data Book (Chapter 8) and the California Plumbing Code, latest edition. Recognized acceptable engineering practices shall be applied for areas where design criteria have not been established specifically by these codes and standards.

Several areas of the Terminal and Concourses experience dramatic pressure fluctuations. The engineer shall make every effort to ensure that new designs do not amplify current conditions. In these areas, static and dynamic pressure calculations shall be performed and submitted.

No assumptions shall be made on plumbing system capacities. All connections to existing plumbing systems shall have capacity calculations proving capacity. The design consultant shall submit all calculations directly to the SFIA Mechanical Engineer in PDF format.

702.4 TERMINAL
The terminal building plumbing facilities shall be designed for optimum passenger use and the total future terminal size to prevent under-sizing of initial terminal building plumbing facilities.

702.5 CONCOURSES
The plumbing facilities in the concourses shall be designed for the current initial passenger use. Expansion in concourse passenger service will be in conjunction with concourse construction expansions. Those expansions will include the necessary additional plumbing facilities. Plumbing utility systems (pipe sizes and arrangement) shall be designed to allow for future facilities expansion.

702.6 SAND TRAPS
Sand or dirt from plumbing fixtures or floor drains shall be connected and disposed of by means of sand traps prior to flow entering Airport system. Design capacity and accessibility shall be subject to SFIA approval.

702.7 INDUSTRIAL WASTE
Industrial waste sewer shall be provided for areas where fueling of aircraft and vehicles take place.

702.8 GREASE AND OIL SEPARATORS
Grease, fats and oils in waste water from kitchen sinks, dishwashers, floor drains or other fixtures, shall be collected and intercepted with grease or oil separator prior to entering Airport sanitary sewer system.

Location of grease or oil separator shall be such that hot grease, fats or oils, shall have adequate time to cool and separate out before waste water enters Airport system. Separators shall be easily accessible for proper cleaning.

702.9 FLOOR DRAINS
Buildings shall be provided with floor drains that have traps and cleanouts. The location and types of all cleanouts shall be noted on the drawing. All drains exiting the building shall have a double cleanout so that the drain line may be cleaned into and out of the building.

Mechanical rooms shall contain general area floor drains and equipment drains for condensate and other miscellaneous drainage. Equipment drains shall not serve dual duty.
All floor drains in chases, basement areas, restrooms, mechanical rooms and entry vestibules shall have trap primers.

702.10 BACKFLOW PREVENTION
The potable water supply system shall be designed, installed and maintained in such a manner as to prevent the contamination from non-potable liquids, solids or gases being introduced into the potable water system through cross-connections or any other connections to the system. Protective measures and the requirement for backflow prevention devices shall meet or exceed the requirements of the California Plumbing Code, San Francisco Building Code Amendments and the requirements of water utility. If there is any conflict between these requirements the most stringent requirement shall apply in the design and/or modification to the existing potable water system. Should existing systems be found that do not comply with the latest backflow prevention requirements, the design will include upgrading the backflow prevention of that system being renovated, added to and/or constructed. All domestic water connections to mechanical, plumbing and fire protection systems, including lawn sprinkling systems, shall be protected from backflow by use of backflow preventers installed in the piping. Plumbing designs shall meet best management practices for cross connection control.

702.11 COORDINATION
It is the responsibility of the plumbing engineer/designer to provide design, specification and detail of all plumbing connections to systems outside of the building (IE: water, storm drainage, sanitary sewer, natural gas, etc). The interface point shall note elevations (building reference and civil reference), sizes and acceptable means of connection of differing materials and allowable tolerances of connection. "See Civil" notes shall not be used to solely identify this connection.

SECTION 703 – PLUMBING SYSTEMS

703.1 STORM DRAINAGE SYSTEM
A. Storm Drainage piping system shall consist of roof drains, overflow drains, area drains, and storm sewer building mains and branch lines for roof drains/overflow drains discharging into a gravity drainage piping system, settlement joints, and connection to the existing pipes and site sewer mains.
B. Horizontal storm drain and overflow drain lines including roof drain bowl shall be wrapped with ½” thick fiberglass insulation to prevent condensation. Exception, pipes located above the vehicle service roads.
C. Storm water pipe sizing shall be per the California Plumbing Code with the rainfall intensity based on a 1.6 inches per hour rainfall intensity.
D. A minimum slope of one-eighth (1/8”) inch per foot or 1% for gravity storm drainage shall be used.
E. Due to ground settlement, all underground storm drain piping shall be supported from the underside of the floor slab and or the vertical faces of the pile caps using Type 316 stainless steel hangers.

703.2 SANITARY SOIL WASTE AND VENT SYSTEM
A. Sanitary sewer system shall consist of sanitary soil, waste and vent connections to plumbing fixtures with gravity drainage piping system for the plumbing fixtures, stub-outs for future tenants including connections to existing pipes, pipe settlement joints, pipe supports, seismic bracings, and connections to site sewer.
B. Underground piping shall be wrapped with 8 mil polyethylene tube encasement in accordance with AWWA C105.
C. A minimum slope of one-fourth (1/4”) inch per foot or 2% for gravity sanitary sewer lines shall be used where possible.
D. Due to ground settlement, all underground soil, waste and vent piping shall be supported from the underside of the floor slab using Type 316 stainless steel hangers, supports and anchors.

703.3 GREASE WASTE SYSTEM
A. Provide 4 inch grease waste line stub-outs for food concession tenants located below the footprint of each food concession space. Provide grease waste piping from the stub-out to the location of future above ground grease interceptor. Provide 4 inch sanitary waste and 4 inch vent stub-outs for future grease interceptor installation.
B. Provide grease interceptor for the Airside Loading Dock floor drains including H20 rated manholes. Grease interceptor shall be supported from the floor slab with type 316 stainless steel supports.
C. Due to ground settlement, all underground grease waste drain piping shall be supported from the underside of the floor slab and/or the vertical faces of the pile caps using Type 316 stainless steel hangers, supports and anchors.
Underground piping shall be wrapped with 8 mil polyethylene tube encasement in accordance with AWWA C105.
703.4 **DOMESTIC COLD WATER SYSTEM**

A. Water Pressure: The available water pressure is in the range of 120-125 psi. Domestic water system pressure shall be limited to 65 PSI through an existing pressure reducing station on the existing incoming cold water main. Existing pressure reducing station to remain as is.

B. Water flow velocity: To avoid any erosion, corrosion and excessive noise generation, the domestic cold water piping shall be sized for a maximum flow velocity of 4 feet per second (FPS) for pipes two inches and smaller, and 6 feet per second (FPS) for larger pipes.

C. System Sizing and Estimated Loads: The domestic water main shall be sized to accommodate the water loads serving fixtures with potable water connections. Plumbing fixtures requiring potable water connections are sinks, lavatories, janitor sinks, hose bibbs, trap primers, drinking fountains and bottle fillers, water heaters, and emergency showers/eyewashes, passenger boarding bridges’ cabinets, and concession plumbing fixtures/equipment. Refer to paragraph for recycled water system. Allowances shall be provided in the domestic water main pipe sizing to accommodate for mechanical make-up water, concession areas and jet bridges.

D. Plumbing fixtures to include sinks, lavatories, drinking fountains and bottle fillers. Refer to paragraph for recycled water system. Allowance shall be provided in the domestic water main pipe sizing to accommodate for mechanical make-up water, concession areas and jet bridges.

1. Toilet Rooms, Janitor Closets, Drinking Fountains and Break Rooms: Allowance shall be provided in the domestic water main pipe sizing to accommodate for public toilet rooms, janitor closets, break rooms, drinking fountains and bottle fillers.

2. Concession Areas: Allowance shall be provided to accommodate future concession areas. Domestic cold water for each future concession tenant shall be metered.

3. Jet Bridges: Allowance shall be provided to accommodate a water supply for jet bridges. Each jet bridge shall be provided with a 1½” cold water supply line, water meter, combination emergency shower/eyewash, and a 1” water line with a backflow preventer for the water cabinet.

4. Mechanical make-up water: Allowance shall be provided to accommodate mechanical make-up water supply for chilled water and heating hot water systems.

5. Provide isolation valve for each battery of water closets, urinals, lavatories; each group of fixtures and for each isolated fixture. Valves shall be located in the plumbing chase and in accessible locations. Provide access panel where required.

E. Smart domestic water meters shall be connected to EMCS. Meters shall record in units of one hundred cubic feet (hcf).

F. Per SFO Mechanical Engineering, installation of water meters are “Owner-provided and Contractor-installed”. SFO Mechanical Engineering will procure water meter hardware from SFPUC. After procurement, the Contractor shall provide all additional material and labor to install the SFO provided water meter, including but not limited to, communication, power and integration into the EMCS. All Contractor supplied materials and labor shall be submitted and approved by SFO Mechanical Engineering prior to procurement and construction.

703.5 **DOMESTIC HOT WATER SYSTEM**

A. General: Domestic hot water for the restrooms, janitor sinks and break room sink shall be provided by an electric water heater located in a janitor room adjacent to the restrooms. Plumbing fixtures shall be supplied with hot water from a pumped re-circulating hot water supply line.

B. Domestic hot water supply and return lines shall be insulated in accordance with Title 24.

C. Temperature: Hot water shall be produced and stored at a minimum of 140°F to prevent the growth of Leginollia. The hot water shall be tempered down to 120°F by use of an ASSE 1017 thermostatic mixing valve installed adjacent to the water heater. Hot water distribution shall be provided with a re-circulating line and pump to provide on-demand hot water to the lavatory faucets. Circulating lines shall be piped close to the hot water supply line to the lavatories, maximum distance shall be 2'-0" from the angle supply stops. Provide balancing valve for each circulating loop.

D. Lavatories: Water supply to lavatories shall be supplied with tepid water. Plumbing code required point of use ASSE 1070 thermostatic mixing valve shall be used to temper the water. Specified faucet is furnished with an ASSE 1070 device.

E. Flow velocity: To avoid any erosion, corrosion and excessive noise generation, the domestic hot water piping system shall be sized for a maximum flow velocity of 4 feet per second (FPS) for pipes two inches and smaller; and 5 feet per second (FPS) for larger pipes. 5 FPS is the code maximum per CPC.
703.6 RECLAIM WATER SYSTEM
A. General: A recycled water piping system shall be provided for flushing of water closets, and urinals. Currently there is no on-site recycled water supply but a recycled water system will be provided by SFO in the future. The recycled water piping system shall be temporarily connected to the existing domestic water main downstream of the existing water meter assemblies. A reduced pressure backflow preventer shall be provided at the point of connection to the domestic water system to prevent a cross connection between the recycled water system and the domestic water system.
B. Recycled water signage, pipe identification and valve identification tags shall be provided in accordance with the CPC.
C. System Sizing and Estimated Loads: The recycled water main shall be sized to accommodate the water closet and urinal fixture loads.
D. Flow velocity: To avoid any erosion, corrosion and excessive noise generation, the recycled water piping system shall be sized for a maximum flow velocity of 4 feet per second (FPS) for pipes two inches and smaller; and 6 feet per second (FPS) for larger pipes.

703.7 CONDENSATE DRAINAGE SYSTEM
A. Mechanical AC Units: Condensate drain lines from Mechanical AC units to approved indirect waste receptors such as floor sinks or funnel drains shall be provided. Condensate drain lines shall be wrapped with ½" thick insulation to prevent condensation.
B. Provide pumped condensate drainage system and 1 inch stub-outs for each Passenger Boarding Bridges including condensate lines terminated at floor sinks.

SECTION 704 - PLUMBING SYSTEM COMPONENTS
704.1 GENERAL
A. It has not been determined how many water services or meters will be provided, however, it is preferred that the terminal building complex should be provided with one central water meter, with the main water entrance located at the terminal building with branch services to each of the concourses. Remote buildings may have separate meters.
B. Electric (instantaneous type or small storage tank) domestic water heaters shall be provided at each toilet room. Larger requirements for domestic hot water such as restaurants, etc., shall have gas-fired or steam hot-water heaters. No central hot water system shall be provided in the terminal building complex or in the concourses.
C. Exterior grease traps and grease separators shall be provided for fixtures in kitchen and food service concessions areas as these facilities may require.
D. All water supply to fixtures shall be protected by an approved vacuum breaker.
E. A detailed area chart/plan shall be prominently displayed in the main equipment rooms showing the locations of all main piping and valves.

704.2 PLUMBING FIXTURE AND EQUIPMENT
A. Plumbing fixtures shall be commercial grade and water conservation type. Vitreous china fixtures, flushometer valves, lavatory sensor faucets and soap dispensing system shall be TOTO, or equal. High efficiency low consumption plumbing fixtures shall be provided for the restrooms. Lavatory and break room sink faucets and electric water coolers shall conform to lead free law and water efficiency standards. ADA compliant fixtures shall be provided at accessible locations.
B. An accessible plumbing chase shall be provided for maintenance access to the plumbing behind a battery of water closets, urinals and lavatories. A minimum inside clearance of 36” on single side and 48” on back to back assemblies shall be provided and an access door shall be provided to enter the chase.
C. Water-closets shall be high-efficiency 1.28 gallons per flush water closets shall be provided. Fixture shall be wall mounted white vitreous china commercial grade type water closets with white elongated open front seats with concealed sensor operated (hydropower self-generating) piston type flushometers.
D. Urinals shall be high-efficiency 0.125 gallon per flush urinals. Fixture shall be wall mounted white vitreous china commercial grade type with concealed sensor operated (hydropower self-generating) piston type flushometers.
E. Urinals shall connect directly downstream of water closet sanitary sewer main for allowance of future low flow fixtures.
F. Lavatories shall be white vitreous china under counter mounted commercial grade type. Wall mounted at single toilet rooms. Lavatory faucets shall be chrome plated sensor operated (hydropower self-generating) metering faucets. Maximum discharge of 0.09 gallons per 10 second cycle. Grid drains shall be provided for and p-trap and water supplies shall be wrapped with preformed insulation. Locate lavatory sensor faucet controller in the plumbing chase directly behind each lavatory.
G. All lavatory faucets in public and private toilet rooms shall be provided with flow restricting devices on all outlets. Provide single tempered water faucet at lavatories with 105°F supply temperature.

H. All lavatories (including physically handicapped) can be wall hung or counter mounted. Wheelchair access must be provided for handicapped fixtures. A minimum 29” clear knee space is required with maximum 34” rim height or as defined by the latest version of the ADA.

I. Janitor mop sinks shall be 24” x 24” x 12” high floor mounted square terrazzo type with stainless steel caps on all sides. Faucet shall be a wall mounted service sink faucet with vacuum breaker spout with pail hook and wall brace.

J. Electric water coolers with bottle filler (hydration stations) shall be provided and located adjacent public/staff toilet rooms and as indicated on architectural floor plans. ADA compliant height units shall be provided.

K. Break room sinks shall be a under counter mounted single compartment sink, type 304 stainless steel with satin finish. Sink shall be furnished with a single lever faucet and a ¾ HP food waste disposal. Flow on sink faucet shall be limited to 1.5 gpm.

L. Emergency safety fixtures shall be provided as follows:
   1. Janitor Closets: Provide emergency eyewash/drench hose unit in each janitor closet.
   2. Jet Bridges: Provide emergency safety station. Combination emergency shower with eye/face wash at each jet bridge for ground personal use.

M. Floor drains with a trap priming device shall be provided for the following areas:
   1. Toilet rooms containing two or more water closets or a combination of one water closet and one urinal.
   2. Janitor rooms.
   3. Mechanical rooms.
   4. Loading docks.
   5. Trash rooms.
   6. Other areas as needed.

N. Stop valves shall be provided on all fixtures including water coolers.

O. All fixture types shall be located in the design documents and called out on the contract drawings.

P. Roof vents (DMV) shall be of 3-inch diameter minimum.

Q. Drains from service and slop sinks shall be minimum of 3-inch diameter.

R. Minimum potable water line size shall be 3/4-inch except for branch to fixture which may be 1/2-inch.

S. Provide a floor drain below all non-carpeted interior vestibule areas. (Drain shall be located below steel mat.)

T. A minimum of one hose bibb shall be located in each mechanical and pump room for general wash down.

U. All sump pumps must have a remote alarm, strobe/light, and sign in a nearby occupied area.

704.2 PIPING

Refer to the specifications for pipe material types. PVC shall not be used inside the building without written permission of the SFIA Mechanical Engineer and BICE Inspector. All sanitary sewer piping shall slope at no less than ¼” per linear foot for allowance of future low flow fixtures.

704.3 EXPANSION SETTLEMENT JOINTS

A. Expansion settlement joints for incoming and outgoing underground building utility mains shall be provided. Flexible connections shall be provided to accommodate a minimum of twelve inches (12”) of differential settlement and accompanying lateral movement for pipes entering or leaving the building and at other transition conditions where differential settlement may occur.

B. Expansion settlement joints shall be wrapped with 8 mil polyethylene tube encasement in accordance with AWWA C105. All necessary supports, hangers and anchors shall be Type 316 stainless steel.

SECTION 705 - ENERGY CONSERVATION IN PLUMBING SYSTEMS DESIGN

705.1 HOT WATER

Hot water for domestic water use shall be designed in accordance with ASHRAE 90.1 and OSHA requirements. ASHRAE 90.1 establishes minimum requirements for hot water generator recovery efficiency, storage tank insulation, pipe insulation, temperature controls, pump operation, equipment automatic shutdown and conservation of hot water.

705.2 TEMPERATURE

The domestic hot water system shall be designed for a supply temperature of 120°F for circulated systems and 140°F for storage systems per OSHA requirements. For the public spaces provide lavatories with 105°F water at each point of use.
705.3 SAFETY DEVICES
Safety devices shall be provided on the hot water generators and storage devices. Safety devices shall be as required by code and as a minimum shall include energy cut-off devices, relief valve and/or temperature or combination temperature and pressure relief valves. All water heaters, regardless of size, shall have an expansion tank on the domestic cold water inlet.

SECTION 706 - NATURAL GAS

706.1 SIZING
Gas piping shall be sized per the requirements of the California Plumbing Code.
  A. Gas specific gravity: 0.65
  B. Gas thermal capacity: 834 BTU per 1,000 cubic feet

706.2 METERING
Smart metering for all buildings shall be connected to EMCS.

706.3 GAS SYSTEMS PROTECTION
Architect and Engineer of Record for design of facilities shall design protective measures for all gas piping systems at SFIA. Protective measures shall be coordinated with the utility company so that all gas systems above ground level are provided for the entire gas system, including upstream and downstream piping from the meter.

All gas piping, meters, pressure regulators, appurtenances and systems shall be fully protected from possible collisions with vehicles, baggage cart tugs, support equipment, etc. To the greatest extent possible, gas systems shall be located away from areas where it is possible for vehicles and/or equipment to strike it directly and/or indirectly through adjacent walls that offer inadequate protection from such vehicle strikes. In addition, gas systems shall be protected from grade level to ceiling as strikes can occur at nearly all elevations that are not either protected and/or concealed in ceilings.

As part of the Net Zero Energy program, all efforts shall be made to avoid and eliminate the use of natural gas in all new facilities. Optional sources of heating shall be assessed and reviewed to comply with Net Zero Energy and Carbon Neutrality objectives.
CHAPTER 8
ENERGY ANALYSIS

SECTION 801 - GENERAL
There are many factors unique to the airport terminal and other airport buildings that enter into the design of an energy efficient facility. These factors include architectural, mechanical and electrical considerations -- all interrelated. The process of Energy Analysis shall comply with the guideline outlined in the Net Zero Energy program. Collaborative, iterative, and comprehensive approach must be utilized to capture an optimized balance of energy efficiency, lifecycle cost analysis, and sustainability objectives.

The San Francisco International Airport terminal, concourses and other buildings shall include design features that emphasize energy conservation. Some of these features have been outlined earlier but will be summarized in this section for emphasis.

Buildings in excess of 5,000 square feet shall have a computer energy model performed to establish energy consumption. Energy budgets shall be established and shall meet the requirements of ASHRAE 90.1. This standard allows tradeoffs between mechanical and electrical systems and the building envelope. These tradeoffs shall supersede specific requirements presented in following discussion. See Section 102 for Predictive Energy Modeling and Section 208 for HVAC System Alternatives.

801.1 CODES AND STANDARDS
All Energy Conservation Analyses shall meet the requirements of:
A. California Building Code
B. California Energy Code
C. California Green Building Code (CalGreen)
D. San Francisco Green Building Code
E. San Francisco Energy Code
F. California Title 24
G. ASHRAE 90.1
H. ASHRAE Guideline 36P High Performance Sequence of Operation for HVAC Systems
I. Net Zero Energy Standard

Where the requirements of this chapter or the Codes and Standards themselves deviate from one another, the more stringent of the two shall apply.

801.2 LEADERSHIP IN ENERGY & ENVIRONMENTAL DESIGN (LEED)
The Consultant shall review the current LEED Rating System and develop design strategies for maximizing the project’s energy efficiency. Following the LEED Rating System, the Consultant and The City shall determine which level of LEED Green Building Certification is achievable for the project. At a minimum all new construction projects and tenant improvement projects over 5,000 SF must be LEED Gold. Following this decision, the Consultant shall tailor the design documents to achieve this certification. The LEED Rating System document can be obtained at the following website: http://www.usgbc.org

Consult the San Francisco Green Building Code for mandatory LEED credits that must be achieved in addition to the prerequisites.

SECTION 802 – ENERGY & ATMOSPHERE

802.1 OPTIMIZE ENERGY PERFORMANCE
Reduce the environmental and economic harms of excessive energy use by achieving energy efficiency for the building and its systems. Analyze efficiency measures during the design process and account for the results in design decision making. Project potential energy savings and holistic project cost implications related to all affected systems.

Complete a whole-building energy simulation that demonstrates an improvement of 20% for new construction, 15% for major renovations, or 15% for core and shell projects in the proposed building performance rating compared with the baseline building performance rating. Calculate the baseline building performance according to ASHRAE Standard 90.1. Such analysis shall include all on-site building energy use, including exterior and security lighting, elevators, all process loads, and receptacle loads.
802.2 ADVANCED ENERGY METERING

Install energy meters on all whole-building energy sources used by the building. Install individual energy end uses that represent 10% or more of the total annual consumption of the building.

Meters must be permanently installed, record at intervals of 15 minutes, and transmit data to a remote location. Either the meters or the data collection system must be capable of reporting hourly, daily, monthly, and annual energy use. The system must be capable of storing all meter data for at least 36 months. The data must be remotely accessible and interface with the EMCS. Device names and data point names must follow SFO naming convention standard.

Metered information must transmit data using open-protocol programming and communication such as BACnet or SFO-approved equal. Mechanical equipment must transmit data into EMCS. Natural Gas meters must transmit data into EMCS. Domestic Water meters must transmit data into EMCS. All electrical equipment must transmit data into the SFO Electric Shop Schneider Electric Power Monitoring Expert (PME) server. All metered data must eventually transmit data into ITT Data Lake and Message Bus.

Access to each utility’s data management system must be available remotely via mobile phones, computers, and tablets for monitoring, reporting, and alarming. All meters shall be tested, calibrated and commissioned. Provide all meters with isolation valves for servicing or replacement.

Mechanical energy consumption must be recorded using BTU meters at the following locations:
  A. Each chiller
  B. Main chiller loop supplying the terminals
  C. Chilled water usage at each pump room
  D. Each boiler
  E. Main boiler loop supplying the terminals
  F. Heating hot water usage at each pump room

Electricity meters must record both consumption and demand. Whole-building electricity meters should record the power factor, if appropriate. Disaggregation of loads should be separated into the following categories:
  A. Each tenant (for billing). Refer to SFO Electric Metering Shop Requirements for more details
  B. All circuits under 100 Amps inside power distribution panels shall be measured and tracked with Branch Circuit Power Meters (BCPMs)
  C. HVAC (VFDs, fans, pumps, and all other major mechanical equipment)
  D. Plumbing loads
  E. Interior Lighting
  F. Exterior Lighting
  G. Plug loads
  H. 400 Hz (airplane charging system)
  I. Pre-Conditioned Air (PCA) system
  J. Photovoltaic (PV) solar renewable energy
  K. Baggage handling system
  L. People-moving equipment (elevators, escalators, and other associated equipment)
  M. Other renewable energy sources
  N. Security systems
  O. Communications
  P. Fire & Life Safety
  Q. Electrical equipment

Electrical metering shall be provided and installed by Electrical subcontractor. Meters shall be integrated into SFO Electric Metering Shop’s Schneider Electric Power Monitoring Expert (PME) Server. Refer to SFO Electric Metering Shop Requirements for more details.

Natural Gas meters must record consumption for each tenant (if applicable) and each central plant boiler.
Domestic water meters must record consumption at each gate and tenant. Additionally, consumption must be recorded at the main pipe feeding each boarding area and walkway between boarding areas. See Section 804.2 for additional metering requirements.

The data collection system must use a local area network, building automation system, wireless network, or comparable communication infrastructure. The system must be capable of storing all meter data for at least 36 months. The data must be remotely accessible and interface with the EMCS.

802.3 ENHANCED COMMISSIONING & MONITOR BASED COMMISSIONING
Enhanced Commissioning and Monitor Based Commissioning are mandatory on all LEED projects. The intent of Enhanced Commissioning is to further support the design, construction, and eventual operation of a project that meets the owner’s project requirements for energy, water, indoor environmental quality, and durability.

As part of Enhanced Commissioning the following activities must be completed for mechanical, electrical, plumbing, and renewable energy systems and assemblies in accordance with the latest revisions of ASHRAE Guidelines for HVAC&R systems, as they relate to energy, water, indoor environmental quality, and durability.

A. Develop/Review Owner’s Project Requirements (OPR), Basis of Design (BOD), and project design.
B. Develop/Implement a Commissioning (Cx) Plan.
C. Confirm incorporation of Cx requirements into the construction documents.
D. Develop construction checklists.
E. Develop a system test procedure and verify system test execution.
F. Maintain an issues and benefits log throughout the Cx process.
G. Prepare a final Cx process report.
H. Review contractor submittals.
I. Verify systems manual updates and delivery.
J. Verify operator and occupant training delivery and effectiveness.
K. Verify seasonal training.
L. Review building operations 10 months after substantial completion.
M. Develop an on-going commissioning plan.

Monitoring Based Commissioning involves developing procedures and identifying points to be measured and evaluated to assess performance of energy and water consuming systems. Include the procedures and measurement points in the commissioning plan. Address the following:

A. Establish roles and responsibilities.
B. Establish measurement requirements (meters, points, metering systems, data access).
C. Develop list of points to be tracked, with frequency and duration for trend monitoring.
D. Set the limits of acceptable values for tracked points and metered values (where appropriate, predictive algorithms may be used to compare ideal values with actual values).
E. Establish the elements used to evaluate performance, including conflict between systems, out-of-sequence operation of systems components, and energy and water usage profiles.
F. Develop an action plan for identifying and correcting operational errors and deficiencies.
G. Provide training on how to prevent and address errors.
H. Develop plan for preventative maintenance needed to maintain performance.
I. Set the frequency of analyses in the first year of occupancy (at least quarterly).

802.4 RENEWABLE ENERGY
The LEED Project Administrator shall confer with SFIA on renewable energy opportunities for municipal construction projects, including photovoltaics, solar hot water and wind power. Space allocation and infrastructure for future renewable energy installations shall be included in municipal construction projects, as advised by SFIA, including but not limited to structural capacity, wiring conduits, supply and return piping, and control wiring. The LEED Project Administrator shall submit documentation verifying that either:

A. At least 1 percent of the building’s energy costs are offset by on-site renewable energy generation, achieving LEED credit EA 2, including any combination of: photovoltaic, solar thermal, wind, biofuel-based electrical systems, geothermal heating, geothermal electric, wave, tidal, or low impact hydroelectric systems, or as specified in Section 25741 of the California Public Resources Code; or,
B. In addition to meeting LEED prerequisite EA 1 Energy Performance requirement, achieve an additional 10 percent compliance margin over Title 24, Part 6, California Energy Standards, for a total compliance margin of at least 25 percent.

SECTION 803 – INDOOR AIR QUALITY

803.1 MINIMUM INDOOR AIR QUALITY (IAQ) PERFORMANCE
Contribute to the comfort and well-being of building occupants by establishing minimum standards for indoor air quality (IAQ). For mechanically ventilated spaces, meet the minimum outdoor air intake flow for mechanical ventilation systems using the ventilation rate procedure from ASHRAE 62.1 or a local equivalent, whichever is more stringent.

For variable air volume systems, provide a direct outdoor airflow measurement device capable of measuring the minimum outdoor air intake flow. This device must measure the minimum outdoor air intake flow with an accuracy of +/-10% of the design minimum outdoor airflow rate, as defined by the ventilation requirements above. An alarm must indicate when the outdoor airflow value varies by 15% or more from the outdoor airflow set point.

803.2 THERMAL COMFORT (DESIGN)
Provide occupants with quality thermal comfort to increase productivity, comfort, and well-being. Meet the requirements for both thermal comfort design and thermal comfort control.

Design the heating, ventilating, and air-conditioning (HVAC) systems and the building envelope to meet the requirements of ASHRAE Standard 55 – Thermal Comfort Conditions for Human Occupancy.

Provisional thermal comfort controls for at least 50% of individual occupant spaces. Provide group thermal comfort controls for all shared multi-occupant spaces, and for any individual occupant spaces without individual controls.

Thermal comfort controls allow occupants, whether in individual spaces or shared multi-occupant spaces, to adjust at least one of the following in their local environment: air temperature, radiant temperature, air speed, and humidity.

803.3 CONTROLLABILITY OF SYSTEMS (THERMAL COMFORT)
Provide individual thermal comfort controls for at least 50% of individual occupant spaces. Provide group thermal comfort controls for all shared multi-occupant spaces, and for any individual occupant spaces without individual controls.

Thermal comfort controls allow occupants, whether in individual spaces or shared multi-occupant spaces, to adjust at least one of the following in their local environment: air temperature, radiant temperature, air speed, and humidity.

SECTION 804 – WATER EFFICIENCY

804.1 INDOOR WATER USE REDUCTION
For the fixtures and fittings listed in Table 804.1, as applicable to the project scope, reduce aggregate water consumption by a minimum of 30% from the baseline. The baseline water consumption for fixtures and fittings are shown in Table 804.1.

<table>
<thead>
<tr>
<th>Commercial Fixtures, Fittings &amp; Appliances</th>
<th>Current Baseline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Closets (Toilets)</td>
<td>1.6 gallons per flush (gpf)</td>
</tr>
<tr>
<td>Urinals</td>
<td>1.0 gallons per flush (gpf)</td>
</tr>
<tr>
<td>Public Lavatory Faucets</td>
<td>0.5 gallons per minute (gpm)</td>
</tr>
<tr>
<td>Private Lavatory Faucets</td>
<td>2.2 gallons per minute (gpm)</td>
</tr>
<tr>
<td>Kitchen Faucets</td>
<td>2.2 gallons per minute (gpm)</td>
</tr>
<tr>
<td>Showerhead</td>
<td>2.5 gallons per minute (gpm)</td>
</tr>
</tbody>
</table>

All newly installed toilets, urinals, private lavatory faucets, and showerheads that are eligible for labeling must be WaterSense labeled (or a local equivalent for projects outside the U.S.).

804.2 WATER METERING
Track water consumption in an effort to manage water usage and identify opportunities for additional water savings.

Install permanent water meters for the following water subsystems, as applicable to the project:
A. Meter domestic water systems serving at least 80% of the indoor fixtures and fitting included in the indoor water use reduction, either directly or by deducting all other measured water use from the measured total water consumption of the building and grounds.

B. Meter domestic hot water use of at least 80% of the installed domestic hot water heating capacity, including both tanks and on-demand heaters.

C. Meter reclaimed water, regardless of rate. A reclaimed water system with a makeup water connection must also be metered so that the true reclaimed water component can be determined.

D. Tie into EMCS (Energy Management & Control System).
APPENDIX B – MASTER LIST OF MANUFACTURERS

This section provides the Master List of Manufacturers approved for Plumbing by SFO organized by section and subsection.

22 05 50 – BASIC PLUMBING MATERIALS AND METHODS

SUPPORTS AND ANCHORS
1. B-Line.
2. Grinnell.
4. Or approved equal.

SEISMIC RESTRAINTS
1. B-Line.
2. Grinnell.
4. Superstrut.
5. Mason.
6. Or approved equal.

22 07 00 – PLUMBING INSULATION
1. Schuller.
2. Owens-Corning.
5. Certainteed
7. Or approved equal.

22 11 13 – PLUMBING EQUIPMENT

DOMESTIC WATER HEATER – ELECTRIC (STORAGE TYPE)
1. A.O. Smith.
3. Lochinvar.
4. RECO.
5. Or approved equal.

DOMESTIC WATER HEATER – ELECTRIC (POINT-OF-USE TYPE)
1. Eemax.
2. Chronomite.
4. In-Sink-Erator.
5. Or approved equal.

RELIEF VALVES
1. Watts.
2. Kunkle.
5. Or approved equal.

EXPANSION TANK
1. Amtrol AST.
2. Adamson.
3. RECO.
5. Or approved equal.

WATER METER
1. Hersey Products Inc #MHD.
2. Niagara.
3. Rockwell.
4. Or approved equal.

22 21 13 – PLUMBING PIPING, VALVES, AND SPECIALTIES

1. Algoma Hardwoods, Inc.
2. Or approved equal.

NATURAL GAS & PIPE FITTINGS (ABOVE GRADE)

A. Fittings and joints
1. Gastite (corrugated stainless steel, mechanical tube fittings manufactured from ASTM B16 type 360 brass, design must incorporate a double wall flare for gas-tight seal with Jacket Lock, mechanical capture of the jacket for enhanced tubing protection.
2. Or approved equal.

B. Trap Primer Piping
1. Scotch Wrap #51.
2. PASCO Wrap, with 50% overlap.
3. Or approved equal.

C. Domestic Hot Water and Cold Water and Reclaimed Water Pipe & Fittings (Above Grade)
1. Viega/Ridgid.
2. Or approved equal.

D. Reclaimed Cold Water Pipe & Fittings (Above Grade)
1. Viega/Ridgid.
2. Or approved equal.

E. Reclaimed Cold Water Pipe & Fittings (Above Grade)
1. Viega/Ridgid.
2. Or approved equal.

F. Sanitary Sewer, Vent, Rainwater Pipe & Fittings:
1. Pipe:
  a. Tyler.
  b. AB&I.
  c. Charlotte Pipe and Foundry.
  d. Or approved equal.
2. Couplings Below Grade: Heavy Duty Type 304 stainless steel couplings conforming to FM 1680 with neoprene sealing sleeve conforming to ASTM C-1540 having minimum shield thickness of 28 gauge. Only the following:
   a. Husky SD-4000.
   b. Clamp All 125.
   c. Or approved equal.

3. Couplings Above Grade: Type 304 stainless steel couplings conforming to ASTMC C-1540, minimum thickness of 34 gauge.
   a. Anaco.
   b. Ideal.
   c. Or approved equal.

4. Couplings Above Grade: Band type stainless steel couplings conforming to ASTM C-1540 having a minimum thickness of 31 gauge with neoprene sealing sleeve conforming to ASTM C-564. Only the following –
   b. Clamp All 80.
   c. Or approved equal.

G. Sanitary Sewer, Vent, Rainwater Pipe & Fittings – Alternative
1. Pipe:
   b. Or approved equal.

2. Fittings:
   a. Must all be a single manufacturer.

H. Vent Piping (Above Grade) (Contractor’s Option)
1. Fittings
2. Elkhart
3. Or approved equal.

VALVES
A. Gate, Ball, Check or Butterfly:
   1. Apollo.
   2. Hammond.
   5. Victaulic.
   7. Or approved equal.

B. Lubricated Plug Valves:
   1. Homestead.
   2. Resun.
   3. Rockwell.
   4. Or approved equal.

C. Backflow Preventors:
   1. Apollo.
   2. Ames.
3. Febco.
4. Cla-Val.
5. Watts.
6. Wilkins.
7. Or approved equal.

D. Pressure Reducing Valves:
   1. Apollo.
   2. Cash-Acme.
   3. Cla-Val.
   5. Wilkins.
   6. Or approved equal.

E. Solenoid Valves:
   1. ASCO.
   2. Automatic.
   3. Magnatrol.
   4. Or approved equal.

F. Balancing Valves:
   1. Bell & Gossett “Circuit-Setter”
   2. Wheatley (Y-globe type only)
   3. Armstrong
   4. Tour & Anderson.
   5. Or approved equal.

DOMESTIC PLUMBING SERVICE VALVES

A. Butterfly Valves:
   1. Hammon 6100 series.
   2. Or approved equal.

B. Ball Valves:
   1. Nibco 585 series.
   2. Apollo 7-200 series.
   3. Or approved equal.

C. Check Valves
   1. Watt #6015.
   2. Or approved equal.

NATURAL GAS VALVES

A. Ball Valves:
   1. Apollo 64 series.
   2. Watts #FBV-1.
   3. Or approved equal.

BACKFLOW PREVENTION VALVES

A. Reduced Pressure Zone Backflow Preventer for High Hazard Applications:
1. **2" and Smaller:**
   a. Watts #909-QT-S-HW valve with #909AG air gap fitting.
   b. Or approved equal.

2. **2-1/2" and Larger:**
   a. Watts #909-S-OSY valve with #909AG air gap fitting.
   b. Or approved equal.

B. **Double Check Valve for Low Hazard Applications:**
   1. **2" and Smaller:**
      a. Watts #007-QT-S.
      b. Or approved equal.

   2. **2-1/2" and Larger:**
      a. Watts #709-S-OSY.
      b. Or approved equal.

**PRESSURE REDUCING VALVES**

A. **Single-seated, direct-operated type:**
   1. Watts #U5.
   2. Or approved equal.

B. **Single seated, pilot operated globe valve type:**
   1. Watts 115 series.
   2. Or approved equal.

**PRESSURE RELIEF VALVES**

A. **Pressure Relief Valves:**
   1. Watts #740.
   2. Or approved equal.

B. **Temperature and Pressure Relief Valve:**
   1. Watts #100XL, 40XL, 140, N240, or 340 series.
   2. Or approved equal.

**GAS PRESSURE REGULATOR VALVES**

1. Sherwood.
2. Fisher.
3. Or approved equal.

**THERMOSTATIC MIXING VALVES:**

A. **Thermostatic valve:**
   1. Powers E480.
   2. Leonard #210 SB.
   3. Or approved equal.

B. **Master Thermostatic Assembly:**
   1. Powers 1432-RC-E-Q.
   2. Leonard type TM186-PRV-RF-LTR-STSTL.
   3. Or approved equal.
THERMOMETER AND GAUGES

A. General:
   1. Weksler.
   2. Winters.
   3. Trerice.
   4. Marshalltown.
   5. US Gauge.
   6. Or approved equal.

B. Air Vents with Valves:
   1. Hoffman #79.
   2. Dole.
   3. Or approved equal.

C. Dielectric Flanges:
   1. Watts Series 3100.
   2. Or approved equal.

D. Unions:
   1. EPCO.
   5. Or approved equal.

E. Pipe sleeves:
   1. Telescopic, submerged, adjustable sleeves:
      a. Adjust-to-Crete.
      b. AMI.
      c. Shamrock.
      d. Or approved equal.

PIPE COATING

   1. Scotch Wrap.
   2. Pasco Wrap.
   3. Or approved equal.

GAS CONNECTORS:

A. Food Service Equipment:
   1. Dormont #1675bpqs.
   2. Or approved equal.

EXPANSION COMPENSATORS:

A. Expansion Compensators:
   1. Keflex #311 series.
   2. Or approved equal.

B. Flexible Expansion Joint/Seismic Connectors for Steel Pipe:
1. Metraflex #Metraloop.
2. Or approved equal.

C. Flexible Connection for Steel Pipe:
1. Metraflex #SST.
2. Or approved equal.

D. Flexible Connection for Copper Pipe:
1. Metraflex #BBS.
2. Or approved equal.
   a. For non-critical pump connections:
      1. Garlock #206 EZ-FLO.
      2. Or approved equal.
   b. Flexible Ball Pipe Joints:
      1. Barco.
      2. Or approved equal.

E. Pipe Alignment Guides:
1. Metraflex #Style IV.
2. Or approved equal.

PIPING SYSTEM JOINTS

A. Solder copper tube and fitting joints
   1. Solder:
      a. JW Harris “Bridgit.”
      b. Englehard “Silvabrite 100.”
      c. Or approved equal.
   2. Flux:
      a. Laco “Flux-Rite 90.”
      b. MW Dunton “Nokorode CDA Flux.”
      c. Hercules “Fluid Action Solder Flux.”
      d. Or approved equal.

B. Alternative Domestic Water Piping Mechanical Press Type Connections:
   1. Viega/Ridgid.
   2. Or approved equal.

22 40 00 – PLUMBING FIXTURES AND SPECIALTIES

FIXTURES AND TRIM

A. Vitreous China Fixtures:
   2. Crane.
   3. Eljer.
   4. Toto.
   5. Kohler.
   6. Or approved equal.
B. Stainless Steel Fixtures:
   1. Elkay.
   2. Halsey Taylor.
   3. Haws.
   4. Just.
   5. Intersan.
   6. Acorn.
   8. Metcraft.
   9. Or approved equal.

C. Faucets:
   2. Kohler.
   3. Toto.
   4. Delta.
   5. Chicago.
   7. Leonard.
   9. Or approved equal.

D. Flush Valves:
   1. Sloan.
   2. Delaney.
   3. Toto.
   4. Zurn.
   5. Or approved equal.

E. E-Traps, Supplies and Stops:
   1. Brass Craft.
   2. Dearborn.
   3. Eastman.
   4. McQuire.
   5. Sanitary Dash.
   6. Teldyne Ansonia.
   7. Or approved equal.

F. Toilet Seats:
   2. Bemis.
   3. Church.
   4. Olsonite.
   5. Sperzel.
   6. Or approved equal.

G. Drains:
   1. J.R. Smith.
   4. Wade.
   5. Zurn.
   6. Or approved equal.
WATER HAMMER ARRESTORS
1. Precision Plumbing series SC.
2. Watts Series 15.
3. Sioux Chief.
4. Or approved equal.

HOSE BIBBS
1. Acorn.
2. Chicago.
3. Or approved equal.
Standards Adoption

The "Building Systems – Plumbing" Version 3.1, March 2018 standards were adopted by the Standards Committee on April 5th, 2018, and are effective immediately.

Confirmed:

Geoffrey W. Neumayr, Standards Committee Chair