

SECTION D2000TG

PLUMBING SYSTEM 07/02

1. D2000 GENERAL

This document provides technical guidance to architects and engineers performing mechanical design services for Naval Facilities Engineering Command, Southwest Division. If you have not done work for the government before, you should read this guide carefully prior to beginning work on Southwest Division projects. Military construction requirements often differ from commercial practice and this guide provides a comprehensive listing of the plumbing requirements for military projects. Direct requests for variances and/or suggestions for improvements to this document to Code 03CN.

1.1 SYSTEM DESCRIPTION

Provide plumbing systems complete and ready for operation. Plumbing systems include piping within 1 ½ meters (5 feet) outside of the building walls and may include piping beyond 1 ½ meters (5 feet) outside of the building walls up to connections to existing exterior distribution systems.

1.2 SYSTEM REQUIREMENTS

- a. Design water supply piping for a maximum velocity of 1.8 meters per second (6 feet per second).
- b. Piping under concrete slabs is prohibited. Only main building water supply at the service entrance will be permitted under floor slab at minimum length.
- c. Provide roof drains as appropriate for selected roof system type.
- d. Design plumbing systems to provide at least 172 kPa (25 PSI) to flush valve toilets. If the water pressure is not adequate, design a booster system and pump per MIL HDBK 1103/1, Plumbing Systems.
- e. Store domestic hot water at 60 degrees C (140 degrees).
- f. Provide tempering valves at the point of source (at water heater or boiler) or at the point of use (plumbing fixtures) to ensure that the maximum temperature of hot water supplied to plumbing fixtures is 49 degrees C (120 degrees F).
- g. Provide label to identify content of above ground pipes and arrows to show direction of flow. Letter size, lengths and colors shall be per ANSI A13.1.]
- h. Provide roof drains as appropriate for selected roof system type.
- i. All buildings require seismically supported equipment and piping. If the acceleration factor is such that seismic bracing is not required (or if this criteria exceeds the seismic criteria, ACOE TI-809-04) then the minimum design criteria for the equipment and pipe supports shall resist forces of 0.5 times its weight in any direction and 1.5 times the weight in the downward direction.
- j. Refrigerants shall have an Ozone Depletion Factor (ODF) of 0.05 or less. The ODF shall be in accordance with the "Montreal Protocol on Substances That Deplete the Ozone Layer", September 1987, sponsored by the United Nations Environment Program.

1.3 CRITERIA

Plumbing system design and installation shall comply with the latest edition of the following:

- a. The International Plumbing Code
- b. ASHRAE Standards and Handbooks
- c. Applicable NFPA Standards
- d. Army Corps of Engineers (ACOE) TI-809-04, Seismic Design for Buildings
- e. MIL HDBK 1003/1 Plumbing

Naval Facilities Engineering Command has officially adopted the International Plumbing Code (IPC) as the codes to be used for Naval facilities. These documents are available from International Conference of Building Officials (ICBO). They may be reached via telephone at 800-284-4406. or the Internet homepage at

<http://www.icbo.org>

MIL-HDBKS referenced in this document can be found on NAVFAC's Internet homepage at

http://www.efdlant.navfac.navy.mil/lantops_15/publications.htm

ACOE TI referenced in this document can be found on Army Corps of Engineers Internet homepage at

<http://www.hnd.usace.army.mil/techinfo/ti.htm>

Other applicable guidance and criteria. For further guidance and sources of criteria refer to the latest revision of:

- a. "Guide For Architect-Engineer Firms, Southwest Division, Naval Facilities Engineering Command."
- b. Parametric Cost Estimate (PCE) or EFD 1391 Package

Southwest Division documents and guidance can be found on the SWDIV Internet homepage at

<http://www.efdsww.navfac.navy.mil/CapitalImprovements/BusinessLineServices.htm>

1.4 COMPLIANCE VERIFICATION

Compliance with the requirements will be determined by a review of the design and construction submittals and by field inspection. See Document 00911, "Design Requirements", for submittal requirements. See Section 01330, "Submittal Procedures", for Submittal Descriptions (SD-xx) and requirements.

1.5 DESIGN SUBMITTALS

Design Analyses, Drawings and Specifications Submittal requirements shall be as described in the RFP for each individual project. See Section 00911 – "Design Requirements".

1.6 CONSTRUCTION SUBMITTALS

Construction Submittal requirements shall be as described in the RFP for each individual project. See Section 01330 – "Submittal Procedures".

1.7 CORROSION PROTECTION FOR BURIED PIPE AND FITTINGS

- a. Cast iron and ductile iron pressure pipe shall have protective coating, a cathodic protection system, and joint bonding. Protective coating shall be factory applied adhesive undercoat and continuously extruded plastic resin coating in accordance with AWWA C105. Joints and fittings shall be cleaned, coated with primer and wrapped with tape conforming to AWWA C203. Tape shall be applied with a 50 percent overlap. Primer shall be as recommended by the tape manufacturer.
- b. Steel pipe shall have protective coating and a cathodic protection system. Pipe, joints, and fittings shall be cleaned, coated with primer, and wrapped with tape. Pipe shall be cleaned, coated, and wrapped prior to pipe tightness testing. Joints and fittings shall be cleaned, coated, and wrapped after pipe tightness testing. Tape shall conform to AWWA C203 and applied with 50 percent overlap.
- c. Cathodic protection system shall be designed by a NACE Certified Cathodic Protection Engineer.

1.8 PLUMBING SYSTEMS TESTING

Upon completion of the installation test all systems per the IPC Section 312 "Testing and Inspections". Correct any deficiencies uncovered during testing of the systems. Prior to utilization disinfect new water piping and existing piping affected by work per IPC Section 610 "Disinfection of Potable Water System".

2. D2010 PLUMBING FIXTURES

2.2 D2011 WATER CLOSETS

2.2.1 Flush Valve Type Water Closets

ASME A112.19.2M, white vitreous china, siphon jet, 6 liters (1.6 gallons) per flush, white solid plastic elongated open-front seat. Provide ASME A112.19.5 trim.

2.2.2 Tank Type Water Closets

Water closets shall be ASME A112.19.2M, white vitreous china, round bowl, floor-mounted. Non-float swing type flush tank valves are not acceptable. Water closet rim height above floor shall be approximately 381 mm (15 inches). Provide white solid plastic round closed-front seat with cover. Water flushing volume shall not exceed 6 liters (1.6 gallons) per flush. Pressure assisted flushing, if specified shall be equal or similar to "G-MAX Flushing System" by TOTO. Provide ASME A112.19.5 trim. Flushing action shall be siphon jet; other types are not acceptable.

2.2.3 Handicapped Flush Valve Type/Tank Type Water Closets

Same as paragraph A or B, except mounting height to top of seat shall be 432 to 483 mm (17 to 19 inches) above finished floor and flush valve shall be mounted 292 mm (11-1/2 inches) above fixture rim to clear grab bars.

2.3 D2012 URINALS

2.3.1 Flush Valve Type Urinals

ASME A112.19.2M, white vitreous china, wall-mounted, wall outlet, siphon jet, integral trap, extended side shields. Water flushing volume of the flush valve and urinal combination shall not exceed 3.8 liters (1 gallon) per flush. Provide ASME A112.19.5 trim and ASME 112.6.1M concealed chair carriers.

2.3.2 Handicapped Flush Valve Type Urinals

ASME A112.19.2M, white vitreous china, wall-mounted, wall outlet, blowout action, integral trap, elongated projecting bowl, 508 mm (20 inches) long from wall to front of flare, and ASME A112.19.5 trim. Provide large

diaphragm (not less than 66 mm (2.625 inches) upper chamber inside diameter at the point where the diaphragm is sealed between the upper and lower chambers), nonhold-open flush valve of chrome plated cast brass conforming to ASTM B 584, including vacuum breaker and angle (control-stop) valve with back check. The water flushing volume of the flush valve and urinal combination shall not exceed 3.8 liters one gallon per flush. Furnish urinal manufacturer's certification of conformance. Provide ASME A112.6.1M concealed chair carriers. Mount urinal with front rim a maximum of 432 mm (17 inches) above floor and flush valve handle a maximum of 1118 mm (44 inches) above floor.

2.4 D2013 LAVATORIES

2.4.1 Countertop Lavatories

ASME A112.19.1M White enameled cast iron, ASME A112.19.2 white vitreous china with ASME A112.6.1M concealed arm carrier support. Provide ASME 112.18.1M copper alloy centerset faucets with aerator.

2.4.2 Handicapped Lavatories

Same as Paragraph "Countertop Lavatories" with the following exceptions: Straight back type 737 mm (29 inches) minimum clearance from bottom of the front rim to floor 864 mm (34 inches) front rim height above floor. Provide copper alloy center set faucets, gooseneck spout with aerator 125 mm (5 inches) above rim, 100 mm (4 inch) wrist action handles, and perforated grid strainers. Faucets shall open within one-quarter turn in opposite directions. Provide offset tailpiece and padding on drain components

2.5 D2014 SINKS

2.5.1 Countertop Kitchen Sinks (Single Compartment)

ASME/ANSI A112.19.3M, 20 gage stainless steel sink with integral mounting rim, minimum dimensions of 381 mm (15 inches) wide by 381 mm (15 inches) front to rear, single compartment with undersides coated with sound dampening material. Provide top-mounted ASME A112.18.1M copper alloy faucets, swing spout with aerator, and stainless steel drain outlet with cup strainer. Provide 40 mm (1-1/2 inch) adjustable P-trap with drain piping to vertical vent stack.

2.5.2 Countertop Kitchen Sinks (Double Compartment)

ASME/ANSI A112.19.3M sink, 20 gage stainless steel with integral mounting rim, minimum dimensions of 840 mm (33 inches) wide by 560 mm (22 inches) front to rear, two compartments with ledge back and undersides coated with sound dampening material. Provide top-mounted ASME A112.18.1M copper alloy faucets, swing spout with aerator, and stainless steel drain outlets with cup strainers. Provide 40 mm (1.5 inch) adjustable P-trap with drain piping to vertical vent stack. Provide UL 430 waste disposer unit in right compartment.

2.5.3 Mop Sinks

Pre-cast terrazzo floor-mounted mop sink, 914 mm x 914 mm x 305 mm (36 inches x 36 inches x 12 inches) shall be made of marble chips cast in white Portland cement to a compressive strength of not less than 25 mPa (3625 PSI) 7 days after casting. Provide brass body drains with nickel bronze strainers cast integral with terrazzo. Provide stainless steel rim guard for mop sink. Provide chrome-plated exposed hot and cold water faucets ASME A112.15.M wall-mounted copper alloy faucets swing spout with 20 mm (3/4 inch) hose connection, vacuum breaker, and pail hook. Provide mop hanger on wall above sink suitable for four mops.

2.6 D2015 BATHTUBS

2.6.1 Bathtubs

ASME A112.19.1M white enameled cast-iron, ASME A112.19.4M white porcelain enameled formed steel bathtubs, recessed type, minimum dimensions of 1524 mm wide by 762 mm front to rear by 406 mm high

(60 inches wide by 30 inches front to rear by 16 inches high) with drain outlet for above-the-floor drain installation. Provide pop-up drain fittings.

2.6.2 Bath and Shower Modules

In each module bathroom, provide a bath and shower module per ANSI Z124.2, made of white fiberglass reinforced plastic (FRP) with slip-resistant bathing surfaces and integral grab bar. Provide outlet at left or right as necessary to suit module arrangement. Provide pop-up drain fittings and 40 mm (1-1/2 inch) adjustable P-trap. Provide copper alloy pressure balance single control type mixing valves with front accessible integral screwdriver stops. Bathtub and shower supply fittings shall be diverter type with body mounted from behind the wall. Provide ASME A112.18.1M, ball joint, self-cleaning adjustable spray pattern shower heads with a maximum flow rate of 0.16 L/s (2.5 GPM). Provided tub fill over-rim spout with diverter. Anchor the pipe, shower arm, and mixing valves in the wall to prevent movement.

2.7 D2017 SHOWERS

Provide tempering valves at the point of source (water heater) or at the point of use (showers) to ensure that the maximum temperature of hot water supplied to showers is 120 degrees F (49°C) to prevent scalding.

2.7.1 Shower Supply Fittings

ASME A112.18.1M, self-cleaning shower heads with a maximum flow rate of 0.16 L/s (2.5 GPM), connected to concealed pipe connected to copper alloy pressure balance single control type mixing valves with front access integral screwdriver stops. Anchor the mixing valves and the pipe to each showerhead in wall to prevent movement.

2.7.2 Handheld Shower Head

ASSE 1014, spray hand-held shower head with swivel fitting, 1524 mm 60 inch minimum hose and in-line vacuum breaker, and bracket or holder to allow the use of the unit as either a hand-held spray or a fixed shower head. Flow shall not exceed 9.5 L/m at 549 kPa 2.5 gpm at 80 psi flow pressure.

2.7.3 Emergency Eyewash/Shower (EW/EWS)

Provide per ANSI Z358.1, column mounted on a floor flange. Design combination unit so components can be operated individually from a common fixture supply line. Provide a self-cleaning, non-clogging 254 mm (10 inch) diameter copper alloy deluge shower head with elbow, full flow stay-open ball valve with pull rod and 203 mm (8 inch) diameter ring or triangular handle one inch interconnecting fittings, with shower head 2 m (7 feet) above floor and 610 mm (2 feet) from wall. Shower shall deliver a minimum of 1.9 L/s (30 GPM) of water at an inlet supply of 207 kPa (30 PSIG). Delivered flushing fluid temperature shall be tepid (36 degrees C (95 degrees F), maximum). Provide a self-cleaning, non-clogging eye and face wash with quick opening, full-flow valves, and stainless steel eye and face wash receptor. Unit shall deliver 0.2 L/s (3 GPM) of aerated water at 207 kPa (30 PSIG) flow pressure, with eye and face wash nozzles 838 to 1143 mm (33 to 45 inches) above finished floor. Provide copper alloy control valves. Provide an air-gap with the lowest potable eye and face wash water outlet located above the overflow rim by not less than the International Plumbing Code minimum, per IPC Table 608.15.1. Water supply shall be configured without long dead ends to prevent stagnant or stale water. Route the floor drain to either the industrial waste system or domestic waste system based on location of the emergency eyewash station. Provide 4 cm (1-1/2 inch) minimum floor drain curb height.]

Waterflow-initiated alarm shall include a local audible signal device, a silencing switch, and a flashing strobe light for each ES/EWS and for each manual alarm. Alarm installations shall be waterproof per NEMA Class 1. Alarm audible signal devices shall have a distinct sound, different from other alarms in this and adjacent facilities. Mount alarm audible signal device, silencing switch, and strobe light on wall or ES/EWS column, immediately above the level of the showerhead.

Provide Ground Fault Circuit Interrupter (GFCI) protection for all electrical power outlets within 6 feet of an ES/EWS and below the elevation of the showerhead.

2.8 D2018 DRINKING FOUNTAINS AND COOLERS

2.8.1 Wheelchair Electric Water Cooler

Provide ARI 1010, wall-mounted bubbler style with ASME A112.6.1M concealed chair carrier, air-cooled condensing unit, 5 ml/s (5 gallon/hour) minimum capacity, stainless steel splash receptor, and all stainless steel cabinet. Provide 686 mm (27 inches) minimum knee clearance from front bottom of unit to floor and 914 mm (36 inch) maximum spout height above floor. Provide push levers, push bars, or touch pads (one on each side or one on front and both sides of cabinet) to control bubblers. Recess water coolers to maintain full corridor width. All water coolers shall be certified to meet ANSI/NSF 61, Section 9.

3. D2020 DOMESTIC WATER DISTRIBUTION

3.1 D2021 COLD WATER SERVICE

3.1.1 Copper tubing and fittings

Use for pipe sizes 100 mm (4 inches) or smaller

- a. Above ground- type L tubing with solder fittings.
- b. Buried - type K tubing with solder fittings.

3.1.2 Chlorinated polyvinyl chloride (CPVC)

Plastic pipe, fittings, and solvent cement per ASTM D 2846/D 2846M for sizes 100 mm (4 inches) and smaller. Provide transition union connections or threaded gate valve between metallic piping and CPVC piping. Provide male threaded adapters with PTFE (polytetrafluoroethylene) pipe thread paste for threaded connections to valves, strainers, and equipment.

3.1.3 Ductile-iron piping

Use for piping larger than 100 mm (4 inches). AWWA C104/A21.4 cement mortar lined. Aboveground piping shall have flanged connections conforming to AWWA C115/A21.15 for flanged pipe and AWWA C110/A21.10 for flanged fittings.

3.1.4 Valves, hydrant and hose bibbs

3.1.4.1 Gate Valves: MSS SP 80 Class 125, except sizes 65mm (2.5 inches) and larger conform to MSS SP 70 Class 125.

3.1.4.2 Globe and Angle Valves: MSS SP 80 Class 125, except sizes 65mm (2.5 inches) and larger conform to MSS SP 85 Class 125.

3.1.4.3 Check Valves: MSS SP 80 Class 125, except sizes 65mm (2.5 inches) and larger conform to MSS SP 71 Class 125.

3.1.4.4 Ball Valves: Full port Design copper alloy, except sizes 65mm (2.5 inches) and larger shall be ductile iron or cast body

3.1.4.5 Non-freeze Wall Hydrant : Building exterior such that all points along the perimeter can be reached with a 30 meter (100 foot) long hose: ASSE 1019, cast bronze, with locking shield and handwheel, 25 mm (1 inch) external thread inlet, 20 mm (3/4 inch) external hose thread outlet with automatic

draining vacuum breaker. Hydrant shall be of sufficient length to extend through walls and place the valve seat inside the building or in the crawl space. Bonnet and valve stem shall be removable from outside of the building.

- 3.1.4.6 Hose Bibbs: Building exterior such that all points along the perimeter can be reached with a 30 meter (100 foot) long hose: Provide angle type copper alloy hose bibbs with lockshield and removable tee-handle. Inlet shall have internal threads. Outlet shall have vacuum breaker with 20 mm (3/4 inch) external hose threads
- 3.1.4.7 Combination Pressure and Temperature Relief Valves : ANSI Z21.22 copper alloy body, automatic reseating, test lever and discharge capacity based on AGA temperature steam rating.
- 3.1.4.8 Pressure Relief Valves: ANSI Z21.22 copper alloy body, automatic reseating with test lever.
- 3.1.4.9 Water Temperature Regulating Valves: Copper alloy or cast iron body valve with adjustable temperature setting.
- 3.1.4.10 Water Temperature Mixing Valves: Temperature adjustable valve of copper alloy body.
- 3.1.4.11 Water Pressure Reducing Valves- ASSE 1003
- 3.1.4.12 Strainer: Copper or cast iron body, stainless steel strainer element with perforations of 1.20 mm (0.047 inch). Provide blow-off outlet with pipe nipple and gate valve and discharge pipe nipple.
- 3.1.4.13 Water hammer arrestors: PDI WH 201
- 3.1.4.14 Pressure gages: Single style, brass case, bronze tube gage cock pressure snubber and siphon.
- 3.1.4.15 Thermometer: Bi-metal dial type with stainless steel case, stem and fixed thread connection. Accuracy within 2% of scale range.

3.2 D2022 HOT WATER SERVICE

Same as D2021

3.3 D2023 DOMESTIC WATER SUPPLY EQUIPMENT

3.3.1 Backflow Preventers

Double check valve [reduced pressure principle] type. Furnish proof that each make, model/design, and size of backflow preventer being furnished for the project is approved by and has a current "Certificate of Approval" from the Foundation for Cross-Connection Control and Hydraulic Research (FCCCHR)-USC. Listing of the particular make, model/design, and size in the current FCCCHR-USC will be acceptable as the required proof.

3.3.2 Water Meter

AWWA C701 turbine type with register reading in liters and US gallons.

3.3.3 Washing Machine Connection Box

Provide recessed wall box. Provide drain nipple and locknut with cover nut for locking drain outlet to box. Provide brass pipe fittings for connecting each supply pipe to valve and locking box. Provide bronze dual washing machine valve with single lever shut-off or dual brass cartridge-operated valves with hose connections.

3.3.4 Water Heaters

For facilities that have high anticipated hot water usage rates, consider heat recovery from mechanical equipment. Perform a life cycle cost analysis to decide if heat recovery is economically advantageous for the particular facility.

a Capacity: Provide a water heater capable of meeting 100% of the hot water demand for a minimum of one hour during peak demand period. Water heaters with input capacity 400,000 BTU/hr or greater shall conform with the requirements ASME CSD-1.

b Temperature Control: Equip service water heating systems with adjustable thermostats. Hot water temperatures for non-medical facilities shall be 120°F-140°F (48.9°C-60°C). Store hot water at not less than 120°F (48.9°C) to inhibit the growth of harmful bacteria. Unless conditions demand otherwise, don't heat and store water at higher than utilization temperature. Where special functions such as dishwashing require a higher temperature, provide a local booster rather than heat all hot water to the higher temperature.

3.3.4.1 Natural Gas/Propane Fired Water Heaters

Gas fired water heaters, and smaller shall be per ANSI Z21.10.1 and ANSI Z21.10.3 for greater than 200,000 Btuh or 120 gallons meeting AGA requirements. Unit efficiency shall meet or exceed that listed for FEMP or ENERGYSTAR, or as listed in ASHRAE 90.1, whichever is greatest. Water heaters shall be equipped with glass-lined steel tanks, polyurethane foam insulation, replaceable anodes, and adjustable range thermostat to allow hot water settings between 43 and 71 degrees C (110 and 160 degrees F). Provide posted operating instructions for water heaters.]

3.3.4.2 [Electric Water Heaters

Provide electric water heaters with double heating element, 200,000 Btuh or 120 gallons per UL 174] and UL 1453 for greater than 200,000 Btuh or 120 gallons. Unit efficiency shall meet or exceed that listed for FEMP or ENERGYSTAR, or as listed in ASHRAE 90.1, whichever is greatest. Water heaters shall be equipped with glass-lined steel tanks, high efficiency type, insulated with polyurethane foam insulation, replaceable anodes, and adjustable range thermostat to allow hot water settings between 43 and 71 degrees C (110 and 160 degrees F). Provide posted operating instructions for water heaters.]

3.3.4.3 [Instantaneous Water Heater (Propane or Natural Gas)

Provide temperature controlled continuous flow gas water heater(s) with electronic ignition. Water heater(s) shall have an integral internal controller to anticipate a change in demand so that the final temperature can be maintained to +/- 2 degrees F of set point temperature under all normal load conditions. Unit(s) shall be certified by AGA/CSA. Unit(s) shall have an efficiency that meets or exceeds that listed for FEMP or ENERGYSTAR, or as listed in ASHRAE 90.1, whichever is greatest.]

3.3.4.4 [Instantaneous Water Heater (Electric)

Domestic water heating shall be provided by electric tankless water heater(s). Heater(s) shall be of the modulating, under the sink, point-of-use type. Output temperature shall be adjustable from 40 degrees F to 160 degrees F. Heating elements shall be field replaceable.

3.3.5 Domestic Water Booster Pressure Pumping System

- a. Factory assembled, tested, and certified by a single manufacturer who assumes undivided responsibility for the system to include providing start-up services, two days instruction and furnishing related operations and maintenance manuals. Each building shall be provided with its own system.
- b. Each system will consist of a minimum of two pumps mounted on a single, welded structural steel base. Provide bladder type low-flow accumulator storage tank, lead-lag pump alternator selector switches and all related controls and alarms required for safe and proper system operation.

3.4 D2024 WATER SUPPLY INSULATION

Provide insulation on all domestic water (hot and cold) supply and recirculation piping. Provide vapor barrier on all cold water piping.

4. D2030 SANITARY WASTE SYSTEMS

4.1 D2031 WASTE PIPING

4.1.1 Below-ground piping

Cast iron hub and spigot pipe and fittings, ASTM A74 with ASTM C564 or CISPI HSN rubber compression gasket joints.

4.1.2 Above-ground piping

Provide cast iron hub and spigot pipe and fittings, ASTM A74 with ASTM C564 or CISPI HSN rubber compression gasket joints or cast-iron hubless pipe and fittings, CISPI 301 with CISPI 310 couplings.

The use of Polyvinyl Chloride (PVC) or Acrylonitrile Butadiene Styrene (ABS) shall be limited to single and two (2) story building. PVC plastic pipe, fittings, and solvent cement shall be per ASTM D 1785. ABS plastic pipe, fittings, and solvent cement shall be per ASTM D 2661. PVC and ABS piping shall be equipped with approved firestopping devices as required by code.

Provide ASTM B 88, Type M or L, hard drawn copper condensate drain piping.

4.2 D2032 VENT PIPING

See D2031

Minimize the number of roof penetrations by combining plumbing vents as allowed by the IPC.

4.3 D2033 FLOOR DRAINS

ASME A112.21.1M, cast iron or ductile iron drains and clamping rings for use with membrane water proofing. Floor drains shall be provided in mechanical rooms, restrooms, plumbing chase areas, and to receive condensate from air handling equipment. Floor drains are not allowed in mechanical rooms that serve as return air plenums.

- a. Flush strainer type. Provide with double drainage flange and adjustable collar.
- b. Floor sink: Cast iron body with white acid resisting porcelain enameled or epoxy interior, double drainage flange, nickel bronze rim and slotted grate, removable stainless steel or aluminum slotted bucket.

4.4 D2034 SANITARY WASTE EQUIPMENT

Submersible Sump Pumps: Complete with cast iron casing, bronze impeller, stainless steel shaft, sealed heavy duty ball bearings, water cooled hermetically sealed motor, built in automatic reset thermal protection, float switches, and water proof three conductor cables and grounding plugs.

Sewage Pumps: FS A-A-50555. Duplex type shall be with automatic control to alternate operation from one pump and to start the second pump in the event the first pump cannot handle the incoming flow

4.5 D2035 PIPE INSULATION

Provide insulation on all piping that may be subject to condensation. Provide a vapor barrier. Insulate condensate drain piping with flexible cellular insulation, ASTM C 534, Type I, with vapor barrier. Thickness shall be 25 mm (1 inch) minimum.

5. D2040 RAIN WATER DRAINAGE

5.1 D2041 PIPE & FITTINGS

5.1.1 Above-ground Piping

Cast iron hub and spigot pipe and fittings, ASTM A74 with ASTM C564 or CISPI HSN rubber compression gasket joints or cast-iron hubless pipe and fittings, CISPI 301 with CISPI 310 couplings.

Plastic Piping, Fittings, and Solvent Cement per ASTM D 1785. PVC piping shall be equipped with approved firestopping devices as required by code.

5.1.2 Below-ground Piping

PVC pipe ASTM D3034, SDR 35 to convey the roof drainage from downspouts to a manhole or catch basin in the drainage system.

Provide ductile iron pipe (ASTM A746) for pipes that cross traffic pavements if there is less than 610mm (24 inches) of cover.

5.2 D2042 ROOF DRAINS

Roof drains shall conform to ASME A112.21.2M. The whole assembly shall be galvanized heavy pattern cast iron. For aggregate surface roofing, the drain shall be provided with a gravel stop. On roofs other than concrete construction, roof drains shall be complete with underdeck clamp, sump receiver, and an extension for the insulation thickness where applicable. A clamping device for attaching flashing or waterproofing membrane to the seepage pan without damaging the flashing or membrane shall be provided when required to suit the building construction. Strainer openings shall have a combined area equal to twice that of the drain outlet. The outlet shall be equipped to make a proper connection to threaded pipe of the same size as the downspout.

5.3 D2043 RAINWATER DRAINAGE EQUIPMENT

The expansion joint shall consist of a heavy cast-iron housing, brass or bronze sleeve, brass or bronze fastening bolts and nuts, and gaskets or packing. The sleeve shall have a nominal thickness of not less than 3.416 mm (0.134 inch). Gaskets and packing shall be closed-cell neoprene, O-ring packing shall be closed-cell neoprene of 70 durometer. Packing shall be held in place by a packing gland secured with bolts.

5.4 D2044 PIPE INSULATION

Provide mineral fiber insulation on all drainage piping that may be subject to condensation. Provide a vapor barrier.

6. D2090 OTHER PLUMBING SYSTEMS

6.1 D2091 GAS DISTRIBUTION

6.1.1 Natural Gas Piping

Conform to requirements of the International Fuel Gas Code. Conform to requirements of ASME B31.8, "Gas transmission and Distribution Piping Systems" for exterior piping. Conform to requirements of NFPA 54, "National Fuel Gas Code" for interior gas piping. Provide meter, pressure regulator, and earthquake valve. Contractor is responsible for providing the complete natural gas system to the facility, including, application or permits and coordination with local utility company.

6.1.2 Materials And Equipment

6.1.2.1 Aboveground Within Buildings: Black steel per ASTM A 53, Schedule 40, threaded ends for sizes [50 mm] [2 inches] and smaller; otherwise, plain end beveled for butt welding. Corrugated stainless steel tubing with polyethylene jacketing and fittings tested and listed in compliance and construction, installation and performance requirements of ANSI/AGA LC-1.

6.1.2.2 Underground: Provide Polyethylene (PE) pipe conforming to ASTM D 2513 for 690 kPa (100 PSI) (gage) working pressure. Standard Dimension Ratio shall be 11.5 maximum. Provide detectable aluminum for plastic backed tape or detectable magnetic plastic tape manufactured specifically for warning and identification of direct buried piping. Tape shall be detectable by an electronic detection instrument.

6.1.2.3 Steel Pipe Fittings: Provide ANSI/ASME B16.3, black malleable iron threaded fittings or ASME/ANSI B16.9, butt-welding fittings. Unions shall be ASME/ANSI B16.39, black malleable iron. Flanges and flanged fittings shall be ASME/ANSI B16.5 steel flanges or convoluted steel flanges conforming to ASME BPVC SEC VIII D1. Flange faces shall have integral grooves of rectangular cross sections which afford containment for self-energizing gasket material.

6.1.2.4 Polyethylene Fittings: ASTM D 2683 socket fittings or ASTM D 2513 molded butt-fusion fittings.

6.1.2.5 Riser: Manufacturer standard anodeless riser, transition from plastic (PE) to steel pipe. Transition fitting shall be with 7-12 mils thick epoxy coating swaged gastight with o-ring seals and metal inserts.

6.1.2.6 Transition Fittings: Manufacturer's standard fittings. Steel to plastic (PE) with tapping tee or sleeve. Coat or wrap steel pipe with heavy-duty plastic coating.

6.1.2.7 Below Ground Valves

- a. Metallic ball valves: ANSI B16.33 or ANSI/ASME B16.38 corrosion resisting steel with threaded or flanged end.
- b. PE ball or plug valves: ANSI/ASME B16.40 and ASTM D 2513 class C material (PE 2306 or PE 3406). SDR matching pipe dimensions and working pressure.d.

6.1.2.8 Aboveground Valves

- a. Shut-off valves: Bronze or steel threaded end in accordance with ANSI B16.33, or Cast iron or steel flanged end in accordance with ANSI/ASME B16.38, non-lubricated, wedged mechanism or tapered lift plug.
- b. Pressure Regulator: ASME B31.8 and AGA service or industrial type, self-contained with spring loaded diaphragm.
- c. Earthquake Automatic Shut-off Valve: ANSI Z21.70 and UL or AGA listed.

6.1.2.9 Gas Meter: ANSI B109.1 or ANSI B109.2 or ANSI B109.3.

6.1.2.10 Valve Boxes: Street valve box with the word "GAS" cast into the box cover. Heavy-duty cast iron cover for roads and traffic areas, and standard duty concrete cover for other areas.

6.1.2.11 Natural Gas Pressure Testing and System Purging

- a. Pressure test per NFPA 54 at 1.5 times maximum working pressure, but in no case less than 350 kPa (50 PSI). Repair leaking joints and repeat test until no reduction in pressure occurs

b. System purging procedure shall conform to NFPA 54 and ASME B31.8. Failure to purge may result in explosion within line when air to gas is at correct mixture.

6.2 D2092 ACID WASTE SYSTEMS

Material for buried pipe and above ground pipe shall be ASTM A 518 Silicon-iron composition. ASTM C 1053 Borosilicate glass pipe and fitting maybe provide for aboveground piping, except vent piping through and above roofs shall be silicon iron composition. Provide clean out and drain as specified for DWV piping except material shall be silicon-iron composition. ASTM D 1785 PVC plastic pipe, fitting and solvent cement maybe provided for buried and aboveground piping.

6.3 D2093 INTERCEPTORS

6.3.1 Oil/Water Separator

The oil/water separator shall be parallel plate pack type, double walled horizontal Type II tank conforming to UL 58. Outer tank shall enclose and provide leak containment across the total surface of the inner main tank.

a. The design of oil water separator system shall be performed by a registered professional engineer showing that the oil water separator system will meet the performance requirements anticipated. The calculations shall be based on Stokes' Law and laminar flow conditions (Reynolds number of 500 or less) through the separator. The designer shall take into account the effective plate pack area (open area) perpendicular to flow during maximum flow rate condition and design fluid temperature. The design shall provide sufficient retention time to allow separation of 50 micron or greater oil globule from the liquid carrier at the maximum flow rate and design fluid temperature. Refer to the following web sites for information on sizing and capacity:

<http://www.highlandtank.com/intercpt.htm>

http://store.fairfieldmaintenance.com/PRODUCTS/OIL_WATER_SEPARATORS/default.htm

<http://www.wateronline.com/content/homepage/>

<http://www.psinternational.com/>

b. Service and Accessibility: Provide the necessary clean out and gage connections, and lockable caps required for removal of separated oily waste. The top of the separator shall provide both physical and visual accessibility to parts subject to wear or requiring adjustment, inspection, cleaning or repair without having to go through manholes. Provide protective bollards, roll away covers, ladders, etc. to allow periodical maintenance.

c. Oil/water separators located away from the facility should be covered in section G30, Site Plumbing Utilities. Coordinate with the civil engineer on the project.

6.4 D2099 OTHER PIPING SYSTEMS

The following web sites provide information to assist in sizing requirements for air compressors:

<http://www.deltech-flair.com/>

<http://www.quincycompressor.com/>

<http://www.ingersoll-rand.com/>

<http://www.mottley.com/selection.html>

<http://www.aircompressorworks.com/kaeser.htm>

<http://www.grainger.com/Grainger/wwg/start.shtml>

6.4.1 General Use Compressed Air Systems

Provide factory packaged compressor conforming to FS XX-C-2816. Maximum allowable discharge temperature is 38 degrees C (100 degrees F). Sound level shall not exceed 84 dBA one meter from compressor unit. Receiver tank shall be per ASME PBVC Sec. VIII D1, labeled, equipped with required valves and trimmings, including gage and automatic drain valve and ASME BPVC pressure safety relief valve.]

For large or multiple air compressor installations, provide an intake structure or opening which avoid shelves, pockets or other surfaces which can attract and accumulate particulates for introduction into the compressors. Wherever practical, design inlet piping for low air velocity to limit the size of particulates that may be carried by the air stream. Pay particular attention to normal wind directions and locations that might trap contaminated air such as flat roofs with parapets. Raise intake at least four feet above horizontal surfaces to minimize dust intake. Select an intake area clear of potential fume or heat accumulation such as closed air pockets, downwind proximity, or recirculation zones.]

6.4.1.1 Refrigerated Air Dryer

Provide a low-pressure compressed air dryer of the mechanical refrigeration type, equipped with an automatic temperature shutdown switch to prevent freezing, a regenerative air-to-air exchanger (as standard with the manufacturer), and a main compressed air cooling exchanger. Refrigeration system shall use non-CFC refrigerant and shall cool compressed air to dry the air. Dryer shall have no internal traps or filters and shall have a pressure drop of not greater than 20 kPa (3 PSI). Air shall leave the dryer at a temperature of 38 degrees C (100 degrees F) and a dew point of 6 degrees C (42 degrees F), based on an inlet temperature of 38 degrees C (100 degrees F). Provide internal tubing, wiring, and piping complete, such that only connections to air inlet and outlet, to refrigerant compressor contactor, and to condensate drain are necessary.

6.4.1.2 Air Receiver

Provide receiver(s) factory assembled and factory tested to 1-1/2 times the working pressure. Receivers shall be per ASME BPVC Sec. VIII D1, labeled and equipped with required valves and trimmings, including gage and automatic drain valve and ASME BPVC pressure safety relief valve. Exterior finish shall be standard factory finish. A display of the ASME seal on the receiver or a certified test report from an approved independent testing laboratory indicating conformance to the ASME Code shall be provided.]

6.4.1.3 Compressed Air Piping System

Piping shall conform to the requirements of ASME B31.1 for materials, assembly, and testing. Piping shall be steel or copper as described in the following paragraphs. Provide isolation valves as necessary to allow portions of the system to be isolated for maintenance or repair. Provide low point drain valves as necessary to remove moisture from the system. Provide compressed air drops with quick disconnects throughout the work areas to allow connection of pneumatic tools, air guns, etc. Each air drop shall be equipped with a filter/moisture separator, pressure gauge, air pressure regulator, and a quick-disconnect.

- a. Steel piping shall be black seamless schedule 40 carbon steel per ASTM A53 with threaded fittings per ANSI/ASME B16.3 or ANSI/ASME B16.11 and valves per ANSI/ASME B16.34. Unions shall be ANSI/ASME B16.39, Class 1.
- b. Copper tubing shall be per ATM B 88, Type K or Type L, hard drawn, Class 1, with wrought copper or bronze fittings per ASME/ANSI B16.22 with silver brazed joints. Brazing filler material shall be per FS QQ-B-654, Class III. Unions shall be bronze, brazed joint type per FS WW-U-516.

- c. Valves: Provide bronze gate valves, MSS SP-80, Class 150 for sizes 50 mm (2 inches) and smaller. Wedge disc, rising stem, inside screw type, with brazed joint ends when used with copper tubing. Provide bronze globe and angle valves per MSS SP-84 50 mm (2 inches) and smaller, Class 200, except that Class 150 valves with brazed ends may be used for copper tubing. Valves shall have renewable seats and discs except brazed-end valves which shall have integral seats. Provide steel gate valves per ASME/ANSI B16.34 for sizes over 50 mm (2 inches), flanged ends, outside screw and yoke type with solid wedge or flexible wedge disc, as recommended by the manufacturer for the conditions indicated.
- d. Provide pressure regulators that are diaphragm type, air loaded, tight closing single seat, brass body with integral filter and bowl.
- e. Provide pressure gages, ANSI/ASME B401. Accuracy Grade A, for air, with steel or brass case, and safety glass, and a pressure blowout back to prevent glass from flying out in case of an explosion. Gages shall have an 89 mm (3-1/2 inch) minimum diameter dial and a dial range of approximately twice the working pressure.
- f. Provide pipe hangers and supports conforming to MSS SP-58, MSS SP-69, and ASME B31.1 except as specified or indicated otherwise. Piping and supports shall comply with the seismic requirements of the (ACOE) TI-809-04, Seismic Design for Buildings. Furnish zinc plated pipe hangers and supports except for copper plated inserts for copper piping. Provide tubing supports of U-shaped steel bolts and nuts firmly secured to adequately support structures such as walls, columns, floors, or brackets. Clips shall fit closely around piping but shall have sufficient clearance to permit longitudinal movement of piping during normal expansion and contraction. Provide supports at valves, fittings, branch lines, outlets, changes in direction, equipment, and accessories.
- g. Quick disconnect couplings shall be all brass and suitable for a working pressure of not less than 862 kPa (125 PSI) gauge. Female side of coupling (fixed end) shall have male thread connection with automatic shutoff. Provide male side of coupling with hose stem and ball check to bleed pressure from hose and prevent hose whipping.
- h. Compressed air hose reels shall be enclosed and self-retracting. Hose length shall be sufficient to allow hose to reach any point within the bay.

6.4.1.4 Compressed Air System fabrication.

- a. Brazing Procedures: Brazing shall meet the requirements of ASME B31.1. Qualification of the brazing procedures is required for each group of materials to be brazed as indicated in ASME BPVC SEC IX. Record in detail and qualify the "Brazing Procedure Specifications" for every brazing procedure proposed. Include provisions for repairs. Qualification for each brazing procedure shall conform to ASME B31.1.
- b. Cleaning: Clean silver-brazed piping to remove residual flux in the system after fabrication. Clean by flushing with for one hour (minimum) with 43 degree C (110 degree F) hot water, or by soaking for 12 hours with 16 degree C (60 degree F) cold water followed by flushing with cold water for not less than 4 hours.
- c. Testing: Hydrostatically test compressed air piping after completion of fabrication per ASME B31.1 using water at one and one-half times the working pressure. If leaks are found, depressurize, repair, and re-test until satisfactory. After satisfactory completion of hydrostatic test, blow systems dry with clean, oil-free compressed air and test with clean, dry compressed air at design working pressure. Brush joints with soapy water solution to check for leaks. Verify system holds pressure using a calibrated pressure gage. Maintain pressure for a sufficient time to allow all joints and connections to be inspected. After completion of air test, operationally test the compressed air system by operating the compressor and the refrigerated air dryer, and verifying the air supply at each drop.

6.4.2 Breathing Air Systems

The breathing air system will include two (2) Compressors (one run and one back-up) with integral mounted air-cooled after-cooler, oil free compression chamber, two (2) air purifier units (one run and one back-up) which includes a refrigerated air dryers, filters, catalysts, CO monitors and CO alarms, and air receivers. The two compressors shall be installed in parallel, oil free compression chamber, and 620 kPa (90 PSI) gauge minimum with output capacity to meet the facility requirements. Units shall be set up to alternate primary/standby designations each day so each unit will get equal run time. Quality of air shall meet OSHA standards for respiration air and CGA Standards for Grade D air NASI/CGA G-7.1, be suitable for face masks, hoods, helmets, and other breathing apparatus.

Provide an intake structure or opening which avoids shelves, pockets, or other surfaces, which can attract and accumulate particulates for introduction into the compressors. Wherever practical, design inlet piping for low air velocity to limit the size of particulates which may be carried by the air stream. Pay particular attention to normal wind directions and locations that might trap contaminated air such as flat roofs with parapets. Raise intake at least four feet above horizontal surface to minimize dust. Select an intake area clear of potential fume or heat accumulation such as closed air pockets, downwind proximity, or recirculation.

6.4.2.1 Intake Air Filter and Muffler

Provide replaceable one micron filter elements. Inlet air filter shall be mounted to the compressor frame and shall be 99.9% efficient at 1 microns and above. Shall be located so contamination from this facility and surrounding facilities will not be drawn in. Maintenance indicator shall indicate filter blockage. Cleaning shall include flushing with hot soapy water according to bottle dish washing instructions and flushing with clean water and drying. All filters shall be easily accessible to maintenance workers.

6.4.2.2 Outlet Air Filters

Provide one micron filters of the indicated flow rate capacity and working pressure. All filters shall be easily accessible to maintenance workers.

6.4.2.3 Breathing Air Piping Systems

Piping to be ASTM B 88M (ASTM B 88) or ASTM B 280 ACR (air conditioning and refrigeration), seamless Type K or L hard-drawn copper tubing for above ground and inside buildings and soft drawn (annealed) for underground. In lieu of copper tubing, standard weight (Schedule 40) brass pipe per ASTM B 43 may be used. Provide ANSI B16.18 cast copper, ASME/ANSI B16.22 wrought copper, or brass fittings.

- a. Valves : NFPA 99. Valves of same type shall be the product of one manufacturer, uniform in pattern and appearance, color coded and labeled for the intended service. Identification plates may be used in lieu of labels.
- b. Pressure Reducing Regulators: Provide with calibrated flow measuring device and CGA V-1 valve connections. Minimum accuracy of flow measure device shall be plus or minus 3 percent for the intended use.
- c. Hangers and Supports: Provide pipe hangers and supports conforming to MSS SP-58, MSS SP-69, and ASME B31.1 except as specified or indicated otherwise. Piping and supports shall comply with the seismic requirements of the (ACOE) TI-809-04, Seismic Design for Buildings. Furnish zinc plated pipe hangers and supports except for copper plated inserts for copper piping. Provide tubing supports of U-shaped steel bolts and nuts firmly secured to adequately support structures such as walls, columns, floors, or brackets. Clips shall fit closely around piping but shall have sufficient clearance to permit longitudinal movement of piping during

normal expansion and contraction. Provide supports at valves, fittings, branch lines, outlets, changes in direction, equipment, and accessories.

- d. Gages: ANSI/ASME B40.1 with restrictor, shall be manufactured and labeled expressly for the intended service, and marked "DO NOT USE OIL." Provide gages with white dials and black lettering, and with sizes, ranges, and case type, as required.
- e. Quick Disconnect Couplings: Provide non-compatible fittings and quick connects (size and type) for breathing air outlets to prevent accidental cross connection with the general use compressed air system.
- f. Brazing Alloy: AWS A5.8, BCuP (Brazing-Copper-Phosphorus) series, greater than 538 degrees C (1,000 degrees F) melting temperature. Use only cadmium free brazing filler. Do not use flux for copper-to-copper connections.
- g. Soldering Alloys: ASTM B 32, Alloy Grade Sb5, Sn94, Sn95, or Sn96.
- h. Welding Filler Metal: AWS A5.28 and compatible with the materials.
- i. Threaded Connections: Jointing compound for pipe threads polytetrafluoroethylene (PTFE) pipe thread paste, tape, pipe cement and oil, PTFE powder and oil; apply only on male threads. Select which one is suitable for the particular application.
- j. Piping Identification: CID A-A-1689, pressure-sensitive adhesive tape and decals. Colors and labels must conform to ANSI A13.1.

6.4.2.4 Breathing Air System fabrication.

- a. Pre-installation Cleaning: Provide only pipe and fittings which have been thoroughly washed. Mix the solution of sodium carbonate or trisodium phosphate in the proportion of 454 grams (one pound) dry chemical in 11.40 liters (3 gallons) of water. Maintain the resulting solution at minimum 82 degrees C (180 degrees F). Wash thoroughly, scrubbing as required. Rinse with clean water and blow dry with oil-free dry nitrogen. Do not use carbon tetrachloride, hydrocarbon, or halogenated hydrocarbon solvents.
- b. Brazing and Soldering: Personnel qualification procedures shall conform to AWS B2.2. Metal preparation and joining procedures shall conform to CDA 404/0 and NFPA 99. Use BCuP Series brazing alloys for joints, except for 50 mm (2 inch) and smaller pipes. Completely clean off excess after brazing and soldering.
- c. Welding: Comply with AWS B2.1.
- d. In-process Cleaning of Piping: During brazing, soldering, or welding operations, continuously purge with oil-free dry nitrogen. As each section is completed, blow lines clear of dirt and contamination with oil-free dry nitrogen in accordance with NFPA 99. Cap or plug open ends when left unattended.
- e. Testing: Comply with testing requirements of the general use compressed air system, except testing medium shall be oil-free dry nitrogen. Test breathing air system to show compliance with OSHA 29 CFR 1910.134.D- Respiratory Protection, for providing Grade D breathing air as described in the Compressed Gas Association Commodity Specification G-7.1-1966. Test shall include lab test for air samples taken and manufacturer certification the compressor and associated dryers, air purification, alarms and monitoring system have been installed per the manufacturer recommendations and is operating properly and is safe for use.

-- End of Section --