

APPENDIX 10.3

Mechanical Engineering Design Criteria

Mechanical Engineering Design Criteria

10.3.1 Introduction

Project design, engineering, procurement, and construction activities will be controlled in accordance with various predetermined standard practices and project-specific programs/practices. An orderly sequence of events for project implementation is planned, consisting of the following major activities:

- Conceptual design
- Licensing and permitting
- Detailed design
- Procurement
- Construction and construction management
- Checkout, testing, and startup
- Project completion

This appendix summarizes the codes and standards, standard design criteria, and industrial good practices that will be used during the project. The general mechanical design criteria defined herein form the basis of the design for project mechanical components and systems. More specific design information will be developed during detailed design to support equipment and erection specifications. It is not the intent of this appendix to present the detailed design information for each component and system, but rather to summarize the codes, standards, and general criteria that will be used. Codes, standards, and general criteria selected during the detail design phase of the project may vary from the information indicated in this appendix per specific project or design requirements.

This appendix also includes the general design criteria for motors, power and control wiring, protective relaying, classification of hazardous areas, grounding, lighting, heat tracing, lightning protection, raceway and conduit, and cathodic protection.

10.3.2 Codes and Standards

The design and specification of all work shall be in accordance with the laws and regulations of the federal government and the state of California, and local codes and ordinances. The following laws, ordinances, codes, and standards have been identified as applying to mechanical engineering design and construction. In cases where conflicts between cited codes (or standards) exist, the requirements of the more conservative code will be met.

Federal

- Title 29 Code of Federal Regulations (CFR) Part 1910, Occupational Safety and Health Administration (OSHA).

- Title 40 CFR Part 60, Standards of Performance for New Stationary Sources.
- Title 40 CFR Part 75, Continuous Emission Monitoring.
- Title 40 CFR Subchapter C, Air Programs, Part 50 et seq.
- Title 40 CFR Subchapter D, Water Programs, Part 100 et seq.
- Title 40 CFR Subchapter I, Solid Waste and Hazardous Waste, Part 260 et seq.
- Title 40 CFR Subchapter J, Superfund Emergency Planning and Community Right-to-Know Act, Part 300 et seq.
- Title 40 CFR Subchapter N, Effluent Guidelines and Standards, Part 400 et seq.
- Title 49 CFR Part 192, Transportation of Natural and Other Gas by Pipeline.

State

- Title 8 California Code of Regulations (CCR) Chapters 4 through 7, Groups 20
- Flammable Liquids, Gases, and Vapors, Chapter 27 Fire Protection.
- Title 14 CCR Natural Resources.
- Title 17 CCR Public Health.
- Title 19 CCR Public Safety.
- Title 20 CCR Public Utilities and Energy.
- Title 22 CCR Social Security Division 4.5 Minimum Standards for Management of
- Hazardous and Extremely Hazardous Waste.
- Title 23 CCR Waters.
- Title 24 CCR California Building Code, California Mechanical Code, and California
- Plumbing Code.
- Title 26 CCR Toxics.
- California Business and Professional Code Section 6704 (requires state registration to practice engineering) and Section 6735 (requires engineering documents to be prepared by a registered engineer).
- South Coast Air Quality Management District – Rules and Regulations.
- State of California, California Regional Water Quality Control Board, Los Angeles
- Region Orders 98-052 and 98-072 concerning the NPDES permit for the Burbank Water Reclamation Plant and the Steam Power Plant, CA0055531.

County

- San Diego County Code of Regulatory Ordinances

- California Referenced Standards Code, 2001 edition as amended by the City of Chula Vista.
- California Energy Code, Title 24 of the California Code of Regulations.
- California Plumbing Code, 2001 Edition as amended by the City of Chula Vista.
- California Fire Code, 2001 Edition as amended by the City of Chula Vista.
- California Mechanical Code, 2001 Edition as amended by the City of Chula Vista.

Industry Codes and Standards

ABMA – American Bearing Manufacturers Association:

ABMA 9 – Load Ratings and Fatigue Life for Ball Bearings.

ABMA 11 – Load Ratings and Fatigue Life for Roller Bearings.

ACPI – American Concrete Pipe Association Standards.

AGMA – American Gear Manufacturers Association Standards.

AISC – American Institute of Steel Construction Standards.

AMCA – Air Moving and Conditioning Association.

API – American Petroleum Institute:

API 5L – Specification for Line Pipe.

ASA – Acoustical Society of America:

ASA 47 – Sound Level Meters.

ASA 53 – Preferred Frequencies, Frequency Levels, and Band Numbers for Acoustical Measurements.

ASHRAE – American Society of Heating, Refrigerating and Air Conditioning Standards.

ASTM – American Society for Testing and Materials:

ASTM A36/A36M – Specification for Structural Steel.

ASTM A53 – Standard Specification for Pipe, Steel, Black, and Hot-Dipped, Zinc-Coated Welded and Seamless.

ASTM A105/A105M – Standard Specification for Forgings, Carbon Steel, for Piping Components.

ASTM A106 – Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.

ASTM A126 – Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.

ASTM A134 – Specification for Pipe, Steel, Electric-Fusion (Arc)-Welded (Sizes NPS16 and Over).

- ASTM A182/ A182M—Standard Specification for Forged or Rolled Alloy Steel Pipe Flanges/Forged Fitting and Valves and Parts for High-Temperature Service.
- ASTM A193/ A193M—Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
- ASTM A194/ A194M—Standard Specifications for Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service.
- ASTM A213/ A213M—Standard Specification for Seamless Ferritic and Austenitic Alloy-Steel Boiler, Superheater, and Heat-Exchanger Tubes.
- ASTM A216/ A216M—Standard Specifications for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service.
- ASTM A217/ A217M—Standard Specification for Steel Castings, Martenitic Stainless and Alloy for Pressure Containing Parts, Suitable for High-Temperature Service.
- ASTM A234/ A234M—Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
- ASTM A283/ A283M—Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
- ASTM A307—Standard Specifications for Carbon Steel Bolts and Studs, 60,000 psi, Tensile Strength.
- ASTM A312/ A312M—Standard Specification for Seamless and Welded Austenitic Stainless Steel Pipes.
- ASTM A335/ A335M—Standard Specification for Seamless Ferritic Alloy-Steel Pipe for High-Temperature Service.
- ASTM A351/ A351M—Standard Specification for Steel Castings, Austenitic, for High-Temperature Service.
- ASTM A387/ A387M—Standard Specification for Pressure Vessel Plates, Alloy Steel, Chromium-Molybdenum.
- ASTM A403/ A403M—Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings.
- ASTM A490—Specification for Heat-Treated, Steel Structural Bolts, 150 ksi Tensile Strength.
- ASTM A672—Specification for Electric-Fusion-Welded Steel Pipe for Atmospheric and Lower Temperatures.
- ASTM B43—Specification for Seamless Red Brass Pipe Standard Sizes.
- ASTM B61—Standard Specification for Steam or Valve Bronze Castings.
- ASTM B62—Composition Bronze or Ounce Metal Castings.
- ASTM B75/ B75M—Specification for Seamless Copper Tube.
- ASTM B88—Standard Specification for Seamless Copper Water Tube.
- ASTM B111—Specification for Copper and Copper-Alloy Seamless Condenser Tubes and Ferrule Stock.
- ASTM B209—Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- ASTM B462—Specification for Forged or Rolled UNS N08020, UNS N08024, UNS N08026, UNS N08367, and UNS R20033 Alloy Pipe Flanges, Forged Fittings, and Valves and Parts for Corrosive High-Temperature Service.

- ASTM C195 – Specification for Mineral Fiber Thermal Insulating Cement.
- ASTM C411 – Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
- ASTM C533 – Specification for Calcium Silicate Block and Pipe Thermal Insulation.
- ASTM C547 – Specification for Mineral Fiber Pipe Insulation.
- ASTM C612 – Specification for Mineral Fiber Block and Board Thermal Insulation.
- ASTM D1248 – Specification for Polyethylene Plastics Molding and Extrusion Materials.
- ASTM D1785 – Specification for Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
- ASTM D2241 – Specification for Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).
- ASTM D2513 – Thermoplastic Gas Pressure Pipe, Tubing and Fittings.
- ASTM D2517 – Reinforced Epoxy Resin Gas Pressure Pipe and Fittings.
- ASTM D3350 – Specification for Polyethylene Plastics Pipe and Fittings Materials.
- ASTM F441/F441M – Specification for Chlorinated Poly Vinyl Chloride (CPVC) Plastic Pipe, Schedules 40 and 80.
- ANSI – American National Standards Institute:
- ANSI/ASME B1.1 – Unified Inch Screw Threads (UN and UNR thread form).
- ANSI/ASME B16.1 – Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800 lb.
- ANSI/ASME B16.5 – Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and Other Special Alloys.
- ANSI/ASME B16.9 – Factory-Made Wrought Steel Buttwelding Fittings.
- ANSI/ASME B16.10 – Face-to-Face and End-to-End Ferrous Valves.
- ANSI/ASME B16.11 – Forged Steel Fittings Socket-Welding and Threaded.
- ANSI/ASME B16.15 – Cast Bronze Threaded Fittings Classes 125 and 250.
- ANSI/ASME B16.21 – Nonmetallic Flat Gaskets for Pipe Flanges.
- ANSI/ASME B16.22 – Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
- ANSI/ASME B16.24 – Bronze Pipe Flanges and Flanged Fittings, Class 150 and 300 lb.
- ANSI/ASME B16.25 – Buttwelding Ends.
- ANSI/ASME B16.28 – Wrought Steel Buttwelding Short Radius Elbows and Returns.
- ANSI/ASME B16.34 – Valves-Flanged, Threaded and Welding End.
- ANSI/ASME B18.2.1 – Square and Hex Bolts and Screws, Inch Series.
- ANSI/ASME B31.1 – Power Piping.
- ANSI/ASME B31.8 – Gas Transmission and Distribution Piping.
- ANSI/ASME B36.1 OM – Welded and Seamless Wrought Steel Pipe.
- ANSI/ASME B36.19M – Stainless Steel Pipe.
- ANSI/ASME B73.IM – Specifications for Horizontal End Suction Centrifugal Pumps for Chemical Process.
- ANSI/ASME B133.1M – Procurement Standards for Gas Turbines.
- ANSI/AWWA C110/A21.10 – Ductile-Iron and Grey-Iron Fittings, 3 inch through 48 inch (75 mm through 1200 mm) for Water and Other Liquids.

ANSI/AWWA C111/A21.11 – Rubber Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

ASME – American Society of Mechanical Engineers:

ASME Section I – Rules for Construction of Power Boilers.

ASME Section VIII – Rules for Construction of Pressure Vessels.

ASME Section IX – Qualification Standard for Welding and Brazing Procedures, Welders, Brazer, and Welding and Brazing Operators.

ASME PTC-4.4 – Gas Turbine Heat Recovery Steam Generators (R. 1192).

ASME PTC-22 – Power Test Code for Gas Turbine Power Plants.

AWS – American Welding Society:

AWS-D1.1 – Structural Welding Code-Steel.

AWWA – American Water Works Association:

AWWA-C504 – Rubber Seated Butterfly Valves.

CGA – Compressed Gas Association Standards.

CTI – Cooling Tower Institute Standards.

EI – Edison Electric Institute Standards.

EJMA – Expansion Joint Manufacturers Association Standards.

FCI – Fluid Controls Institute.

FCI 70-2 – Quality Control Standard for Control Valve Seat Leakage.

HEI – Heat Exchange Institute:

Performance Standards for Liquid Ring Vacuum Pumps.

Standards and Typical Specifications for Deaerators.

Standards for Closed Feedwater Heaters.

Standards for Power Plant Heat Exchangers.

Standards for Steam Jet Vacuum Systems.

Standards for Steam Surface Condensers.

HI – Hydraulic Institute:

ANSI/HI 1.1-1.5 – Centrifugal Pumps Nomenclature, Definitions, Applications and Operation

ANSI/HI 1.6 – Centrifugal Pump Tests

ANSI/HI 2.1-2.5 – Vertical Pumps Nomenclature, Definitions, Application and Operation

ANSI/HI 2.6 – Vertical Pump Tests

ANSI/HI 9.1-9.5 – Pumps-General Guidelines Types, Definitions, Application and Sound Measurements.

IGCI – Industrial Gas Cleaning Institute Standards.

MIL – U.S. Department of Defense - Military Specification:

MIL-1-24244C Amendment 3 – Insulation Material, with Special Corrosion, Chloride, and Fluoride Requirements.

MSS – Manufacturers Standardization Society of the Valve and Fittings Industry:

MSS-SP-25 – Standard Marking System for Valves, Fittings, Flanges and Unions.

MSS-SP-42 – Class 150 Corrosion-Resistant Gate, Globe, Angle, and Check Valves with Flanged and Butt-Weld Ends.

MSS-SP 55 – Quality Standard for Steel Castings-Visual Method.

MSS-SP 67 – Butterfly Valves.

MSS-SP 80 – Bronze Gate, Globe, Angle and Check Valves.

MSS-SP-91 – Guidelines for Manual Operation Valves.

NACE – National Association of Corrosion Engineers Recommended Practices.

NFPA – National Fire Protection Association Codes:

ANSI/NFPA 10, Portable Fire Extinguishers.

ANSI/NFPA 12, Carbon Dioxide Extinguishing Systems.

ANSI/NFPA 13, Installation of Sprinkler Systems.

ANSI/NFPA 14, Installation of Standpipe and Hose Systems.

ANSI/NFPA 15, Water Spray Fixed Systems.

ANSI/NFPA 20, Installation of Centrifugal Fire Pumps.

ANSI/NFPA 22, Water Tanks for Private Fire Protection.

ANSI/NFPA 24, Private Fire Service Mains and Their Appurtenances.

ANSI/NFPA 26, Supervision of Valves Controlling Water Supplies for Fire Protection.

ANSI/NFPA 30, Flammable and Combustible Liquids Code.

ANSI/NFPA 37, Stationary Combustion Engines and Gas Turbines.

ANSI/NFPA 54, National Fuel Gas Code.

ANSI/NFPA 70, National Electrical Code.

ANSI/NFPA 72, National Fire Alarm Code.

ANSI/NFPA 78, Lightning Protection Code.

ANSI/NFPA 255, Method of Test of Surface Burning Characteristics of Building Materials.

ANSI/NFPA 850, Steam Electric Generating Plants.

ANSI/NFPA 1961, Fire Hose.

ANSI/NFPA 1962, Care, Use, and Service Testing of Fire Hose Including Couplings and Nozzles.

ANSI/NFPA 1963, Screw Threads and Gaskets for Fire Hose Connections.

PFI – Pipe Fabrication Institute Standards.

PPI – Plastic Pipe Institute Standards.

SSPC – Steel Structures Painting Council:

SSPC-PA1 – Shop, Field, and Maintenance Painting.

SSPC-PA2 – Measurement of Dry Paint Thickness with Magnetic Gages.
SSPC-SP1 – Solvent Cleaning.
SSPC-SP2 – Hand Tool Cleaning.
SSPC-SP3 – Power Tool Cleaning.
SSPC-SP6 – Commercial Blast Cleaning.
SSPC-SP8 – Pickling.
SSPC-SP10 – Near-White Blast Cleaning.

TEMA – Tubular Exchanger Manufacturers Association Standards.

UBC – Uniform Building Code:

Chapter 3, Classification of All Buildings by Use or Occupancy and General Requirements for All Occupancies.
Chapter 6, Type 11 One-Hour and 11-N Buildings.
Chapter 10, Exits.
Chapter 15, Roof Construction and Covering.
UL – Underwriters' Laboratories Standards.

UPC – Uniform Plumbing Code

Other recognized standards will be used as required to serve as design, fabrication, and construction guidelines when not in conflict with the above listed standards. The codes and industry standards used for design, fabrication, and construction will be the codes and industry standards, including all addenda, in effect as stated in equipment and construction purchase or contract documents.

10.3.2.1 Reliability Codes and Standards

The design and specification of work will be in accordance with the laws and regulations of the federal government, the state of California, and with local codes and ordinances. The following laws, ordinances, codes, and standards have been identified as applying to power plant reliability, design, and construction. In cases where conflicts between cited codes (or standards) exist, the requirements of the more conservative code will be met.

10.3.2.1.1 Federal

None are applicable.

10.3.2.1.2 State

Both the Warren-Alquist Energy Resource Conservation and Development Act, Public Resources Code (PRC) Section 25000 et seq., and the California Energy Commission (CEC) Siting Regulations require the applicant to submit detailed information describing measures proposed to ensure the safe and reliable operation of the facility and the design and feasibility of all systems and components related to the generation of power (PRC Sections 25511 and 25520).

10.3.2.1.3 County

None are applicable.

10.3.2.2 Industry Codes and Standards

There are no industry codes or standards that govern power plant reliability; however, there are trade organizations or associations that are generally recognized as authorities and leaders in the field of power plant availability and reliability. Definitions used by these organizations have become generally accepted as a common means of communicating and the data published have been found useful. The organizations are as follows:

- The Electric Power Research Institute (EPRI):
P.O. Box 50490
Palo Alto, CA 94303
Telephone (415) 965-4081
- North American Electric Reliability Council (NERC):
Research Park
Terhune Road
Princeton, NJ 08540-3573
Telephone (609) 924-6050

10.3.3 Mechanical Engineering General Design Criteria

The systems, equipment, materials, and their installation will be designed in accordance with the applicable codes; industry standards; and local, state, and federal regulations; as well as the design criteria; manufacturing processes and procedures; and material selection, testing, welding, and finishing procedures specified in this section.

Detailed equipment design will be performed by the equipment vendors in accordance with the performance and general design requirements.

10.3.3.1 HRSGs

HRSGs will be sized in accordance with the heat balances. The HRSG design will meet the requirements of the ASME Boiler and Pressure Vessel Code, Section I, ASME Boiler and Pressure Vessel Code, ASME B31.1, and other applicable codes and standards. Access design and egress requirements for the HRSGs will meet the requirements of NFPA and OSHA.

10.3.3.2 CTs

CTs will be sized in accordance with the heat balances. CT design will meet the requirements of ASME, ANSI B133, NFPA, and other applicable codes and standards.

10.3.3.3 ST

The ST will be sized in accordance with the heat balances. ST design will meet the requirements of the ASME Boiler and Pressure Vessel Code, ASME TDP-1, and other applicable codes and standards.

10.3.3.4 Pumps

Pumps will be sized in accordance with industry standards. Where feasible, pumps will be sized for maximum efficiency at the normal operating point. Pumps will be designed to be free from excessive vibration throughout the operating range.

10.3.3.5 Tanks

Water storage tanks will be designed in accordance with API or AWWA.

Large outdoor storage tanks will be uninsulated except where required to maintain appropriate process temperatures or for personnel protection.

Overflow connections and lines will be provided. Maintenance drain connections will be provided for complete tank drainage.

Manways will be at least 18 inches in diameter and hinged to facilitate removal. Storage tanks will have ladders and cleanout doors as required to facilitate access/maintenance. Provisions will be included for proper tank ventilation during internal maintenance.

10.3.3.6 Heat Exchangers

The air cooled condenser and cooling water heat exchanger will be sized based on the heat balances and equipment manufacturer heat loads. The condenser and cooling water heat exchanger will be designed in accordance with HEI, ASME Boiler and Pressure Vessel Code, and TEMA.

10.3.3.7 Pressure Vessels

Pressure vessels will be designed in accordance with the ASME Boiler and Pressure Vessel Code, Section VIII, Division I. Pressure vessels will include all necessary vent, drains, process connections, manways, and relief valves.

10.3.3.8 Piping

Piping will be designed, selected, and fabricated in accordance with the following criteria.

10.3.3.8.1 Design Temperature and Pressure

The design pressure and temperature for piping will be consistent with conditions established for the design of the associated system.

The design pressure of a piping system generally will be based on the maximum sustained operating pressure that may act on the system plus 25 psi rounded up to the next 10 psi increment.

The design temperature of a piping system generally will be based on the maximum sustained operating temperature which may act on the system plus 10° F rounded up to the next 5° F increment.

10.3.3.8.2 General Design and Selection Criteria

Piping will be designed in accordance with the requirements of the ASME Code for Pressure Piping, ASME B31.1-Power Piping, and other codes and standards referenced in Section

2.5.3. Pipe stress analysis will be performed in accordance with ASME B31.1. All pipe supports will be suitable to restrain the piping where subjected to external loads as stipulated by the Uniform Building Code - Seismic and Wind Load Criteria.

Material selection will generally be based on the design temperature and service conditions in accordance with the following:

- Carbon steel piping materials will be used for design temperatures less than or equal to 750° F.
- ASTM A335 Grade P22 or P91 steel piping materials will be used for design temperatures greater than 750° F.
- Five percent chromium alloy steel piping materials will be used where flashing may occur.
- Stainless steel piping materials will be used as follows:
 - Piping applications requiring a high degree of cleanliness generally including
 - Injection water supply piping after strainers, air compressor inlet piping,
 - Miscellaneous lubricating oil system piping, and sampling piping after process isolation valves.
 - Piping generally subjected to corrosive service applications.
- Copper piping materials will be used for aboveground control air piping and for 2 inch and smaller service air piping in which cleanliness is critical.
- Fiberglass reinforced plastic piping materials will be used only in applications requiring corrosion-resistant materials.
- The above listed materials, or other suitable piping materials listed in Section 10.3.1.3, Piping Materials, will be used where required for special service to meet specific requirements.

Materials selected for use with main cycle systems will be free of copper materials to allow the cycle to be treated at the optimum pH for corrosion protection of carbon steel components.

10.3.3.8.3 Piping Materials

Piping materials will be in accordance with applicable ASTM and ANSI standards. Materials to be incorporated in permanent systems will be new, unused, and undamaged. Piping materials will be in accordance with the following criteria:

- Carbon steel piping 2-inch nominal size and smaller will be ungalvanized ASTM A106, Grade B minimum.
- Carbon steel piping 2.5 inch through 26-inch nominal size will be ungalvanized ASTM A53 Grade B seamless or A106 Grade B, with the indicated grades as a minimum. Carbon steel piping larger than 26 inch nominal size will be ASTM A672 Grade B70,

Class 21, for steam service, and ASTM A134 (with ASTM A283 Grade C plate material) for cold water service, with the industrial grades as a minimum.

- Alloy steel pipe, including large diameter special wall pipe, will be ungalvanized seamless type. Alloy steel pipe with a 1.25 percent chromium content will conform to ASTM A335, Grade P11. Alloy steel pipe with a 2.25 percent chromium content will conform to ASTM A335, Grade P22. Alloy steel pipe with a 5 percent chromium content will conform to ASTM A335, Grade P5. Alloy steel pipe with a 9 percent chromium content will conform to ASTM A335, Grade P91.
- Stainless steel pipe will be ASTM A312 Grades TP 304, TP 304L, TP 316, or TP 316L, seamless piping. All stainless steel piping materials will be fully solution annealed prior to fabrication. The Type 316 materials will be utilized for high resistance to corrosion. The Type 316L materials will be utilized for applications requiring hot working (welding, etc.).
- Schedule numbers, sizes, and dimensions of all carbon steel and alloy steel pipe will conform to ANSI B36.10. Sizes and dimensions of stainless steel pipe designated as Schedule 5S, 10S, 40S, or 80S will conform to ANSI B36.19. Schedule numbers, sizes, and dimensions of stainless steel pipe not designated as 5S, 10S, 40S, or 80S will conform to ANSI B36.10.
- Galvanized carbon steel piping will be ASTM A53 Grade B. The piping will be hot-dip galvanized. The use of galvanized steel pipe will be limited to systems where a high degree of cleanliness is required or where codes require the use of galvanized steel pipe rather than black steel pipe.
- Lining materials for rubber lined carbon steel pipe, method of application, and lining manufacturer will be chosen in accordance with service requirements.
- Copper alloy pipe will conform to ASTM B43, Seamless Red Brass Pipe.
- Polypropylene lined pipe will be ASTM A53 steel pipe with an applied liner of polypropylene.
- Fiberglass reinforced plastic pipe will be chosen in accordance with the specific service requirements.
- Polyvinyl chloride (PVC) pipe will conform to ASTM D1785 or ASTM D2241.
- Chlorinated polyvinyl chloride pipe will conform to ASTM F441.
- High density polyethylene pipe will conform to ASTM D3350 with a Plastic Pipe Institute rating of PE 3406 or 3408.

10.3.3.8.4 Tubing Materials

Tubing materials will generally be in accordance with the following criteria:

- Copper tubing 3/8 inch and smaller will be light drawn temper tubing conforming to ASTM B75. Copper tubing, 1/2 inch and larger, will be ASTM B88 Type K drawn

temper. Copper tubing will be oxygen-free or phosphorus deoxidized copper. Oxygen bearing tough pitch copper tubing will be used.

- Stainless steel tubing will conform to ASTM A213, Type 316. All stainless steel tubing will be of the fully annealed type, with a carbon content greater than 0.04 percent. Stainless steel tubing for use with tubing fittings will not exceed Rockwell B80 hardness.
- Wall thickness for tubing will be as required for specific design pressure and temperature conditions.

10.3.3.8.5 Fitting Materials

Fittings will be constructed of materials equivalent to the pipe with which they are used, except for special cases such as polypropylene lined steel pipe and rubber lined steel pipe:

- Steel fittings 2.5 inches and larger will be of the butt welding type and steel fittings 2 inches and smaller will be of the socket welding type, except galvanized steel fittings will be threaded.
- The wall thicknesses of butt welding fittings will be equal to the pipe wall thickness with which they are used. The fittings will be manufactured in accordance with ANSI B16.9, ANSI B16.28, and ASTM A234 or ASTM A403.
- Forged steel fittings will be used for socket weld and steel threaded connections and will conform to ANSI B16.11.
- Cast carbon steel flanged fittings will conform to ANSI B16.5 and will be of materials conforming to ASTM A216 WCB.
- Reducing outlet tees should be used in lieu of specially designed adapters for branch piping 2.5 inches and larger whenever possible. Branch connections 2 inches and smaller will be made with special reinforced welding adapters.
- Flanged cast iron or ductile iron fittings used with rubber-lined pipe will be lined with the same materials as the pipe with which they are used.
- Screwed brass and bronze pipe fittings will conform to ANSI B16.15. Flanged brass and bronze pipe fittings will conform to ANSI B16.24.

10.3.3.8.6 Flanges, Gaskets, Bolting, and Unions

Flanged joints will be in accordance with the following requirements:

- Flanges mating with flanges on piping, valves, and equipment will be of sizes, drillings, and facings, which match the connecting flanges of the piping, valves, and equipment. Flange class ratings will be adequate to meet the design pressure and temperature values specified for the piping with which they are used. Flanges will be constructed of materials equivalent to the pipe with which they are used.
- Steel flanges will conform to ANSI B16.5. Carbon steel flanges will be of ASTM A105 material. Carbon steel flanges will not be used for temperatures exceeding 750° F.
- Chromium alloy steel and stainless steel flanges will conform to ASTM A182.

- Brass and bronze screwed companion flanges will be plain faced and will conform to Class 150 or Class 300 classifications of ANSI B16.24. Drilling will be in accordance with ANSI Class 125 or Class 250 standards.
- Compressed fiber gaskets will be used with flat face flanges and raised face slip-on flanges.
- Spiral wound gaskets will be used with raised face flanges, except for raised face slip-on flanges. Gaskets containing asbestos are not acceptable.

Gaskets will be suitable for the design pressures and temperatures:

- Compressed fiber gaskets will be in accordance with ANSI B16.21, and materials will be suitable for a maximum working pressure of 600 psi and a maximum working temperature of 75° F.
- Spiral wound gaskets will be constructed of a continuous stainless steel ribbon wound into a spiral with nonasbestos filler between adjacent coils.
- Rubber gasket materials will be cloth inserted sheet rubber and will conform to ANSI B16.21.

10.3.3.8.7 Cathodic Protection

Where required, underground piping will be electrically isolated from aboveground piping and other steel components to allow the underground piping to be cathodically protected. Isolation will be achieved by installation of isolation flanges with insulating gaskets, tubes, and washers.

10.3.3.8.8 Piping Fabrication

Piping fabrication will generally be in accordance with the requirements of the Piping Fabrication Institute (PFI) and ASME B31.1.

Welding procedures, welders, and welding operators will be qualified in accordance with code requirements. Backing rings will not be used for shop or field welds except where specifically permitted.

Inspection and testing of piping will be performed in accordance with the requirements of the applicable code.

Nondestructive testing will generally include visual, radiographic, magnetic particle and liquid penetrant, and ultrasonic examinations:

- Visual examination of welds will be performed by personnel qualified and certified in accordance with AWS QC1, Standard for Qualification and Certification of Welding Inspectors.
- Radiographic examination will be performed on welds requiring examination under the applicable code.
- Magnetic particle and liquid penetrant examination will be performed as required by the applicable code.

- Ultrasonic tests will be performed as required by the applicable code.

10.3.3.8.9 Pipe Supports and Hangers

The term “pipe supports” includes all assemblies such as hangers, floorstands, anchors, guides, brackets, sway braces, vibration dampeners, positioners, and any supplementary steel required to attach pipe supports.

All support materials, design, and construction will be in accordance with the latest applicable provisions of the Power Piping Code, ASME B31.1.

Seismic design of piping systems will be in accordance with criteria as stipulated by the Uniform Building Code.

10.3.3.9 Valves

Valve pressure classes, sizes, types, body materials, and end preparations will generally be as described herein. Special features, automation, and special application valves will be utilized where required.

Steel body gate, globe, angle, and check valves will be designed and constructed in accordance with ANSI B16.34 as applicable.

Iron body gate, globe, and check valves will have iron bodies and will be bronze mounted. The face-to-face dimensions will be in accordance with ANSI B16.10.

Rubber-seated butterfly valves will be generally constructed in accordance with AWWA C504 Standard for Rubber-Seated Butterfly Valves. The valves will also generally conform to the requirements of MSS Standard Practice SP-67, Butterfly Valves. Valves of the wafer or lug wafer type will be designed for installation between two ANSI flanges. Valves with flanged ends will be faced and drilled in accordance with ANSI B16.1. The selected use of butterfly valves will be in accordance with the pressure temperature ratings specified in AWWA C504, the pressure temperature ratings specified by the manufacturer.

10.3.3.10 Insulation and Lagging

The insulation and lagging to be applied to piping, equipment, and ductwork for the purposes of reducing heat loss, reducing sweating, and personnel protection will be in accordance with the following criteria.

10.3.3.10.1 Insulation Materials and Installation

Insulation materials will be inhibited and of a low halogen content so that the insulation meets the requirements of MLL-1-24244 Amendment 3 regarding stress-corrosion cracking of austenitic stainless steel. Insulation materials will contain no asbestos.

All piping operating above 130° F will be insulated with calcium silicate molded insulation in accordance with ASTM C533.

Equipment and ductwork operating at elevated temperatures will be insulated with calcium silicate block or mineral fiber block insulation.

Mineral fiber block insulation for use on equipment surfaces will be in accordance with ASTM C612, Class 3, and have a density of 8 to 12 pcf.

Insulating cements will be mineral fiber thermal insulating cements and will conform to ASTM C195.

10.3.3.10.2 Lagging Materials and Installation

All insulated surfaces of equipment, ductwork, piping, and valves will be lagged. All aluminum lagging will be ASTM B209 Alclad 3004 or an acceptable equal. All aluminum lagging will be stucco pattern embossed.

10.3.3.10.3 Freeze Protection

All aboveground water and steam piping will be arranged to allow drainage to protect the piping from freezing. The piping systems will be arranged to minimize the amount of piping requiring drainage for freeze protection.