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MECHANICAL DESIGN CRITERIA

(PROJECT STANDARDS AND SPECIFICATIONS)

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SCOPE

This Project Engineering Standard summarizes the codes, standards, criteria, and practices that will be generally used in the design and construction of mechanical engineering systems for general chemical industries. The general mechanical design criteria defined herein form the basis of the design for the mechanical components and systems of the project. 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 is generally used.

DEFINITIONS AND TERMINOLOGY

Code - a set of rules or principles or laws (especially written ones)

Safety valve - a valve mechanism for the automatic release of a substance from a boiler, pressure vessel, or other system when the pressure or temperature exceeds preset limits. It is part of a bigger set named pressure safety valves (PSV) or pressure relief valves (PRV)

Joint - junction by which parts or objects are joined together

Flange - plate or ring to form a rim at the end of a pipe when fastened to the pipe

Gasket - mechanical seal that fills the space between two mating surfaces,may also be called a seal, generally to prevent leakage from or into the joined objects while under compression.

Cathodic protection (CP) - a technique to control the corrosion of a metal surface by making it work as a cathode of an electrochemical cell. This is achieved by placing in contact with the metal to be protected another more easily corroded metal to act as the anode of the electrochemical cell.

Welding - fastening two pieces of metal together by softening with heat and applying pressure

Lubrication - process, or technique employed to reduce wear of one or both surfaces in close proximity, and moving relative to each another, by interposing a substance called lubricant between the surfaces to carry or to help carry the load (pressure generated) between the opposing surfaces

UNITS

This Standard is based on Units of the design country, except where otherwise specified.

CODES AND STANDARDS

The design and specification of all work shall be in accordance with all applicable laws and regulations of the federal government, the State of California, and the applicable local codes and ordinances. A summary of the codes and industry standards to be used in design and construction is listed below.

- American Boiler Manufacturers Association (ABMA)
- AFBMA - Antifriction Bearing Manufacturers Association
- AGMA - American Gear Manufacturers Association Specification 390 - Gear Classification
- AMCA - Air Movers Control Association
- ASCE - American Society of Civil Engineers
- ASME - American Society of Mechanical Engineers Boiler and Pressure Vessel Code:
  - Section II - Materials Specification - Section V - Nondestructive Examination
  - PTC 22 - Performance Test Code
- ASNT - American Society for Nondestructive Testing
- AWS - American Welding Society
- AWA-D-100 Welded Steel Tanks for Water Storage
- EJMA - Expansion Joint Manufacturing Association
- EPA - Environmental Protection Agency
- HI - Hydraulic Institute
- HEI - Heat Exchange Institute
- IEEE - Institute of Electric and Electronics Engineers
- ISA - Instrument Society of America
- NBS - National Bureau of Standards
- NEMA - National Electrical Manufacturers Association
- OSHA - Occupational Safety and Health Administration, Department of Labor

- CALOSHA - California Occupational Safety and Health Administration
- PFI - Pipe Fabrication Institute
- TEMA - Tubular Exchanger Manufacturers Association
- TIMA - Thermal Insulation Manufacturers Association
- BOCA - Building Officials and Code Administrators
- API - American Petroleum Institute
  - SL Specification for Line Pipe
- ASTM - American Society for Testing and Materials
- ASTM Standard Material Specifications
  - ASTM A36-Standard Specification for Structural Steel
  - ASTM A53-Standard Specification for Pipe, Steel Black and Hot-Dipped Zinc-Coated Welded and Seamless
  - ASTM A105-Standard Specification for Forgings, Carbon Steel for Piping Components
  - ASTM A106 Standard Specification for Seamless Carbon Steel Pipe for High Temperature Service
  - ASTM A159 Standard Specification for EFW Steel Pipe (size 4' and over)
  - ASTM A126 Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
  - ASTM A182-Standard Specification for Forged or Rolled Alloy Steel Pipe Flanges/Forged Fitting and Valves and Parts for High-Temperature Service
  - ASTM A193-Standard Specification for Alloy-Steel and Stainless Steel Bolting
- Materials for High-Temperature Service
  - ASTM A194-Standard Specifications for Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service
  - ASTM A213-Standard Specification for Seamless Ferritic and Austenitic Alloy Steel Boiler,
  - Superheater, and Heat-Exchanger Tubes
  - ASTM A216-Standard Specifications for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service

- ASTM A217-Standard Specification for Steel Castings, Martenistic Stainless and Alloy for Pressure Containing Parts, Suitable for High-Temperature Service
- ASTM A234-Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
- ASTM A307-Standard Specifications for Carbon Steel Bolts and Studs, 60,000 psi, Tensile Strength
- ASTM A312-Standard Specification for Seamless and Welded Austenitic Stainless Steel Pipes
- ASTM A335-Standard Specification for Seamless Ferritic Alloy-Steel Pipe for High-Temperature Service
- ASTM A351-Standard Specification for Steel Castings, Austenitic, for High Temperature Service
- ASTM A387-Standard Specification for Pressure Vessel Plates, Alloy Steel Chromium-Molybdenum
- ASTM A403-Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings
- ASTM A490-Specification for Heat-Treated, Steel Structural Bolts, 150 ksi Tensile Strength
- ASTM B61-Standard Specification for Steam or Valve Bronze Castings
- ASTM B62-Composition Bronze or ounce Metal Castings
- ASTM B75-Standard 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 C195 (83)-Specification for Mineral Fiber Thermal Insulating Cement
- ASTM L411 (87)-Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation
- ASTM C533-Specification for Calcium Silicate Block and Pipe Thermal Insulation
- ASTM C612-Specification for Mineral Fiber Block and Board Thermal Insulation

- ASTM D1248-Specification for Polyethylene Plastics Molding and Extrusion Materials
- ASTM D1785-Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120
- ASTM D2241-Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
- ASTM D3350-Standard Specification for Polyethylene Plastic Pipe and Fittings Materials
- ASTM F441-Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80

- ANSI - American National Standards Institute
  - ANSI/NFPA 70 - National Electrical Code (NEC)
  - ANSI C50.10 - Synchronous Machines
  - ANSI C50.14 - Combustion-Gas Turbine Driven Cylindrical Rotor Synchronous Generators
  - ANSI C50.22 - Guide for Testing Insulation Resistance of Rotating Machinery
  - ANSI B1.1 - Unified Inch Screw Threads (UN and UNR thread form)
  - ANSI B18.2.1 - Square and Hex Bolts and Screws, Inch Series
  - ANSI B133.1 - Procurement Standards for Gas Turbines
  - ANSI B133.8 - Gas Turbine Installation Sound Emissions
- 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, Brazers, and Welding and Brazing Operators
  - ASME PTC-22 - Power Test Code for Gas Turbine Power Plants
  - ASME 1.20.1-Pipe Threads, General Purpose (inch)
  - ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800 lb.
  - ASME B16.3 - Malleable Iron Threaded Fitting, Class 150 and 300

- ASME B16.5 - Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and Other Special Alloys
- ASME B16.9 - Factory-Made Wrought Steel Buttwelding Fittings
- ASME B16.10 - Face-to-Face and End-to-End Ferrous Valves
- ASME B16.11 - Forged Steel Fittings Socket-Welding and Threaded
- ASME B16.20 - Metallic Gaskets for Pipe Flanges - Ring Joint, Spiral Wound & Jacketed
- ASME B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges
- ASME B16.24 - Bronze Pipe Flanges and Flanged Fittings, Class 150 and 300 lb.
- ASME B16.25 - Buttwelding Ends
- ASME B16.28 - Wrought Steel Buttwelding Short Radius Elbows and Returns
- ASME B16.34 - Valves - Flanged, Threaded and Welding End
- ASME B16.36 - Orifice Flanges
- ASME B16.47 - Large Diameter Steel Flanges NPS26 through NPS60
- ASME B31.1. - Power Piping
- ASME B36.10M - Welded and Seamless Wrought Steel Pipe
- ASME B36.19M - Stainless Steel Pipe
- ASME B46.1 - Surface Texture
- ANSI B73.1 - Specifications for Horizontal End Suction Centrifugal Pumps for Chemical Process

- MSS - Manufacturers Standardization Society of the Valve and Fittings Industry
  - MSS-SP 55 - Quality Standard for Steel Castings for Valves, Flanges, Fittings and Other Piping Components -Visual Method
  - MSS-SP 67 - Butterfly Valves
  - MSS-SP 80 - Bronze Gate-Globe-Angle and Check Valves
  - MSS-SP 84 - Steel Valves-Socket Welding and Threaded Ends
- AWS - American Welding Society
  - AWS - D1.1 - Structural Welding Code-Steel

- AWWA - American Water Works Association.
  - AWWA-C504 - Rubber Seated Butterfly Valves
  - AWWA-D100 - Standards for Welding Steel Tanks
- SSPC - Steel Structures Painting Council, Volume 2
  - SSPC-PA1 - Shop, Field, and Maintenance Painting
  - SSPC-PA2 - Measurement of Dry Paint Thickness with Magnetic Gages
  - SSPC-SPl - 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
- California Administrative Code, Title 8
  - Chapters 4 through 7, Groups 20 Flammable Liquids, Gases, and Vapors
  - Group 27, Fire Protection
- National Fire Protection Association (NFPA) codes
  - NFPA 10, Portable Fire Extinguishers
  - NFPA 12, Carbon Dioxide Extinguishing Systems
  - NFPA 13, Installation of Sprinkler Systems
  - NFPA 14, Installation of Standpipe and Hose Systems
  - NFPA 15, Water Spray Fixed Systems
  - NFPA 20, Centrifugal Fire Pumps
  - NFPA 22, Fire Water Storage Tank
  - NFPA 24, Private Fire Service Mains and Their Appurtenances
  - NFPA 26, Supervision of Valves Controlling Water Supplies for Fire Protection
  - NFPA 30, Flammable and Combustible Liquids Code
  - NFPA 37, Stationary Combustion Engines and Gas Turbines.
  - NFPA 70, National Electrical Code

  - NFPA 72E, Automatic Fire Detectors
  - NFPA 214, Water Cooling Towers
- California Building Code (CBC)
- Cooling Tower Institute (CTI)
- Hydraulic Institute Standards (HIS)
- Uniform Building Code (UBC)
- UL – Underwriter's Laboratory
- UFC - Uniform Fire Code
- NEC - National Electrical 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.

GENERAL DESIGN CRITERIA

General

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

The equipment vendors in accordance with general performance requirements will perform detailed equipment design. The Engineering, Procurement, and Construction (EPC) contractor will specify general performance requirements. Equipment vendors will be responsible for using construction materials suited for the intended use.

Materials

Asbestos will not be present in the materials and equipment supplied. Materials will be selected to withstand the design operating conditions, including expected ambient conditions for the design life of the facility. It is anticipated that some materials will require replacement during the life of the facility due to corrosion, erosion, or other factors.

Equipments

Pumps

For each application, pumps will be sized to accept an impeller at least 1/8 inch larger in diameter than the impeller specified without having to change the casing. Where necessary, vent and drain valves will be fitted at suitable points on the pump casing. Horizontal split case pumps will allow the removable half-casing and impeller to be withdrawn without disturbing any of the process piping or valves. Horizontal end-suction pumps will allow the impeller to be withdrawn from the motor end without disturbing the motor or discharge piping.

Vertical shaft pumps will generally be arranged to work with the pump casing submerged in a sump or tank. The suction branch will be arranged vertically downward and, if required for the service conditions, will be fitted with a strainer. The discharged piping and non return valve will be arranged to facilitate withdrawing the complete shaft and pump casing as a unit by splitting a pipe joint above floor level.

Strainers (startup or permanent) will be installed in the suction piping of horizontal pumps or sets of pumps. Horizontal-shaft centrifugal pumps will have radially fully balanced impellers. The driver will be mounted on an extension of the pump bedplate and will drive the pump through a flexible coupling with OSHA coupling guard.

Where necessary, pumping systems with variable flow requirement will have a recirculation line for pump protection. The recirculation line will normally be routed to the source from which the system takes suction. Modulating or two-position automatic recirculation valves or restriction orifices will be used as applicable. For boiler feed water pump and condensate pump, modulating automatic recirculation control valves or combined recirculation/check valves will be used.

Pumps may have either packing or mechanical seals, as determined by the application. Pumps that have mechanical seals will be arranged to facilitate seal removal. Shaft slingers will be specified to prevent packing gland leakage water from entering the bearing housings.

Bearings requiring cooling water will include the appropriate pipework, valves, and strainers. For vertical shaft fresh water or condensate pups, bearings below water level will be water lubricated.

The weight of the impeller and shafting for vertically suspended pumps will be supported by the motor thrust bearing.

Couplings and intermediate shafting will be guarded. Bedplates will be of ample proportions and stiffness to withstand the loads likely to be experienced in shipment and service.

Tanks

Large outdoor storage tanks will not be insulated 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.

Manholes, where provided, will be at least 24-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.

Heat Exchanger

Heat exchangers will be provided as components of mechanical equipment packages and may be shell-and-tube or plate type. Heat exchangers will be designed in accordance with TEMA or manufacturer's standards.

Fouling factors for shell-and-tube exchangers will be in accordance with TEMA practices. The heat exchangers shall be designed and constructed in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, latest edition and addenda.