

MECHANICAL ENGINEERING DESIGN CRITERIA

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E.1 INTRODUCTION

This appendix summarizes the codes, standards, criteria, and practices that will be generally used in the design and construction of mechanical engineering systems for the Bullard Energy Center (BEC). More specific project information will be developed during execution of the project to support detailed design, engineering, material procurement specification, and construction specifications.

E.2 CODES AND STANDARDS

The design of the mechanical systems and components will be in accordance with the laws and regulations of the federal government, the State of California, County of Fresno, and City of Fresno local ordinances and industry standards. The most current issue or revision of rules, regulations, codes, ordinances, and standards at the time of filing this Application for Certification (AFC) will apply, unless otherwise noted. If there are conflicts between cited documents, the more conservative requirements will apply.

The following codes and standards are applicable to the mechanical aspects of the power facility:

- California Building Standards Code, 2001
- American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code
- American National Standards Institute (ANSI) B16.5, B16.34, and B133.8
- ASME/ANSI B31.1 Power Piping Code
- ASME Performance Test Codes
- American Boiler Manufacturers Association (ABMA)
- American Gear Manufacturers Association (AGMA)
- Air Moving and Conditioning Association (AMCA)
- American Society for Testing and Materials (ASTM)
- American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE)
- American Welding Society (AWS)
- Cooling Tower Institute (CTI)
- Heat Exchange Institute (HEI)
- Manufacturing Standardization Society (MSS) of Valve and Fitting Industry
- National Fire Protection Association (NFPA)
- Hydraulic Institute Standards (HIS)
- Tubular Exchanger Manufacturers Association (TEMA)

E.3 GENERAL DESIGN CRITERIA

E.3.1 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.

E.3.2 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 plant. It is anticipated that some materials will require replacement during the life of the plant due to corrosion, erosion, or other factors.

E.3.3 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.

E.3.4 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.

E.3.5 Heat Exchangers

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 will be specified in accordance with TEMA.

E.3.6 Pressure Vessels

Pressure vessels will include the following features and appurtenances:

- Process, vent, and drain connections for startup, operation, and maintenance.
- Materials compatible with the fluid being handled.
- A minimum of one manhole and one air ventilation opening will be provided where required for maintenance or cleaning access.
- For vessels requiring insulation, shop-installed insulation clips spaced not greater than 18-inches on center will be utilized.
- Relief valves will be provided for all pressure vessels in accordance with applicable codes.

E.3.7 Piping and Piping Supports

Stainless steel pipe may be Schedule 10S where design pressure permits. Stainless steel piping will be used for portions of the lubricating oil system downstream of the filters. Carbon steel piping may be used elsewhere. Underground piping may be high-density polyethylene (HDPE) or polyvinyl chloride (PVC) where permitted by code, operating conditions, and fluid properties. Victaulic or equal couplings may be used for low pressure aboveground piping, where feasible. Threaded joints will not be used in piping used for steam, lubricating oil, and for natural gas service.

In general, water system piping will be HDPE or PVC where embedded or underground and carbon steel where aboveground. Appropriately lined and coated carbon steel pipe or ductile iron pipe may be used for buried water piping.

Piping systems will have high-point vents and low-point drains. Hose and process tubing connections to portable components and systems will be compatible with the respective equipment suppliers' standard connections for each service.

E.3.8 Valves

E.3.8.1 General Requirements

Valves will be arranged for convenient operation from floor level where possible and, if required, will have extension spindles, chain operators, or will be gearing. Hand-actuated valves will be operable by one person. Gear operators will be provided on manual valves 8 inches or larger.

Valves will be arranged to close when the handwheel is rotated in a clockwise direction when looking at the handwheel from the operating position. The direction of rotation to close the valve will be clearly marked on the face of each handwheel.

The stops that limit the travel of each valve in the open or closed position will be arranged on the exterior of the valve body. Valves will be fitted with an indicator to show whether they are open or closed; however, only critical valves will be remotely monitored for position.

Valve materials will be suitable for operation at the maximum working pressure and temperature of the piping to which they are connected. Steel valves will have cast or forged steel spindles. Seats and faces will be of low-friction, wear-resistant materials. Valves in throttling service will be selected with design characteristics and of materials that will resist erosion of the valve seats when the valves are operated partly closed.

Valves operating at less than atmospheric pressure will include means to prevent air in-leakage. No provision will be made to repack valve glands under pressure.

E.3.8.2 Drain and Vent Valves and Traps

Drains and vents in 600-pound class or higher piping and 900 degrees Fahrenheit (°F) or higher service will be double-valved.

Drain traps will include air cock and easing mechanism. Internal parts will be constructed from corrosion-resistant materials and will be renewable.

Trap bodies and covers will be cast or forged steel and will be suitable for operating at the maximum working pressure and temperature of the piping to which they are connected. Traps will be piped to drain collection tanks or sumps and returned to the cycle if convenient.

E.3.8.3 Low-Pressure Water Valves

Low-pressure water valves will be the butterfly type of cast iron construction. Ductile iron valves will have ductile iron bodies, covers, gates (discs), and bridges; the spindles, seats, and faces will be bronze. Fire protection valves will be Underwriters Laboratories (UL)-approved butterfly valves meeting NFPA requirements.

E.3.8.4 Instrument Air Valves

Instrument air valves will be the ball type of bronze or stainless steel construction, with valve face and seat of approved wear-resistant alloy.

E.3.8.5 Non-return Valves

Non-return valves will be in accordance with ANSI standards and properly drained. Non-return valves in vertical positions will have bypass and drain valves. Bodies will have removable access covers to enable the internal parts to be examined or renewed without removing the valve from the pipeline.

E.3.8.6 Motor Actuated Valves

Electric motor actuators will be designed specifically for the operating speeds, differential and static pressures, flowrates, operating environment, and frequency of operations for the application intended. Electric actuators will have self-locking features. A handwheel and declutching mechanism will be provided to allow handwheel engagement at any time except when the motor is energized. Actuators will automatically revert back to motor operation by disengaging the handwheel. The motor actuator will be placed in a position relative to the valve that prevents leakage of liquid or gas from valve joints.

E.3.8.7 Safety and Relief Valves

Safety valves or relief valves will be provided as required by code for pressure vessels, heaters, and boilers. Safety and relief valves will be installed vertically. Piping systems that can be over-pressurized by a higher-pressure source will also be protected by pressure-relief valves. Equipment or parts of equipment that can be over-pressurized by thermal expansion of the contained liquid will also have thermal relief valves.

E.3.8.8 Instrument Root Valves

Instrument root valves will be specified for operation at the working pressure and temperature of the piping to which they are connected. Test points and sample lines in systems that are 600-pound class or higher service will be double-valved.

E.3.9 Heating, Ventilating, and Air Conditioning (HVAC)

HVAC system design will be based on site ambient conditions as described in Section 3.0, Facility Description and Location. Air conditioning will include both heating and cooling of filtered air.

Except for the HVAC systems serving the control room and administration areas, the systems will not be designed to provide comfort levels for extended human occupancy.

Air velocities in ducts, louvers, and grills will be low enough to minimize noise levels in areas where personnel are normally located.

Fans and motors will be mounted on anti-vibration bases to isolate units from the building structure. Exposed fan outlets and inlets will be fitted with guards. Belt-driven fans, pulleys, and belts will be provided with appropriate guards.

Air filters will be housed in a manner that facilitates removal. The filter frames will be designed to pass the air being handled through the filter without leakage.

Ductwork, filter frames, and fan casings will be constructed of galvanized mild steel sheets stiffened with galvanized mild steel flanges. Ductwork will be sectional bolted type and will be adequately supported. Duct joints will be leak tight. Grills and louvers will be of adjustable metal construction.

E.3.10 Thermal Insulation and Lagging

Parts of the facility requiring insulation to reduce heat loss or afford personnel safety will be thermally insulated. Minimum insulation thickness for hot surfaces near personnel will be designed to limit the outside lagging surface temperature to a maximum of 140°F, based on 80°F ambient temperature and 1 mile per hour (mph)/hour air velocity. Other insulation minimums will be designed to limit heat loss to 80 British thermal units (Btu)/hour-square foot based on 80°F ambient condition and an air velocity of 20 mph.

The thermal insulation will have as its main constituent calcium silicate, foam glass, fiberglass, or mineral wool, and will consist of pre-formed slabs or blankets, where feasible. Asbestos material will be prohibited. An aluminum jacket or suitable coating will be provided on the outside surface of the insulation. Where a hard setting compound is used as an outer coating, it

will be non-absorbent and non-cracking. Thermal insulation will be chemically inert even when saturated with water. Insulation system materials, including jacketing, will have a flame spreading rating of 25 or less when tested in accordance with ASTM E84.

Insulation at valves, pipe joints, or other points where access may be required for maintenance will be removable with minimum disturbance to the pipe insulation. At each flange joint, the molded material will terminate on the pipe at a distance from the flange equal to the over all length of the flange bolts to permit their removal without damaging the molded insulation.

Aboveground insulated piping will be clad with pebbled or corrugated aluminum lagging of not less than 30 millimeters (mm) thickness and frame reinforced. At the joints, the sheets will be sufficiently overlapped and corrugated to prevent moisture from penetrating the insulation.

Design temperature limits for thermal insulation will be based on system operating temperatures during normal operations.

Outdoor and underground insulation will be moisture resistant.

Any piping that is subject to freezing will be heat traced or have other means of freeze protection.

E.3.11 Testing

Hydrostatic testing, including pressure testing at 1.5 times the design pressure, will be performed for those components where in-service test is not feasible or permitted by code.

E.3.12 Welding

Welders and welding procedures will be certified in accordance with the requirements of applicable codes and standards before any welding is permitted. Contractors will maintain indexed records of welder qualifications and weld procedures.

E.3.13 Painting

Except as otherwise specified, equipment will receive the respective manufacturer's standard shop finish. Finish colors will be selected from amongst the paint manufacturer's standard colors.

Finish painting of uninsulated piping will be limited to that required by the Occupational Safety and Health Administration (OSHA) for safety or for protection from the elements.

Piping to be insulated will not be painted.

E.3.14 Lubrication

The types of lubrication specified for facility equipment will be suited to the operating conditions and will comply with the recommendations of the equipment manufacturers.

The initial startup charge of flushing oil will be the equipment manufacturer's standard lubricant for the intended service. Subsequently, such flushing oil will be sampled and analyzed to determine whether it can also be used for normal operation or must be replaced in accordance with the equipment supplier's recommendations.

Appendix E

Mechanical Engineering Design Criteria

Rotating equipment will be splash lubricated, force lubricated, or self lubricated. Oil cups will be provided as necessary. Where automatic lubricators are fitted to equipment, provision for emergency hand lubrication will also be specified. Where applicable, equipment will be designed to be manually lubricated while in operation without the need to remove protective guards. Lubrication filling and drain points will be readily accessible.

