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APPENDIX 10C

Mechanical Engineering Design Criteria

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10C1 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 Project. More specific project information will be developed prior to construction of the Project to support detailed design, engineering, material procurement specification and construction specifications as required by the California Energy Commission.

10C2 Codes and Standards

The design of the mechanical systems and components will be in accordance with the laws and regulations of the federal government, state of California, and industry standards. The current issue or revision of the documents, at the time of the filing of this AFC will apply, unless otherwise noted. If there are conflicts between the cited documents, the more conservative requirements shall apply.

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

- Uniform Building Code
- Uniform Mechanical Code
- Uniform Plumbing Code
- ASME Boiler and Pressure Vessel Code
- ASME B31.1 Power Piping Code
- ASME Performance Test Codes
- ASME Standard TDP-1
- ANSI B16.5, B16.34, B133.1 and B133.8
- American Boiler Manufacturers Association (ABMA)
- American Gear Manufacturers Association (AFMA)
- Air Moving and Conditioning Association (AMCA)
- American Petroleum Institute (API) – except for electrical requirements
- American Society for Testing and Materials (ASTM)
- American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE)
- American Water Works Association (AWWA)
- American Welding Society (AWS)
- Cooling Tower Institute (CTI)
- Heat Exchange Institute (HEI)
- Manufacturing Standardization Society (MSS) of the Valve and Fitting Industry
- National Fire Protection Association (NFPA)

10C3 Mechanical Engineering General Design Criteria

10C3.1 General

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 specified by the Design Engineers. Equipment vendors will be responsible for using construction materials suited for the intended use.

Asbestos will not be used in the materials and equipment supplied. Flanges manufactured in the People's Republic of China will be prohibited from use on any mechanical equipment. Where feasible, 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, etc.

10C3.2 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.

10C3.3 Tanks

Large outdoor storage tanks will not be insulated. Tanks will have butt-welded seams.

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

Maintenance holes, where provided, 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.

10C3.4 Heat Exchangers

The surface condenser will be designed in accordance with Heat Exchanger Institute (HEI) standards. Other 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 Tubular Exchanger Manufacturers Association (TEMA). Fouling factors will be specified in accordance with TEMA.

10C3.5 Pressure Vessels

Pressure vessels will include the following features / appurtenances:

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

10C3.6 Piping and Piping Supports

Stainless steel pipe may be Schedule 5S or 10S where design pressure permits. Underground piping may be high density polyethylene (HDPE) where permitted by code, operating conditions, and fluid properties. In general, water system piping will be HDPE where embedded or underground and carbon steel where above ground.

Piping systems containing steam will be of welded construction. Threaded joints will not be used in piping used for steam, lubricating oil, and CTG natural gas service. Natural gas piping components will not use synthetic lubricants. Victaulic, or equal, couplings will be used for low energy aboveground piping, where feasible.

Piping systems will have high point vents and low point drains. Drains with restricting orifices or steam traps with startup and blowdown drains and strainers/crud traps will be installed in low points of steam lines where condensate can collect during normal operation.

Steam piping systems and steam drain lines in the plant will be sloped in the direction of steam flow. Condensate collection in piping systems will be avoided by installing automatic drain devices and manual devices as appropriate.

Steam lines fitted with restricting devices, such as orifices in the process runs, will include adequate drainage upstream of the device to prevent water from collecting in lines.

Hose and process tubing connections to portable components and systems will be compatible with the respective equipment suppliers' standard connections for each service.

Stainless steel piping will be used for the lubricating oil system.

10C3.7 Valves

10C3.7.1 General Requirements

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

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.

10C3.7.2 Drain and Vent Valves and Traps

Drains and vents in 900 pound class or higher piping and 500º 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 tank or sumps and returned to the cycle if convenient.

10C3.7.3 Low Pressure Water Valves

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

10C3.7.4 Instrument Air Valves

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

10C3.7.5 Non-return Valves

Non-return valves for steam service 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.

10C3.7.6 Motor-Actuated Valves

Motor-actuated valves will be fitted with both hand and motor operating gear. The hand and motor actuation mechanisms will be interlocked so that the hand mechanism is disconnected before the motor is started.

Motor actuators will include torque switches to stop the motor automatically when the valve gate has reached the "full open" or "full closed" position.

The motor actuator will be placed in a position relative to the valve that prevents leakage of liquid, steam, or corrosive gas from valve joints onto the motor or control equipment.

10C3.7.7 Safety and Relief Valves

Safety valves and / 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 fluid will have thermal relief valves. HRSG safety valves will be flanged.

10C3.7.8 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.

10C3.8 Heating, Ventilating, and Air Conditioning

HVAC system design will be based on site ambient conditions specified in Section 2.0.

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 conditioning will include both heating and cooling of the inlet-filtered air. Air velocities in ducts and from louvers and grills will be low enough not to cause unacceptable noise levels in areas where personnel are normally located.

Fans and motors will be mounted on anti-vibration bases to isolate the units from the building structure. Exposed fan outlets and inlets will be fitted with guards. Wire guards will be specified for belt-driven fans and arranged to enclose the pulleys and belts.

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

Ductwork, filter frames, and fan casings will be constructed of mild steel sheets stiffened with mild steel flanges and galvanized. Ductwork will be the sectional bolted type and will be adequately supported. Duct joints will be leaktight.

Grills and louvers will be of adjustable metal construction.

10C3.9 Thermal Insulation and Cladding

Parts of the project 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 mph / hr air velocity. Other insulation minimums will be designed to limit the heat loss to approximately 80 Btu / hr-ft^2 based on an 80 °F ambient condition and an air velocity of 20 mph / hr.

The thermal insulation will have as its main constituent calcium silicate, foam glass, fiber glass, or mineral wool, and will consist of pre-formed slabs or blankets, where feasible. Asbestos materials 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 nonabsorbent and noncracking. Thermal insulation will be chemically inert even when saturated with water. Insulation system materials, including jacketing, will have a flame spread rating of 25 or less when tested in accordance with ASTM E 84.

Insulation at valves, pipe joints, steam traps, or other points to which access may be required for maintenance will be specified to be removable with a minimum of disturbance to the pipe insulation. At each flanged joint, the molded material will terminate on the pipe at a distance from the flange equal to the overall length of the flange bolts to permit their removal without damaging the molded insulation. Steam trap stations will be "boxed" for ease of trap maintenance and freeze protection.

Above ground insulated piping will be clad with pebbled or corrugated aluminum of not less than 30 mil 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 temperature during normal operation.

Outdoor and underground insulation, if required, will be moisture resistant.

10C3.10 Testing

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

10C3.11 Welding

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

10C3.12 Painting

Except as otherwise specified, equipment will receive the respective manufacturer's standard shop finish. Finish colors will be selected from among the paint manufacturer's standard colors and colors approved by the CEC.

Finish painting of uninsulated piping will be limited to that required by OSHA for safety or for protection from the elements.

Piping to be insulated will not be painted.

10C3.13 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 provided by the equipment manufacturer and will be the 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.

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 removal of protective guards. Lubrication filling and drain points will be readily accessible.