

ELECTRODE BOILER PACKAGE

1. GENERAL: The Seller shall design, fabricate, package, and deliver complete one (1) 100% shop-assembled packaged electrode type boiler with dedicated chemical feed system, sampling, controls and other required equipment and accessories for a complete Boiler Package. The boiler and associated equipment will be installed [*indoors or outdoors with more details*]. The electrode boiler and associated equipment shall be capable of continuously generating the required amount of saturated steam at the conditions specified in [*Table No.*]. The electrode boiler and associated equipment will supply steam to the [*process description*]. The electrode boiler shall be capable of operating from a [*supply voltage*] three phase electric power supply.

2. SCOPE OF WORK: The Seller shall be responsible for furnishing all Equipment and materials required by the Contract for a complete operational boiler package. The electrode boiler and associated equipment listed below shall meet the requirements for performance and efficiency as stated herein. The boiler package shall include the following at a minimum:

- [*Qty*] Electrode Steam Boiler operating on [*supply voltage*], 3-phase, 60Hz, 4- wire power supply.
- Boiler Surface blowdown valve(s)
- Boiler Bottom blowdown valve(s)
- Chemical Feed System that includes electrically driven feed pumps and controller, chemical storage tank, suction and discharge tubing/piping and valves
- Safety relief valves as required by the ASME Boiler and Pressure Vessel Code (with gags, drip pans and discharge piping)
- Startup vent valves sized for a minimum flow to support startup (if required)
- All necessary interconnecting piping within ASME Section I boundaries
- All necessary valves within ASME Section I boundaries
- Relief valve supports
- Water level gauges
- All pipe supports required for piping provided by Seller
- Connections for chemical feed for water chemistry control
- Electrode Boiler Circulation pump(s)
- Electric Standby Immersion heater(s)
- Steam and feedwater sampling system including sample conditioning equipment
- Necessary instrumentation for boiler level control feedwater flow element and steam outlet flow element
- Drain connections and valves for draining of the electrode boiler
- Steam flow nozzle and transmitter
- Feedwater flow nozzle and transmitter
- Chemical feed stop, check and vent valves
- Remotely operated blowoff valves

- High and low water alarms, and primary low water cut out including drain valves
- Steam and feed water trim including steam gauge with steam gauge shutoff valve
- Main steam stop/non-return valve and flow control valve
- Second main steam stop valve
- Vent valves
- Platforms and stairs/ladders to access top of boiler, relief valves, vent valve(s), and high voltage power cage.
- Programmable Logic Controller (PLC)

2.1 Electrode Boiler: The high-voltage electrode steam boiler shall be designed per ASME Power Boiler Code, Section I, and shall be built to ASME and NEC standards. The skid mounted and pre-wired electrode boiler unit shall include the electrode system, pressure vessel, circulating water system, and control system integrated together to function as a steam generating system. The electrode boiler shall work in conjunction with other associated equipment and accessories specified in this specification to provide the plant with steam based on the design requirement specified in the [*steam requirements*] Table.

The electrode boiler shall operate on the principle of utilizing the conductive and resistive properties of water to carry electric current and generate steam. The boiler shall generate heat by passing electric current from the electrode and nozzles through the boiler water using the water as the resistor. The electric resistance of water generates heat directly in the water as electric current flows through it.

2.1.1 Circulation Control: Regulation of the boiler output shall be accomplished by delivering boiler water to the nozzle header so that a greater or smaller number of nozzles are supplied with water, and thus, a greater or smaller amount of water comes into contact with the boiler electrodes. Control of the boiler water delivery, in turn, is accomplished by varying, via the variable speed circulation pump, the water flow to the header in accordance with the respective boiler control -- either to maintain the desired steam pressure or to prevent the boiler from drawing more than the desired kilowatts when the steam requirements exceed the KW set-point. The boiler electrodes shall be located entirely in the boiler steam space so that stopping of the boiler circulation pump will automatically affect boiler shutdown.

The unit shall be designed such that the electrodes remain energized when the circulation pump is off thus starting and stopping of the unit is accomplished by either changing the speed of the VFD or starting and stopping the circulation pump.

2.1.2 Immersion Heater: A Boiler Standby Heater shall be provided by the Seller to minimize the steam production time required from the boiler when transitioning from stand-by to full load. The heater shall be an immersion element type and shall maintain the boiler at the desired standby pressure when the circulation control is not generating steam.

2.1.3 Sampling: An automated sampling system and chemical feed shall be provided by the Seller to treat makeup water and maintain the required boiler water quality and

conductivity. The sampling system shall include sample conditioning equipment (sample coolers, PRV, flow metering) and a provision for grab. The conductivity analyzer transmitter shall be wired to the boiler system PLC.

2.4 Dedicated Boiler Chemical Feed System: The boiler feedwater at the boiler vessel is fed a chemical mixture containing boiler feed water treatment chemicals independent of the water treatment chemicals supplied to the feedwater tank. The metering pump shall have manual stroke adjustment capability for fine adjustment.

The Seller shall provide the chemical feed system required to maintain proper conductivity for proper boiler operation. One (1) chemical storage tank shall be supplied for the boiler.

2.5. Boiler Chemical Feed: The boiler chemical feed shall consist of a chemical storage tank, [*quantity*] boiler chemical feed pumps and appropriate valving, piping, instrumentation and controls to make a complete system.

[Option for redundant pumps: Two (2) boiler chemical metering pumps shall be provided in parallel. One pump is required for normal operation and the second pump shall be provided as a spare for the other pump.]

3. DESIGN AND CONSTRUCTION: The electrode boiler, associated equipment, and all accessories shall be in accordance with the detailed requirements of this Specification, Table [*number*] and all codes and standards as listed in Section [*number*].

It shall be the Seller's responsibility to ensure that all equipment, material and services meet the requirements of this Specification and that all of the Seller's suppliers comply with these requirements.

The design shall ensure reliable and efficient performance under varying operating conditions, keeping maintenance requirements to a minimum. In addition, all pressure parts shall be such that the capacity specified can be achieved without undue strain or deterioration. Provision shall be made for ready inspection and removal and for repair of all parts.

3.1 Mechanical: The Seller shall provide all shop and field installed pipe supports, piping, valves, instruments and primary control elements as required for a complete and functional boiler package. The electrode boiler shall be designed in accordance with ASME Boiler and Pressure Vessel Code, Section VIII with National Board registration. All components within the scope of administrative jurisdiction of the ASME Boiler and Pressure Vessel Code Section I shall be provided. The Seller shall furnish all safety valve drip pans/vents and supports, drains and miscellaneous trim piping as required.

During the manufacture of the boiler the Seller shall perform all tests necessary to show that the equipment conforms in all respects with the requirements of the Specification. The shop-assembled pressure containing components including external piping shall be hydrostatically tested in the shop and radiographed where required by the ASME code, Section I and VIII, and B31.1.

Steam sample point takeoffs shall be provided to allow continuous monitoring of boiler steam

quality. Makeup water and steam quality requirements are provided in [*document*].

The Seller shall furnish all boiler valves and trim as required by, and under the administrative jurisdiction of, ASME Boiler and Pressure Vessel Code Section I. All components are to be shop installed. The Seller shall provide double valves on all boiler vents and drains and where required by code. The vent and drain valves required for startup and shutdown shall be furnished with power actuators to enable remote operation from the plant Control Room.

All required equipment insulation for personnel protection and heat conservation shall be shop installed. Insulating materials shall be securely anchored to the insulated surface. Lagging shall not serve to support or hold insulation in place. Where required for inspection and maintenance purposes, insulation and lagging shall be installed in readily removable and replaceable sections. Where near-horizontal areas may be exposed to foot traffic, lagging insulation shall be stiff enough to support such traffic without distortion of the insulation or lagging.

3.2 Electrical: The electrode boiler and other accessories shall be suitable for operation on power feeds as described in this Section. The electrode boiler, and chemical feed units shall be completely wired. All internal wiring shall be in accordance with the National Electrical Code. All external wiring from devices located in the cabinet shall be terminated on terminal strips.

The Seller shall provide all motor starters for motors 480V and less (as required). The Contractor shall provide and install all field power cabling between Seller furnished starters and motors 480V and less. For instruments required to be field installed, Contractor will wire between components and local PLC terminal block interface.

Wiring between the electrode boiler PLC and 480V and less starters (if required) shall be by Seller. Starters supplied by Seller shall be located in PLC panels or in separate cabinets as required. Seller shall provide [*indoor/outdoor*] dry-type transformers as required to step voltage down to required control voltages. Seller shall control from Seller's PLC all 480V supplied motors. Ground fault protection must be in compliance with NEC article 230.95 Ground-Fault Protection of Equipment.

All electric motors shall be sized and selected for continuous operation at the required full load operating conditions, at maximum and minimum ambient temperature or equipment enclosure temperatures (whichever is the most severe condition) and meet all of the requirements outlined in Section [*number*].

3.3 Controls: The Seller shall provide all primary control elements and instrumentation required to support a control system provided by the Seller.

All modulating control shall be furnished by the boiler control system (BCS) provided by the Seller. The boiler pressure set point shall be maintained within the Seller PLC. The Seller furnished control system (BCS) shall control the electrode boiler and associated auxiliaries. All local and remote (through the DCS) instrumentation required for safe and reliable operation with detailed alarm notification shall be included.

The primary communication between the DCS and BCS will be via the Modbus TCP/IP communications link. All I/O points and internal calculated points (alarms, set points, flows, etc.) shall be available over the Ethernet link. In addition to this link, a limited number of critical signals shall be hardwired between the DCS and Boiler Control System (the quantity and specifics regarding these signals shall be determined during detailed design).

All control devices shall be shop installed and pre-wired to local control panels, to the maximum extent possible. For instruments, which are required to be field installed, Contractor will wire between components and local PLC.

The control shall permit the boiler to operate automatically with positive timed, programmed shutdown, standby, and safety interlock control. Seller shall provide a set of auxiliary dry contacts to signal high boiler vessel level and pressure. Seller shall include a common alarm back to the DCS provided by Others.

The electrode boiler controls shall provide for the boiler to maintain normal pressure without steam production for extended periods.

The boiler package shall be capable of being started, monitored and controlled from the plant DCS. As a minimum, boiler feedwater quality, boiler water level, power usage, boiler steam pressure and automated valve positions shall be available in the DCS.