



TECHNICAL SPECIFICATION

STEAM AND WATER SAMPLING SYSTEM

FOSSIL POWER PLANT

A. SPECIFICATION OVERVIEW

The sampling system shall monitor key chemical parameters which relate to the quality of process fluids in the steam-condensate-feedwater cycle and the quality of various other process fluids. The system provides data to operating personnel for detection of deviations from control limits so that corrective action can be taken. As a minimum, the following components shall be included in each sample line:

- Inlet Isolation Valve
- Primary Sample Cooler
- Variable Pressure Reducing Valve
- Secondary Sample Cooler
- Blowdown Valve
- Pressure Indicator
- Temperature Indicator
- Total Sample Line Flow Indicator
- High Temperature Shutoff Valve
- Back Pressure Regulating/Relief Valve
- Grab Sample
- Analyzer Branch Lines and Valved Flow Indicators as appropriate

The water analysis equipment shall be designed complete with all sample conditioning devices, analyzers, transmitters, indicators, recorders, annunciators, interlocks, etc. The general arrangement of the water analysis equipment proposed shall be shown by the bidder. The sample points and components on each line will be shown on the water analysis system P&ID.

B. SAMPLE CONDITIONING AND ANALYSIS EQUIPMENT

Under all sampling conditions, cells or analyzers not requiring minimum sample flow rate shall be designed with a flow rate of approximately 50-100 cc/min. If the analytical equipment requires some different flow rate, the analyzer minimum flow shall be the design basis. Total sample line flow should be at a rate of 6 feet/second (2 M/sec) to ensure a contemporary sample.



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To ensure representative samples, each sample shall flow continuously. Bumpless transfer shall be incorporated so that the flow to the analyzer is undisturbed by grab sampling or maintenance of analyzers.

The sampling system will be designed to include the following sub-systems and skids as required:

1. Sample Conditioning Rack
2. Wet Analyzer Rack
3. Control and Recorder Panel
4. Temperature Control Unit (TCU)

1. Sample Conditioning Rack

The conditioning rack shall be a free standing rack, into which all conditioning equipment is mounted. The sample shall be connected to the rack at the top rear side. From this point, the sample shall flow through tubing and various control instruments to condition its pressure, temperature, and flow rate.

The rack shall be constructed of structural steel that is finished in accordance with this specification. In addition, the rack should include a sample sink, drain and recovery headers, primary and secondary cooling water header system and sample conditioning and analysis modules, as described herein.

a. Components

The sample conditioning rack shall consist of sample lines as shown on the water analysis system P&ID. A typical line shall include the following items:

- 1) Bulkhead connection.
- 2) Manual isolation valve.

The manual isolation valve (immediately downstream of the interface point) shall allow the operator to isolate the sample line for maintenance and repair.

This valve shall be selected for the appropriate temperature and pressure requirements that will allow proper sample flow and provide for safety of the operator.

- 3) High pressure blowdown valve. To be located in parallel with the manual isolation valve (Item #2). (Option)

The optional manual high pressure blowdown valve shall allow the operator to manually blowdown the sample line to remove any particulate build up in the line. All blowdown valves shall be selected to meet the temperature and pressure requirements of the hottest sample. The blowdown discharge shall be piped to a blowdown header.



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4) Primary coolers and cooling water system.

Sample temperature shall be reduced using full counterflow sample coolers to achieve a temperature within 5⁰ F of the temperature of the primary cooling water. All coolers are furnished as an integral part of the conditioning rack. Certified performance data on all coolers shall be provided at design conditions.

All coolers shall be of the coil in shell design, with counterflow of sample and cooling water. Coolers shall be Sentry type TLF, FLF or FXF, with a single flange and gasket shell design. For maintenance, the sample coolers shall have removable shells. All coolers shall have 316 stainless steel tubing and 304 stainless steel shells.

All coolers shall be arranged side by side in the rack, and shall be connected to an inlet and an outlet cooling water header. Coolers shall be located for easy access to the throttling valves and for simplified maintenance and replacement, as necessary. In addition, cooling water piping shall not disturb the sample piping. Sample piping shall not interfere with the removal and replacement of the cooler coils and/or shells.

All coolers shall be equipped with outlet globe valves for throttling the flow of cooling water, and a 3-way ball valve on the inlet. Cooling water headers shall be of carbon steel and of the appropriate size to handle the required flow rate to the coolers. The inlet cooling water header shall be equipped with a relief valve sized to adequately relieve excess cooling water pressure. Outlet cooling water headers shall include a vent for air removal, as required.

5) Pressure reducing valve.

On sample lines with inlet pressures exceeding 500 psig (35 barg), a Sentry VREL[®] pressure reducing valve shall be used to provide this pressure reduction. The VREL[®] must have tapered rods with a threaded shaft extension into a bushing for support and guidance for the nut with tapered rod. Lines with sample pressures less than 500 psig (35 barg), shall use a metering type valve sized to provide the proper flow rate and pressure reduction of the sample.

6) Low pressure blowdown valve. (Option – preferred over high pressure blowdown)

The sampling system shall provide for appropriate blowdown connection for each sample line. The blowdown connection shall be downstream of the sample cooler and the pressure reduction device to assure complete flushing of the upstream sample line. The blowdown shall be routed to the sample sink for visual inspection.



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7) Thermal Shut-Off Valve. (Option)

The system shall include a Sentry Thermal Shut-Off Valve (TSV) on each sample line, to protect down-stream analyzers from cooling water failure by isolating the sample line at temperatures in excess of 120⁰ F. A contact on the temperature shut-off mechanism shall be used to provide an alarm upon actuation of the mechanism. The shut-off device shall be located down-stream of the pressure reducing valve and low pressure blowdown valve. This device should be a locking, mechanical only device suitable for sample pressures up to 4400 psig.

8) Secondary cooler. (Option)

Secondary coolers shall be provided to be used in conjunction with a closed Temperature Control Unit (TCU), to achieve a controlled temperature of 77± 1°F (25 ±0.5°C). The temperature control system will automatically maintain the sample temperature at 77± 1°F (25 ±0.5°C). All coolers are furnished as an integral part of the conditioning rack. Certified performance data on all coolers shall be provided at design conditions.

All coolers shall be of the coil in shell design, with counterflow of sample and cooling water. Coolers shall be Sentry type TLF single flange and gasket shell design. For maintenance, the sample coolers shall have removable shells. All coolers shall have 316 stainless steel tubing and 304 stainless steel shells.

All coolers shall be arranged side by side in the rack, and shall be connected to an inlet and an outlet cooling water header. Coolers shall be located for easy access to the throttling valves and for simplified maintenance and replacement, as necessary. In addition, cooling water piping shall not disturb the sample piping. Sample piping shall not interfere with the removal and replacement of the cooler coils and/or shells.

9) Pressure and temperature indicators.

Thermowells with bi-metal thermometers shall be installed in each of the sample lines at locations which will provide an accurate representation of each grab sample process condition. Minimum diameter acceptable is 3".

Pressure gauges shall be furnished after the pressure reducing device. The indicators shall be of type 316 stainless steel construction. Minimum diameter acceptable is 2-1/2".

All thermometers, gauges and indicators shall be clearly visible to operating personnel.



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10) Flow Indicators.

Rotameters shall be used to measure the total flow rate in the sample system. Rotameters shall be panel mounted such that flow tubes can be easily removed for cleaning from the front of panel. Minimum flow rating is 1600 cc/min. Each analyzer shall be provided with a flow indicator with integral control valve. Flow meters shall have the proper range for the particular analyzer being serviced.

11) Distribution line for the in line analysis.

12) Back pressure regulating/relief valve.

In order to provide a precise flow control, a back pressure regulator/relief valve shall be provided for each sample line. The back pressure regulating/relief valve shall provide pressure relief capability downstream of the pressure reducing valve. This relief protects the associated measuring cells and/or analyzers from overpressure in accordance with pressure limitations imposed by the cell/analyzer manufacturer. The valve shall be Sentry Model No. BPRVa-20. The discharge of the BPRV shall be used to allow grab sample collection without affecting flow to the analyzers. The discharge of the valves shall be piped to the sample sink.

b. Sample Sink

A grab sample collection facility consisting of a common 304 stainless steel sink and individual flexible tubing connected to the outlet of the back pressure/relief valve shall be furnished. The sink shall be large enough to accommodate one (1) liter bottles and shall have a 6" workshelf. The sink shall be a minimum of 7 3/4" (196 mm) wide x 6" (152 mm) deep and shall be sloped to one side for drainage. Grab samples will flow continuously into the sink or into a recovery header and will be moved into a collecting vessel when grab sample is needed, without manipulation of any valves.

c. Conditioning Modules

To the greatest extent practical, all sample conditioning components, except the inlet isolation valve and sample coolers, shall be mounted on a modular stainless steel sub-plate, easily removable and accessible by the operator. This will provide for easy maintenance with minimum downtime and interchangeability.

d. Analysis Modules

The sample conditioning rack will also house the cell type analyzers on modular stainless steel sub-plates similar to the conditioning modules (usually specific conductivity, cation conductivity, pH, dissolved oxygen, and



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turbidity). Modules will be designed for each cell and associated component removal and replacement.

The cell modules will be mounted on the front of the conditioning rack to minimize disturbance of maintainability of other components in the rack. As a minimum, every cell module will include a valved flow indicator to enable adjustment of sample flow through the cell.

e. Waste Header (Option)

The sample conditioning rack shall have a nominal 1 inch Sch. 40 304 or 316 stainless steel waste header extending the length of the rack for collection of all wastes. It shall be provided with connections for all installed analyzers.

f. Recovery Header (Option)

The rack shall have a nominal 1 ¼ inch (32 mm) 304 or 316 stainless steel sample recovery header which shall extend the length of the sample rack. It shall have a sufficient number of openings on the top of the header to accommodate all samples to be reclaimed. Each appropriate line will be connected to the recovery header via a flexible tubing which is also used for grab sample. This arrangement assures an uninterrupted in line analysis while taking grab samples.

2. Wet Analyzer Rack

The Wet Analyzer Rack shall be designed to be located in close proximity to the Sample Conditioning Rack and Control and Monitor Panel, and either mounted on the same base or bolted to it if possible. The analyzers will be surface mounted to this rack. Insofar as practicable, panel instruments, electrical devices, and conduit shall be arranged logically according to function. Panels shall be constructed of carbon steel and painted in accordance with this specification. Units shall be designed so that the wet analyzer(s) can be easily accessible from the front of the rack, with all drain, electrical and other connections located in the rear.

The Wet Analyzer Rack shall include the following, but not be limited to:

- Hydrazine analyzers
- Sodium analyzers
- Silica analyzers
- Other non-cell type analyzers, such as chlorides or phosphate analyzers

Analyzer sample lines will originate from a dedicated bulkhead area near the top of the rack, or will continue from the attached conditioning rack.

Unless one is included with the analyzer, each measuring analyzer shall include a flowmeter with a needle valve for manual flow adjustment. The flow meter range



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shall be suitable for the flow requirements of the analyzer. A glass tubed flow meter is required, acrylic type flow meters are not allowed.

A drain line will collect all the liquids leaving the analyzers, and lead them to the conditioning rack drain or other drain as appropriate.

The analyzers on the Wet Analyzer Rack will be wired to the Control & Monitor Panel to terminate all the signals from the cells, analyzers, and power supply. The electrical enclosure, as well as the electronics enclosure of each analyzer, should have a NEMA Type 12 rating as a minimum.

3. Control and Monitor Panel

- a. The Control and Monitor Panel shall be an enclosed structure, built in accordance with NEMA Type 12. It shall include appropriate cutouts for the instruments and components listed below, and include rear doors for access to repair or replace components inside the cabinet. The internals of the cabinet shall include appropriate electrical connections for power and signals and include interior lights with on/off switch and a minimum of one convenience/utility outlet for operator use.

The Control and Monitor Panel shall be designed to be located in close proximity to the Sample Conditioning Rack and Wet Analyzer Rack, and either mounted on the same base or bolted to it if possible.

- b. The panel shall include the following instruments, switches and indicators:
 - 1) Power distribution breaker(s)
 - 2) All monitors/transmitters for cell type analyzers
 - 3) Terminal blocks for all outgoing signals and incoming power supply and distribution. The panel shall be NEMA Type 12 and shall have rear doors for maintenance.
 - 4) Operation switches (on/off/auto) for manual control of the chiller unit (option)
 - 5) Annunciator windows, push button for test, acknowledge and reset, and audible horn. (Option)

4. Temperature Control Unit (TCU)

The temperature control unit shall be a packaged, chilled water cooling and control system, mounted on a skid, with all necessary accessories included within the confines of the skid. Included are: a full-capacity circulation pump for the cooling water, full-capacity hermetically sealed compressor, and all necessary piping,



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valves and controls.

The chiller unit shall be mounted outside of the panel in an adjacent area. The Supplier shall establish the chiller load based upon the requirement for a $77 \pm 1^\circ\text{F}$ ($25 \pm 0.5^\circ\text{C}$) outlet temperature from the secondary coolers. This $77 \pm 1^\circ\text{F}$ ($25 \pm 0.5^\circ\text{C}$) outlet sample temperature shall be obtained with a wide range of sample flows and cooling water temperatures without the need for operator adjustment.

A minimum of a 20% safety factor shall be applied to the estimated heat load when calculating the design tonnage of the Temperature Control Unit (TCU). The TCU shall also provide heating capability by means of a hot gas bypass design in the event of sub-cooled sample temperatures from the primary coolers.

The unit shall be equipped with a solid state electronic temperature control capable of maintaining $\pm 0.5^\circ\text{F}$ ($\pm 0.28^\circ\text{C}$) outlet temperature.

A temperature control valve to regulate the condenser cooling water flow shall be furnished (option).

The temperature control unit shall be equipped with gauges and isolation valves to simplify maintenance and troubleshooting (option).

C. ANALYZER REQUIREMENTS

Analyzers shall be furnished to meet the sample conditions outlined in the Required Sample Points and Analysis Table.

Each analyzer shall have a self-contained readout meter.

All instruments shall be of proven design. Solid state measuring and alarm circuitry shall have suitable electrical filters so that instruments will not be sensitive to power spikes, either induced or in supply line.

Each analyzer shall have 4-20 mA DC isolated (non-grounded) outputs. Analyzers shall meet accuracies required for proper power plant operating and maintenance and shall exhibit a constant repeatability with less than 1 percent error full scale after initial calibration.

Supplier shall include pH probes and analyzers appropriate for the purity of the sample water.

Time sharing of wet analyzers shall be provided where practical. Analyzer time sharing shall be accomplished using a Sentry Sample Sequencer or engineer approved equal and be microprocessor-based with track and hold capability.

Cation conductivity resin columns shall be Sentry Model RC-100, refillable ion



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exchange resin columns, with color indicating dye. Resin column shall be supplied with initial charge of resin, corrosion proof quick disconnect mounting bracket and barbed quick disconnects.

1. Required Sample Points and Analysis Table (Example Only)

Sample Point #	Sample Source	Operating Temp. °F	Operating Press., psig	Analyzer (s)
EX 1	Unit 1 Boiler Steam	xxx	x,xxx	PH, cation conductivity
EX 2	Unit 2 Condensate	xxx	x,xxx	

Anticipated analyzer measurement ranges, such conductivity (in microsiemens), should be included in table by specifier. This will allow the supplier to provide the correct probes and analyzers.

D. GENERAL SYSTEM DESIGN REQUIREMENTS

1. General Requirements

The water analysis equipment shall be designed to operate accurately, reliably and safely under the operating conditions described in this specification, without undue heating, vibration, wear, corrosion or other operational conditions.

The design and arrangement of the equipment shall be subject to approval by the buyer. Arrangement of the equipment and sub-assemblies shall afford maximum accessibility and maintainability of all parts. Piping, tubing and fittings shall be so arranged that instruments or devices may be removed and/or serviced without disturbing piping or tubing runs. No pipe or tube shall be routed across the face or rear of an instrument, junction box or other device in such a manner as to prevent the opening of covers or to obstruct access to leads, terminals or instruments for servicing. Parts subject to wear, corrosion or other deterioration, or requiring adjustment, inspection or periodic maintenance, shall be made accessible and capable of convenient removal when required.

The sample system shall be completely assembled, piped and wired at the factory, ready for installation when received at the site. Equipment will be mounted with properly designed supports and complete factory-installed internal piping, tubing and electrical wiring for all devices. Internal piping, tubing, wiring and connections shall be securely fastened, compactly arranged and readily accessible. It shall be suitably braced to prevent distortion and damage during shipping and handling.

All incoming and exiting piping and tubing connections are to be clearly identified by engraved nameplates carrying the sample line number and appropriate text. Nameplates shall be made of 2mm (1/16") laminated plastic and are fastened to panel with fasteners or adhesive. Nameplates are to be black text engraved on a white background.



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2. Sample Tubing

The Supplier's responsibility for tubing begins with and includes the bulkhead fittings and rack isolation valves at the inlet of the conditioning rack. All tubing shall be 1/4" OD x 0.042", 3/8" OD x 0.065 wall and/or 1/2" OD x 0.072 wall, as needed for proper sample conditioning. Tubing material shall be SA-249 Grade 316.

All fitting connections internal to the rack shall comply with ANSI B31.1. All instruments, piping, tubing, valves and fittings shall be securely mounted. Fittings shall be as required by sample conditions and pipe specifications. Supports shall provide complete freedom from strain on equipment. Runs shall be so arranged that connections can be broken without distortion of the tubing.

3. Materials

All piping/tubing and system components wetted by the sample stream shall be type 316 stainless steel. Type 304 is acceptable for other components.

All parts subject to high pressure or temperatures or other severe duty shall be of materials suitable for the service.

4. Mounting

All instruments, valves and accessories shall be mounted so that they are within the dimensional confine of the rack/panel.

All required pressure, temperature and flow indicators, and sample isolation valves shall be mounted to permit viewing or manipulation from the front of the panel.

5. Surface Preparation and Painting

All surfaces of non-corrosion resistant materials shall be properly cleaned, shop blasted, and painted with enamel type paint as specified below. Prior to painting, all welded joints, drilled holes, etc. shall be properly cleaned and ground to assure a smooth appearance.

Sharp welds and sharp corners shall be ground smooth and blended into the base material. The interior surfaces of shells and nozzles shall be cleaned of all mill scale, cuttings, weld spatter, and other foreign matter. Exterior ferrous metal surfaces shall be cleaned and painted in accordance with manufacturer's standard practice for shop primer.

Machined faces and fittings, parts to be embedded in concrete, nonferrous parts, nameplates and instruction plates shall not be painted. Suitable means, such as coating with grease or preservative shall be employed to provide protection of ferrous surfaces during shipment and storage.



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Cleaning and painting procedures shall be submitted to buyer for acceptance before they are implemented.

6. Structural - Welding

All welding shall be performed by qualified welders in accordance with applicable procedures. Procedures qualification and welder performance qualification shall be in accordance with ASME Section IX, as applicable.

The structural welding shall be performed by qualified welders in accordance with AWS D1.1 or ASME Section IX.

All welded joints in piping and equipment pressure parts shall be inspected in accordance with ANSI B31.1. Procedures employed for inspection shall be approved by the buyer.

7. Electrical

Distribution of power to each panel section shall be centralized from a panel of cartridge-type fuse blocks, fuses, and/or circuit breakers located together on the rear of each panel section. Separate circuits for utility power (utility outlet, heaters, and panel lighting) and for instrument power shall be provided. AC branch circuits shall have fuses in the live leg. DC circuits shall have fuses in each leg. All fuse blocks, fuses and circuit identifying nameplates shall be readily accessible for inspection and maintenance.

Indicating lights for operation shall be provided on the Control and Monitor Panel to indicate when an operation switch is in the open or closed position. Lamps and lenses shall be replaceable from the front of the panel.

Where more than one device utilizes the same measurement or control signal, the transmitter or other components shall be fully equipped to provide all signal requirements. The system shall be arranged so that failure of any recorder, indicator, control component, etc., shall not open the signal loop nor cause loss or malfunction of signal to other devices using the same basic signal.

E. SAMPLE SYSTEM P&ID (example attached)