1.3.31 PAINTING

(1) All exterior surfaces shall be thoroughly cleaned, and shall be given at least one base painting coat before shipping.

Coating thickness shall be 40 microns.

(2) The Contractor shall, at the site, paint the entire steam generator and auxiliary equipment as specified in Clause 1.12 of "Painting" in Section II of Part I.

1.3.32 WELDING

(1) To the extent possible and compatible with assembled size for shipment, the maximum amount of required welding of steam generator pressure parts for boiler assembly shall be done at the manufacturer's shops.

(2) All welding of pressure parts shall be subject to inspection and shall be performed by welders duly qualified in accordance with the applicable standards and codes.

(3) All welding shall fully comply with requirements of the latest edition of the applicable standards and codes.

(4) 20% of shop welded parts shall be inspected by non-destructive test. All field welded parts shall be inspected by non-destructive test in accordance with the applicable standards and codes.

(5) The Contractor shall pay special attention to keep all welding rods in good condition at all times, particularly at site.

1.3.33 TEST AND TESTING MATERIALS

(1) Test

The Contractor shall carry out all tests which are specified in Clause 1.2.5 of "Testing" in this specification.

(2) Testing materials

(a) The materials and equipment necessary for construction and field testing shall be included in the scope of supply, but shall not be limited to the items below.

Hydrostatic test pumps

Air leak test blowers and related equipment

Pumps for chemical cleaning such as chemical injection pumps, circulation pumps, etc.

Silencer for blowing out

Gags for safety valve test

All temporary materials for field testings

(b) Field test piping for tests stated in Clause 1.2.5 of "Testing" in this specification shall be provided.

(c) Necessary expendables to be used during construction and field testing shall be provided, but will not be limited to the following.

Chemicals

Lubricants

Gas

Reagents

Burner packing

Drum level gauge glass

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Valve packing and gaskets

Burner tips

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1.3.34 SPECIAL TOOLS AND STANDARD TOOL SETS

The Contractor shall supply the special tools and standard tool sets for the steam generator including gasket cutter.

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2. STEAM CONVERTER SYSTEM

2.1 SCOPE OF SUPPLY

The steam converter system shall include the following major components with accessories, but not be limited, the followings.

(1) Steam converter with deaerator

(2) Drain tank (Primary heating steam)

(3) Steam converter drain cooler

(4) Steam converter feed water tank

(5) Steam converter feed water pumps

(6) Safety valve, level control valves, strainers, orifice, check valves, stop valves, sight glasses, pressure gauges and all other necessary fittings

(7) Steam piping from the steam converter to:

  (a) Heavy fuel oil heaters

  (b) Heavy fuel oil suction heaters in heavy fuel oil service tanks

  (c) Steam trace lines for all heavy fuel oil piping

  (d) Steam heating coils of heavy fuel oil service tanks

  (e) Central air conditioning unit and air conditioning unit for computer room

  (f) Others, such as steam hose connections for oil strainer cleaning

(8) Heating steam from pressure control valve to steam converter

(9) Heating steam drain from the steam converter to the condenser

(10) Heating steam drain from the items specified in (7) to steam converter condensate drain tank

(11) Steam converter feedwater make-up piping from demineralized water transfer pumps

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(12) Steam converter feedwater piping from steam converter feed-water tank to deaerator on the steam converter

(13) Drain and air vent piping

(14) Control panel

(15) Anchor bolts, nuts, sleeves, etc.

(16) Special tools and standard tools including chain blocks with trolleys

(17) Cables

(18) Insulation

2.2 GENERAL INFORMATION

2.2.1 APPLICABLE STANDARDS AND CODES

The steam converter system shall be designed and constructed in accordance with the requirements of Clause 6 of Applicable Standards and Codes" in Section I of Part I.

2.2.2 OUTLINE

(1) The steam converter shall be installed to supply low pressure heating steam to the equipment which may be subjected to oil contamination in the steam drain lines.

The heating steam drain shall be returned to steam converter feed water tank.

House boiler steam will be used as back up steam when steam from the steam converter is not used.

In this case, the heating steam drain will be returned to house boiler drain collecting tank.

Steam converter, its auxiliaries, tank, control panel, etc., shall be installed under the sunshade having a monorail.

The sunshade and the monorail shall be designed by the

Contractor.

(2) Two steam converter feedwater pumps shall be provided. One (1) set shall be for normal operation and the other for stand-by.

The stand-by pump shall be automatically started up under the low pressure of the pump discharge piping. The steam converter feed pump shall take suction from steam converter feedwater tank and discharge the feedwater to the steam converter through a level control valve for the steam converter, steam converter drain cooler and deaerator. Minimum flow line shall be provided at the pump discharge side to avoid overheating of the pump.

(3) Heating steam piping to the steam converter shall be supplied from H.P. auxiliary steam header through the terminal point at a pressure control valve for the secondary steam.

A pressure relief valve shall be fitted downstream of the pressure control valve.

(4) Heating steam drain shall be led to the condenser through a level control valve for steam converter tube side level.

(5) Steam converter system shall be operated at the local control panel.

2.2.3 DESIGTN DATA

(1) Steam converter

(a)	Type	Horizontal, U tube
(b)	Number	One (1) set
(c)	Installation	Indoor
(d)	Heating steam	17 kg/cm^2G at approx. 350^oC maximum
(e)	Secondary steam	
	Capacity	To be decided by the Contractor
	Pressure	4.0 kg/cm^2 (Saturated steam)

(2) Drain tank

(a)	Type	Vertical cylindrical
(b)	Number	One (1)
(c)	Capacity	To be decided by the Contractor

(3) Steam converter drain cooler

(a)	Type	Horizontal tube type
(b)	Number	One (1) set
(c)	Capacity	To be decided by the Contractor

(4) Steam converter feed water tank

(a)	Type	Box and atmospheric pressure
(b)	Number	One (1)
(c)	Capacity	To be decided by the Contractor

(5) Steam converter feedwater pump

(a)	Type	Horizontal, centrifugal
(b)	Number	Two (2) (One set for stand-by)
(c)	Capacity	To be decided by the Contractor

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2.2.4 PERFORMANCE

(1) The steam converter shall be installed to supply low pressure heating steam to the equipment which may be subjected to oil contamination in the steam drain lines. The heating steam drain shall be returned to steam converter feedwater tank.

Steam generating capacity of the steam converter shall be able to supply the steam for the following two cases.

Case 1 (In winter) Ambient temperature ..... 6°C

(a) Steam supply to steam trace lines from oil receiving tank to service tanks.

(b) Steam supply to heating coils of oil service tank to maintain outlet oil temperature of 45°C.

(c) Steam supply to oil heater to increase oil temperature from 45°C to 95°C.

Case 2 (In summer) Ambient temperature ..... 32°C

(a) Steam supply to steam trace lines from oil receiving tank to oil service tanks

(b) Steam supply to heating coils of oil service tank to maintain outlet oil temperature of 45°C

(c) Steam supply to oil heater to increase oil temperature from 45°C to 95°C

(d) Steam supply to air conditioning unit for maximum service condition

The Contractor shall guarantee the values of steam flow and secondary steam pressure as given in the Tenderer's data sheets for the steam converter.

2.2.5 TESTING

The Contractor shall execute the following tests, and shall submit the reports to the Engineer for approval.

(1) Shop test

(a) Steam converter and steam converter drain cooler

Hydrostatic tests for shell side and tube side

(b) Drain tank

Hydrostatic test

(c) Steam converter feedwater pump

Pump performance tests

(d) Steam converter feedwater tank

Water filling test

(e) Control panel

Withstand voltage test

(2) Test at Site

The Contractor shall execute the steam converter performance test at site in regard to the total system in the presence of the owner and the Engineer. The necessary equipment and instruments for the performance test shall be prepared by the Contractor.

2.3 ACCESSORIES

(1) The necessary operating platform, supporting structure, foundation bolts, nuts, sleeves, piping for maintenance, etc., shall be provided.

(2) Maintenance and overhauling devices, such as monorail, chain block, eye plates, etc., shall be provided for the steam converter system.

2.4 INSTRUMENTATION

Thermometers, pressure gauges, level gauges, etc., shall be provided. Oil detector shall be provided on steam converter feedwater tank. The signal of oil detector shall be transmitted to central control room.

2.5 INSULATION

The Contractor shall insulate the steam convertor and its related auxiliaries, heat exchangers and piping in accordance with Clause 1.11 of "Insulation" in Section II of Part I.

2.6 MOTOR

The motor shall be in conformity with Clause 2.2 of "Electric Motor" in Section II of Part I.

2.7 PAINTING

The painting shall be in conformity with Clause 1.12 of "Painting" in Section II of Part I.

2.8 CABLES

The Contractor shall furnish the power cables, control cables, cable ducts, trays, conduits and grounding wires for the steam converter system.

Further information regarding scope of work and material supply for all items in the above shall be in accordance with Clause 10 of "Erection" in Section V of Part II.

2.9 SPECIAL TOOLS AND STANDARD TOOL SETS

The Contractor shall provide the special tools and standard tool sets for the steam converter system.

3. INSTRUMENT AIR SYSTEM

3.1 SCOPE OF SUPPLY

The instrument air system shall comprise the following major components with accessories, but not be limited to the followings.

(1) Suction air filters

(2) Compressors and drive motors

(3) Loading control equipment for compressors

(4) After coolers

(5) Air receiver

(6) Air dryer

(7) Pressure regulators and air filter sets

(8) Drain traps, safety valves, check valves, stop valves, solenoid valves, flow relays, sight glasses, pressure gauges and other necessary devices.

(9) Interconnection piping

- (a) between suction filter and air compressor
- (b) between air compressor and after cooler
- (c) between after cooler and air receiver
- (d) between air receiver and air dryer
- (e) between air dryer and pressure reducing valve
- (f) between pressure reducing valve and air filter set
- (g) between air filter set and main piping for the steam generator and steam turbine
- (h) between main piping and all instruments for the steam generator and steam turbine
- (i) between main piping and outlet piping of the dryer
- (j) future connection with valves

(k) Instrument air piping for the steam turbine shall be referred to relevant Clauses for "piping for instrumentation" of Section II of Part I.

(l) Drain piping

(m) Others

(10) Special tools and standard tool set

(11) Cables

(12) Control panel for compressors

(13) Anchor bolts, nuts, sleeves, etc.

3.2 GENERAL INFORMATION

3.2.1 APPLICABLE STANDARDS AND CODES

The instrument air system shall be designed and constructed in accordance with the requirements of Clause 6 of "Applicable Standards and Codes" in Section I of Part I.

3.2.2 OUTLINE

(1) Two (2) sets of instrument air compressors shall be installed for the control air source of the plant.
One (1) set shall always be in operation, and the other shall be for stand-by.
The stand-by compressor shall be automatically started up by the low pressure signal from the pressure switch of the air receiver.

(2) These instrument compressors shall be operated automatically. The compressors shall be operated alternately to balance the operating hours of the compressors.
The delivery air pressure of compressor shall be

controlled in the range of 5.6 to 7 kg/cm^2g.

The compressor shall be of the oil-free type to keep instrument air clean.

The compressed air shall be sent to instrument air receiver through the air after cooler.

Instrument air shall be dehumidified in the dryer and supplied to instruments or control system through the pressure regulators and air filter sets.

(3) The following instrument air system branches shall be provided.

(a) Boiler control (STC, ACC, FWC, etc.)

(b) Burner control system

(c) Steam generator local junction boxes

(d) Reverse current valves of turbine extraction steam line

(e) Turbine local junction boxes

(f) Interconnection line for neighboring units

(g) Instrument and electrical repair room

3.2.3 DESIGN DATA

(1) Compressor

(a)	Type	Vertical, belt driven, oil-free, reciprocating, water cooled
(b)	Installation	Indoor
(c)	Numbers	Two (2) sets one for normal operation and the other for stand-by

(d) Discharge air pressure — 7 kg/cm^2g

(e) Capacity — To be decided by the contractor

(f) Ambient air temp. — 32^oC

(g) Loading-unloading control — 0% and 100%, two-step type

(2) Motor

(a) Type — Indoor use, horizontal

(b) Numbers — Two (2) sets

(3) Control panel

(a) Type — Self-standing, indoor type

(b) Number — One (1)

(4) After cooler

(a) Type — Horizontal pipe line
Tube side : air
Shell side: cooling water

(b) Numbers — Two (2) sets

(5) Air receiver

(a) Type — Vertical, cylindrical, welded steel construction

(b) Capacity — To be decided by the contractor

(c) Number — One (1) set

(6) Cooling water shall be supplied at the compressor inlet in the following condition:

Pressure — Approx. 6 kg/cm^2g max.

Temperature — 40^oC

(7) Drain from after coolers and air receiver shall be collected by the drain funnel.

(8) Air dryer

(a)	Type	Refrigerative, fully automatic, package type
(b)	Installation	Indoor
(c)	Numbers	Two (2) sets
(d)	Pressure	7 kg/cm^2g
(e)	Capacity	100% of actual air consumption for one unit
(f)	Dew point of discharge air	$-15^{o}C$ or less

(9) Pressure regulators and air filter sets

(a)	Type	Self-operated regulator with filter (washable)
(b)	Installation	Indoor and outdoor
(c)	Reducing valves and air filter set	For 1.4 kg/cm^2g Required for instrument or other pressure
(d)	Numbers	1 set for each instrument

(10) Piping materials SGPW, or equal

3.2.4 PERFORMANCE

(1) Each compressor shall have the capacity according to the requirement of the system at free air.

(2) The air temperature leaving the after cooler shall be $45^{o}C$ or less.

(3) The sound pressure level shall not exceed 85 dB at one (1) meter distance when the center line frequency is 1000 Hz.

(4) The Contractor shall submit to the Engineer the performance

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curves which show the pressure, horsepower, capacity and efficiency of the compressors.

(5) Excess vibration of the piping, cooler and compressor shall be adjusted by the Contractor during field testing.

3.2.5 TESTING

The Contractor shall execute the following tests and shall submit the results to the Owner and the Engineer.

(1) Shop test

(a) Dimension check and visual inspection

(b) Performance test

(c) Safety valve setting

(d) Hydrostatic test for compressor cylinder, after cooler, air receiver and air dryer

(e) Dew point test for air dryer

(2) Field test

(a) Operation test including measurements of noise level and vibration

(b) Safety valve setting for air compressor and air receiver

(c) Leak test for piping system

(d) Dew point test for air dryer

3.3 TECHNICAL INFORMATION

(1) The compressor shall be free from excessive vibration, noise and leaks under all conditions of operation.

(2) The air compressor shall be a heavy duty, single stage machine, and shall be designed to deliver, as far as possible, air free from any oil or oily vapors due to lubrication.

(3) The compressor shall be factory assembled and provided with suitable base plate, as required, with provisions for mounting on the foundations.

(4) All electrical wiring and piping integral to the compressor shall be factory installed, and shall have convenient terminal points for connection to the external wiring and piping systems.

(5) The compressor shall be provided with the integral air piping and bearing cooling water piping, and shall include thermometers, flow relays, flow glasses, pressure gauges, pressure switches, pressure transmitter etc.

(6) The stuffing box where the piston rod passes through the cylinder shall be deepened and fitted with non-lubricated carbon packing to assure tightness without excessive pressure and piston rod wear.

(7) Frame of the compressor shall be completely sealed and absolutely dust tight.
The openings shall be sealed by lightweight covers to permit easy access to the frame interior.

(8) Window type or glass gauge type oil level indicators shall be mounted on the frame.

(9) The suction filter shall be of the cartridge type.

(10) The compressor cylinders shall be automatically unloaded during starting and stopping.

(11) The compressor shall include 0 and 100% load-unload control by automatic operation of inlet and outlet valves on the cylinder during compressor operation.

(12) The compressor shall be furnished with solenoid operated

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cooling water valves on the cooling water inlet lines, and furnished with flow glasses on the outlet lines.

The discharge air temperature switch with alarm shall be provided for safety operation.

The cooling water supply shall be stopped automatically when the compressor stops.

(13) The compressor shall be provided with an appropriate belt cover for human protection.

(14) The after cooler shall be furnished with a drain separator, drain chamber, level glass gauge, automatic drain trap, safety valve and thermometer.

(15) The check valve shall be provided on the pipe line between the after cooler and air receiver.

(16) The air receiver shall be of the vertical cylinder type with manhole, supporting legs, inlet and outlet nozzles, drain and instrument taps.

(17) The air receiver shall be provided with an automatic drain trap.

(18) The pressure switch to automatically start the stand-by compressor shall be provided on the receiver.

(19) The Contractor shall furnish the base frame, anchor bolts, nuts, sleeves and other pertinents for the compressor, after cooler, air receiver, air dryer and air filter.

(20) The drain trap for the air dryer shall have sufficient capacity to discharge the drain and oil mist from the air line.

(21) The dryer shall utilize inert gas as its cooling medium.

(22) The dryer shall be provided with integral inert gas piping,

air piping, and electrical wiring with all necessary instruments.

(23) The dryer shall have one set of stand-by compressor, if required.

(24) The air filter shall be of the vertical cylinder type with inlet nozzle, outlet nozzle, supporting legs and drain nozzle.

(25) The material of instrument air piping shall be SGPW, or equal.

The outlet air piping of air dryer shall be provided with antisweat insulation. A sufficient number of drain traps shall be provided on the instrument air piping.

(26) Further information regarding instrument air piping shall be refered to the relevant Clauses for "Piping for Instrumentation" in Section II of Part I.

(27) The electric motor shall be in accordance with Clause 2.2 of "Electric Motor" in Section II of Part I.

(28) Control switches, indicating lamps, pressure gauges and pressure switches shall be provided on the control panel of the compressors.

Further information of the control box shall be referred to in Clause 2.1 of "Panels and Boards" in Section II of Part I.

A summarized alarm, operation signals and indicator shall be indicated on the BTG board and AUXILIARY board in the central control room.

(29) Painting shall be in conformity with Clause 1.12 of "Painting" in Section II of Part I.

(30) The Contractor shall furnish the power cables, control cables,

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cable ducts, trays, conduits and grounding wires for the instrument air system.

(31) Further information regarding scope of works and material supply for all items in (30) shall be in accordance with Clause 10 of "Erection" in Section V of Part II.

(32) The Contractor shall provide the special tools and standard tool sets for instrument air system.

4. SERVICE AIR SYSTEM

4.1 SCOPE OF SUPPLY

The service air system shall include the following major components with accessories, but not be limited to the followings.

(1) Suction air filters

(2) Compressor and drive motor

(3) Inter cooler

(4) Load control equipment for compressor

(5) After cooler

(6) Air receiver

(7) Drain traps, safety valves, check valves, stop valves, solenoid valves, flow relays, sight glasses, pressure gauges and others.

(8) Piping

- (a) between suction filter and compressor
- (b) between compressor and inter cooler
- (c) between compressor and after cooler
- (d) between after cooler and air receiver
- (e) air receiver to main piping for steam generator and steam turbine
- (f) main piping to all equipment (including hose connections) for steam generator and common auxiliaries
- (g) Service air piping to work shops
- (h) Drain piping
- (i) Connections with valves (if future extension is planned)
- (j) Control panel
- (k) Anchor bolts, nuts, sleeves, etc.

(l) Special tools and standard tool sets

(m) Cables

(9) Lubricating oil tank

4.2 GENERAL INFORMATION

4.2.1 APPLICABLE STANDARDS AND CODES

The service air system shall be designed and constructed in accordance with the requirements of Clause 6 of "Applicable Standards and Codes" in Section I of Part I.

4.2.2 OUTLI1NE

(1) One (1) set of service air compressors shall be installed for the service air which is used for aspirating air, air supply for hose connections, etc.

(2) The delivery air pressure of compressor shall be controlled within the range of 5.6 to 7 kg/cm^2g.

(3) A back-up control system shall be provided so as to maintain the constant air pressure for the instrument air system by automatically supplying service air to the instrument air system, in case the air pressure for instrument air is abnormally reduced.

(4) The following service air branches shall be provided.

(a) Aspirating air for inspection holes and openings of steam generator

(b) Back up air for instrument air system

(c) Purge air for primary piping for instrumentation

(d) Hose connections for turbine and steam generator areas

(e) Hose connections for outdoor equipment

(f) Air motorized simplex oil strainers

(g) Work shop supply

4.2.3 DESIGN DATA

(1) Compressor

(a)	Type	Direct coupled motor driven, reciprocating, lubricated, water-cooled, 2 stage, V type
(b)	Installation	Indoor
(c)	Number	One (1)
(d)	Discharge air pressure	7 kg/cm^2g
(e)	Capacity	To be decided by the Contractor
(f)	Ambient air temp.	$32^{o}C$
(g)	Speed	To be decided by the contractor
(h)	Loading-unloading control	0%, 50% and 100%, three-step type

(2) Motor

(a)	Type	Indoor, horizontal
(b)	Number	One (1) set

(3) Control panel

(a)	Type	Self-standing, indoor
(b)	Number	One (1) set

(4) Inter cooler

(a)	Type	Horizontal pipe line Tube side: air Shell side: cooling water

(b) Number — One (1) set

(5) After cooler

(a) Type — Horizontal pipe line
Tube side: air
Shell side: cooling water

(b) Number — One (1) set

(6) Air receiver

(a) Type — Vertical, cylindrical, welded steel construction

(b) Capacity — To be decided by the contractor

(c) Number — One (1) set

(7) Drain from inter coolers, after coolers and receivers shall be collected by the drain funnel.

(8) Piping materials — SGP, or equivalent

(9) Hose connections — 25 A coupling type

(10) Lubricating oil tank consisting of four independent tanks each having 50 liter capacity

4.2.4 PERFORMANCE

(1) The compressor shall have the capacity according to the requirement of the system at free air.

(2) The air temperature leaving the after cooler shall be 45°C or less.

(3) The noise level shall not exceed 85 dB (A) at one (1) meter distance when the centerline frequency is 1000 cycles.

(4) The Contractor shall submit to the Engineer performance curves which show the pressure, horsepower, capacity and efficiency of the compressor.

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(5) Excess vibration of the piping, coolers and compressors shall be eliminated by the Contractor during field testing.

4.2.5 TESTING

The Contractor shall execute the following tests and shall submit the reports to the Engineer.

(1) Shop test

(a) Dimension check and visual inspection

(b) Performance test

(c) Safety valve setting

(d) Hydrostatic tests for compressor cylinders, after cooler and air receiver

The Engineer will attend the shop test of compressors.

(2) Field test

(a) Operation test including measurements of noise level and vibration

(b) Safety valve setting for air compressor and air receiver

(c) Leak test for piping system

4.3 TECHNICAL INFORMATION

(1) The compressor shall be free from excessive vibration, noise and leaks under all conditions of operation.

(2) The air compressor shall be of the heavy duty, two stage type, and shall be designed to deliver compressed air free from any oil or oily vapors due to lubrication.

(3) The compressor shall be assembled at factory and provided with suitable base plate, as required, with provisions for

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mounting the foundations.

(4) All electrical wiring and piping integral to the compressor shall be installed at factory, and shall have convenient terminal points for connection to the external wiring and piping systems.

(5) The compressor shall be provided with integral air piping, bearing cooling water piping and lubricating oil piping, and shall include thermometers, flow relays, flow glasses, pressure gauges, pressure switches, etc.

(6) The stuffing box where the piston rod passes through the compression room shall be deepened and fitted with metallic packing to assure tightness without excessive pressure and piston rod wear.

(7) Frame of the compressor shall be completely sealed, absolutely dust tight and waterproof.
The openings of frame shall be sealed by lightweight covers to permit easy access to the frame interior.

(8) Full forced feed lubrication shall be furnished for all bearing surfaces within the frame and crosshead guide.

(9) Window type or glass gauge type oil level indicators shall be mounted on the frame.

(10) The suction filter shall be of the oil coated cartridge type. Window type or glass type oil level indicator shall be mounted on the filter.

(11) The compressor cylinders shall be automatically unloaded during starting and stopping.

(12) The compressor shall include 0, 50 and 100% load-unload controls by automatic operation of inlet and outlet valves

on the cylinder during compressor operation.

(13) A low oil pressure shutdown switch shall be furnished on the compressor to shutdown the compressor motor in case the lubrication system fails.

(14) The compressor and inter cooler shall be furnished with solenoid operated cooling water valves on the cooling water inlet lines, and shall be furnished with flow relays and flow glasses on the outlet lines. If the supply of cooling water fails and the air temperature increases, the discharge air temperature switch shall operate to sound an alarm. Cooling water for the compressor shall be stopped automatically when the compressor stops.

(15) The inter cooler shall be of the shell and tube type, and shall be mounted externally on the compressor or located on the frame of the compressor between stages.

(16) The inter cooler shall be provided with a drain separator with an automatic drain trap, level glass gauge and safety valve.

The cooling water shall flow through the tube inside in the inter cooler.

(17) The after cooler shall be provided with a drain separator, drain chamber, level glass gauge, automatic drain trap, solenoid valve, flow relay, flow glass, thermometer and safety valve.

(18) The check valve shall be provided on the air pipe line between the after cooler and the air receiver.

(19) The air receiver shall be of the vertical cylinder type with manhole, supporting legs, inlet and outlet nozzles, drain

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and instrument taps.

(20) The air receiver shall be provided with an automatic drain trap.

(21) The Contractor shall furnish the base frame, anchor bolts, nuts, sleeves, after cooler, air receiver and other pertinents for the compressor.

(22) Control switches, indicating lamps, pressure gauges and pressure switches shall be provided in the control panel of the compressor. Summarized alarm and operation signals shall be indicated on the BTG board in the central control room.

(23) A sufficient number of drain traps shall be provided on the service air piping.

The material of service air pipe shall be SGP, or equivalent. Further information of the service air piping shall be in accordance with Clause 1.1, 1.3 of "Power Plant Piping", "Valve and Specialities" in Section II of Part I.

(24) The motor shall be in conformity with Clause 2.2 of "Electric Motor" in Section II of Part I.

(25) Further information of the control panel shall be referred to in Clause 2.1 of "Panels and Boards" in Section II of Part I.

(26) The painting shall be in conformity with Clause 1.12 of "Painting" in Section II of Part I.

(27) The Contractor shall furnish the power cables, control cables, cable ducts, trays, conduits and grounding wires for the service air system.

(28) The Contractor shall provide the special tools and standard tool sets for the service air system.

(29) The Contracror shall supply one lubricating oil tank consisting of four independent tanks each having 50 liter capacity, and install it near the compressors. Each 50 liter tank shall have oil level gauge, a filling cap and one outlet cock with key lock. The tank shall be constructed so as to receive oil from each tank by a small can or an oil feeder.

5. CHEMICAL FEED SYSTEM

5.1 SCOPE OF SUPPLY

The chemical feed system shall include the following major components with accessories, but not be limited to the followings.

(1) Phosphate solution tank

(2) Concentrated hydrazine tank

(3) Diluted hydrazine tank

(4) Ammonium solution tank

(5) Phosphate pumps with motors

(6) Hydrazine pumps with motors

(7) Ammonium pumps with motors

(8) Mixer and motor for phosphate solution tank

(9) Hand operated feed pumps and measuring tank

(10) Control panel and instruments

(11) Interconnecting pipings with valves and pertinents

(12) Anchor bolts, nuts, sleeves, etc.

(13) Special tools and standard tool sets

(14) Cables

(15) Painting

(16) Chemical storage rack

5.2 GENERAL INFORMATION

5.2.1 APPLICABLE STANDARDS AND CODES

The chemical feed system shall be designed and constructed in accordance with the requirements of Clause 6 "Applicable Stnadards and Codes" in Section I of Part I.

5.2.2 OUTLINE

(1) One (1) set of the chemical feed system shall be installed for the water quality control of the plant.

(2) Diluted hydrazine shall be applied to remove dissolved oxygen contained in the feedwater and to control pH value in the feedwater.

(3) Concentrated hydrazine shall be provided so as to protect steam generator internals, etc., from rust during long term shutdown of the plant.

(4) Ammonium solution shall be provided to control the pH value in the feedwater for plant start up and shut down.

(5) Phosphate shall be provided to remove hardness of boiler water and as a precaution in the event of cooling water leakage.

5.2.3 DESIGN DATA

(1) Phosphate solution tank

(a)	Capacity	To be decided by the contractor
(b)	Type	Stainless steel, vertical, cylindrical, self-standing
(c)	Number	One (1) set

The tank shall have a direct motor driven propeller type mixer and dissolving screen.

(2) Concentrated hydrazine solution tank

(a)	Capacity	To be decided by the contractor
(b)	Type	Stainless steel, vertical, cylindrical, self-standing
(c)	Number	One (1) set

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The tank shall have a measuring tank and hand pump.

(3) Diluted hydrazine solution tank

(a)	Capacity	To be decided by the contractor
(b)	Type	Stainless steel, vertical, cylindrical, self-standing
(c)	Number	One (1) set

The tank shall have a measuring tank and hand pump.

(4) Ammonium solution tank

(a)	Capacity	To be decided by the contractor
(b)	Type	Stainless steel vertical, cylindrical, self-standing, Closed type
(c)	Number	One (1) set

(5) Phosphate pumps and motors

(a)	Capacity	To be decided by the contractor
(b)	Outlet pressure	230 kg/cm^2g (To be decided)
(c)	Type	Positive displacement, controlled volume, simplex
(d)	Number	Two (2) sets
(e)	Motor	Indoor

(6) Hydrazine pumps and motors

(a)	Capacity	To be decided by the contractor
(b)	Outlet pressure	To be decided by the contractor
(c)	Type	Positive displacement, controlled volume, simplex
(d)	Number	Two (2) sets
(e)	Motor	Indoor

(7) Ammonium solution pumps and motors

(a)	Capacity	To be decided by the contractor
(b)	Outlet pressure	To be decided by the contractor
(c)	Type	Positive displacement, controlled volume
(d)	Number	Two (2) sets
(e)	Motor	Indoor

(8) Control panel

The control panel shall be the self-standing indoor type, and shall be equipped with control switches, power devices, indicating lamps, annunciator equipment, etc., as a complete system.

5.2.4 PERFORMANCE

(1) Each pump shall have a sufficient capacity as stated in this specification.

(2) Each storage tank shall have a sufficient capacity as stated in this specification.

5.2.5 TESTING

(1) Shop testing

The Contractor shall execute the following shop tests and submit the reports to the Owner and the Engineer for approval.

(a) Pump performance test

(b) Withstand voltage test for control panel

(2) Field test

The Contractor shall execute the following field tests and submit the test reports to the Owner and the Engineer for

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approval.

(a) Dimension check and visible inspection

(b) Pump running test

(c) Performance test

5.3 TECHNICAL INFORMATION

(1) All tanks and integral parts shall be made of stainless steel plate and shall be of vertical, cylindrical sloped bottom with leg supports.
The leg supports shall be made of galvanized steel plate or stainless steel plate having a free clearance of 500 mm from bottom of tank to floor.

(2) Each tank shall have level switches for pump interlock, alarm and name plate.

(3) Each hydrazine solution tank shall have a measuring tank, hinged or flanged top cover, glass gauge and level alarm detector.

(4) Each hydrazine solution tank shall have a hand pump to feed the hydrazine through the measuring tank.

(5) The Contractor shall supply and construct the automatic dissolving system for ammonia injection system including all accessories such as pressure reducing valves, conductivity meter, agitator, ammonia gas storage room, etc.

(6) The phosphate solution tank shall have a motor-driven mixer and dissolving screen made of stainless steel.

(7) The mixer shall be of propeller type, and shall be capable of agitating the maximum capacity of feed solutions in the tank. The shaft and propeller shall be made of stainless

steel.

(8) Each pump shall be of positive displacement, simplex and adjustable stroke type as manufactured by Milton Roy, or equivalent. Each pump shall be provided with suction and discharge double-ball or cone-type check valves, suction strainers, motor drivers, reduction gears, couplings and relief valve.

(9) The stroke of ammonia pump shall be adjusted automatically by the signal from the selector station for conductivity value.

(10) Each pump shall have a variable feed in quantity and shall be equipped with a remote-manual adjustment or automatic adjustment.

(11) While the pumps are in operation from 0 to 100% capacity, each pump shall be capable of delivering full capacity against a maximum pressure at the chemical injecting point. The pump flow accuracy shall be within ±3% of the total rated flow.

(12) Pump material shall be of the best suitable material. Inner parts contacting the chemicals shall be of stainless steel.

(13) Pump relief valve shall be set at the maximum pressure of chemical injection point, and the pump and accessories shall be designed based on the stipulated pressure condition.

(14) The Contractor shall provide interconnecting piping between tanks and pumps, and shall provide chemical feed piping between pump and chemical injection points including drain and vent piping with stop and check valves, relief valves, pressure gauges, pipe supports and all necessary

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pertinents.

The Contractor shall provide the dilute water piping between the condensate pipe, make up water pipe and all tanks. Further information regarding piping shall be referred to in Clause 1.1, 1.3 of "Power Plant Piping", "Valve and Specialities" in Section II of Part I.

(15) Further information regarding motors shall be referred to in Clause 2.2 of "Electric Motor" in Section II of Part I.

(16) The working platform and stairs shall be installed around the tanks for safety and for ease of operation and maintenance.

(17) The control panel shall be provided with the following devices.

(a) Instruments and devices

Control switches and lamps for each pump motor and mixer

Annunciating equipment for overload of pump motors and low level of tank

One contact for summarized alarm

(b) Power circuit apparatus

All power devices necessary to supply motor power such as circuit breakers, contactors, thermal protectors, control transformer, etc. shall be provided.

(18) The panel shall be installed indoors and near the chemical equipment so as to operate the pumps and mixer and to monitor their operation conditions.

(19) The summarized alarm shall be indicated in the water laboratory room and central control room in the main power

house.

Further information regarding control panel shall be referred to in Clause 2.1 of "Panels and Boards" in Section II of Part I.

(20) The Contractor shall provide platforms or stage to inspect the tank level and pump conditions of the chemical feed system.

(21) The painting shall be in accordance with Clause 1.12 of "Painting" in Section II of Part I.

(22) The Contractor shall furnish the power cables, control cables, cable ducts, trays, conduits and grounding wires for the chemical feed system.

(23) Further information regarding scope of works and material supply of items in (22) shall be in accordance with Clause 10 of "Erection" in Section V of Part II.

(24) The Contractor shall provide the special tools and standard tool sets for the chemical feed system.

(25) Chemical storage rack shall be supplied.

(a) The storage rack shall be furnished in the main power house and at a place to be decided by the Owner.

(b) Wire mesh enclosure shall be furnished on the racks, and doors shall be equipped with key locks.

(c) The chemical storage rack shall be formed of three (3) stage shelves.

(d) The material for storage rack shall be of steel plate with corrosion resistant hard surface coating.

6. SAMPLING RACK SYSTEM

6.1 SCOPE OF SUPPLY

The sampling rack system shall include the following major components with accessories, but not be limited to the followings.

(1) Sampling rack

(2) Analyzers, indicators and recorders

(3) Sample controllers

(4) Sampling piping with valves and supports

(5) Special tools and standard tool sets

(6) Cables

(7) Anchor bolts, nuts, sleeves, etc.

(8) Painting

6.2 GENERAL INFORMATION

6.2.1 APPLICABLE STANDARDS AND CODES

The sampling rack system shall be designed and constructed in accordance with the requirements of Clause 6 of "Applicable Standards and Codes" in Section I of Part I.

6.2.2 OUTLINE

The sampling rack system shall be installed to supervise the quality of plant make up water, condensate, feedwater, boiler water and steam, and shall maintain the quality of the above liquids in the adequate values so as to ensure safe plant operation.

6.2.3 DESIGN DATA

(1) Sampling rack

(a)	Type	Open, self-supporting steel frame type, single side mounting
(b)	Numbe	One (1) set
(c)	Installation	Indoor

(d) Sampling rack shall contain all sample conditioning components such as piping, tubing, pressure reducing devices, needle and flow control valves, shut off valves, uni-sampler, heat exchangers, resin column, analyzing cells and thermometers.

(e) Analyzers, indicator and junction boxes shall be provided on the sampling rack.

(f) The sampling rack shall include a stainless steel sink.

(g) Three (3) recorders shall be furnished on the auxiliary control panel in the central control room.

(h) Signal cable between analyzer and recorder shall be of shield wiring, if required.

(2) Cooling water for the sampling rack shall be led from the bearing cooling water line.

(3) Drain valves and pipings shall be installed upstream of the sampling cooler to enable flush out of sampling piping before initial operation.

Drain piping shall be collected to single header and discharged to the drain funnel.

(4) The following samples shall be installed on the sampling

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rack.

(a) Boiler drum water

(b) Boiler drum outlet steam

(c) Main steam

(d) Reheater steam

(e) Condensate (Condensate pump outlet)

(f) Condensate (Deaerator inlet)

(g) Condensate (Deaerator outlet)

(h) Boiler feed water (Economizer inlet)

(i) Make up water (Demineralized water transfer pump outlet)

(j) HP heater drain

(k) LP heater drain

(l) Drain pump outlet

(m) S.C.A.H. Drain

(n) Evaporator drain

(o) Bearing cooling water

(5) The analyzers, sensors for recorder, computer and indicators for the following items shall be installed in the sampling rack.

(a) pH

Boiler feedwater (Economizer inlet)

Boiler drum water

Condensate (Dearator inlet)

(b) Conductivity

Make up water

Condensate (Deaerator inlet)

Condensate (Condensate pump outlet)

Condensate (Deaerator outlet)

Boiler feedwater (Economizer inlet)

Boiler drum water

Boiler drum outlet steam

(c) Dissolved Oxygen

Condensate water (Deaerator inlet and outlet)

(d) Residual hydrazine

Boiler feedwater (Economizer inlet)

6.3 TECHNICAL INFORMATION

(1) The sampling rack shall be of the open frame steel and self-supporting type, and shall include a stainless steel sink.

(2) All sample points, devices and valves shall be furnished with permanent name plates.

(3) All piping and tubing shall be of stainless steel. Tube connections shall be of stainless steel union joint.

(4) Sampling coolers shall be provided so that temperature of sampling water is in the range of 38°C to 45°C for supply of each sampling line.

Cooling water for the sampling cooler shall be supplied from cooling water system and returned to it after cooling.

Flow sight glasses shall be installed at the outlet of each sample cooler.

(5) All valves in sampling rack shall be of stainless steel.

(6) Analyzed values, such as pH, conductivity, dissolved oxygen and hydrazine, shall be recorded on the recorder installed on the auxiliary control panel in the central control room.

Respective analyzers shall have computer input.

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(7) The Contractor shall select the analyzer based on easy operation and maintenance signals.

(8) The conducitivity and pH recorder shall have alarm sets for each sample.

(9) The temperature control equipment of uni-sampler type or equivalent shall be provided to maintain the constant temperature of the sample for the pH cells, hydrazine analyzer and dissolved oxygen meter.

(10) All components shall be assembled and provided with the necessary pertinents for mounting on the foundations.

(11) All electric wiring, piping and tubing integral to the system shall be factory installed, and shall have convenient terminal points for external connections.

(12) All sampling piping between the detecting (take out) point and sampling rack shall be of stainless steel.
Further information regarding sampling piping shall be referred to in Clause 1.1, 1.3 of "Power Plant Piping", "Valve and Specialities" in Section II of Part I.

(13) The motor shall be in conformity with Clause 2.2 of "Electric Motor" in Section II of Part I.

(14) Further information regarding control panel shall be referred to in Clause 2.1 of "Panels and Boards" in Section II of Part I.

(15) Painting shall be in conformity with Clause 1.12 of "Painting" in Section II of Part I.

(16) The Contractor shall furnish the power cables, control cables, cable ducts, trays, conduits and grounding wires for the sampling conditioning system.

(17) Further information regarding scope of works and material supply of the items in (16) shall be in accordance with Clause 10 of "Erection" in Section V.

(18) The Contractor shall provide the special tools and standard tool sets for the sampling rack system.

(19) All chemical instruments shall be in conformity with Clause 3.1.6 in Section II of Part I.

(20) The summarized alarm shall be indicated in the water laboratory room in the main power house.

7. SPARE PARTS FOR STEAM GENERATOR AND AUXILIARY EQUIPMENT

The following mandatory spare parts shall be provided. In addition, the Contractor shall propose the recommended spare parts for five (5) years for the steam generator and auxiliary equipment (including compressed air, chemical feed and sampling rack system) as stated in PA.14 of "Spare Parts" in Section IV, Volume I.

	Numbers of spare
(1) Boiler and furnace	
(a) Gasket for boiler and furnace inspection door	200 %
(b) Glass for boiler and furnace inspection holes	200 %
(c) Gasket and packing for boiler and furnace access (manhole)	300 %
(d) Tubes	2 % each size and each material
(2) Drum	
(a) Disk and ring pins of drum safety valves	100 %
(b) Packing and gasket for drum manhole	300 %
(c) Bolt, nut and washers for drum internals	10 %
(d) Glass and gasket including mica for drum level gauge	500 %
(e) Lamp for level gauge	300 %

		Numbers of spare
	(f) Color screen for level gauge glass	200 %
	(g) Valve packing	200 %
(3)	Economizer	
	(a) Tubes	2% each size
(4)	Superheater, reheater and attemperator	
	(a) Disk of safety valves	100 %
	(b) Disk of power control valve (PCV)	200 %
	(c) Disk of pilot valve of PCV	200 %
	(d) Seal ring of PCV	200 %
	(e) Plug seal ring of PCV	200 %
	(f) Gasket for PCV	200 %
	(g) Tubes	2 % each size and each material
(5)	Casing, refractory, insulation and lagging	
	(a) Casing (each material)	5 % each
	(b) Refractory, insulation and lagging	15 % each
(6)	Piping, valves and fitting	
	(a) Blow down valve (complete)	1 set
	(b) Drain valves for steam generator (SH, RH, Econ., Downcomer, etc.)	50 %
	(c) Packing for drain and vent valves	30 %
	(d) Welding rods (each kind) to be used for boiler	30 kg each

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		Numbers of spare
(7)	Air preheater	
	(a) Cold end elements	100%
	(b) Intermediate layer element	50%
	(c) Hot end elements	30%
	(d) Post seal assembly	100%
	(e) Radial seal assembly	100%
	(f) Circumferential seal assembly	100%
	(g) Soot blowing nozzle for air preheater	100%
	(h) Washing nozzles for air preheater	100%
	(i) Oil seal and packing for oil pump	100%
	(j) Gasket for manhole and inspection door	100%
	(k) Glass for inspection door	100%
	(l) Manometer	1 set
	(m) Motor bearing	1 set
	(n) Lamp for observation light	3 pieces
(8)	Steam coil air preheater	
	(a) Fin tubes	30%
	(b) Flange gasket	20%
(9)	Heavy fuel oil firing system	
	(a) Heavy fuel oil system	
	Heavy fuel oil heater gasket	10%
	Tube of heavy fuel oil heater	5%
	Bearing for pump	One (1) complete set
	Gland packing for pump	200%
	Flexible hose for tank	1 set each

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		Numbers of spare
(b)	Warm up gas and ignition gas system	
	Bearing for pump	One (1)
		Complete set
	Gland packing for pump	200%
	Flexible hose for tank	1 set each
(c)	Burner and igniter	
	Fuel oil guns without tips	50%
	Tips, burner plate and tip nut for fuel oil guns	500% each
	Igniter guns without tips	50%
	Tips, burner plate and tip nut for igniter guns	500%
	Packing and "O" ring for fuel oil guns	500 pieces
	Packing and "O" ring for igniter guns	500 pieces
	Flexible hose or ball joint for fuel oil burner (each size)	30%
	Flexible hose for igniter (each size)	30%
	Flame detector for fuel oil and igniter	50%
	Complete set of atomizer for main burner and igniters	100%
	Gasket for access doors	100%
	Glass for access doors	100%
	Defuser cones	300%
	Solenoid valves for igniter	50%
	Spare plug	200%
	Pilot box for igniter (complete set)	30%

		Numbers of spare
(10)	Soot blowing system	
	(a) For boiler soot blower	
	Complete soot blower set	2
	Head valves (complete set)	2
	Chain and chain pins or gear assembly	2
	Gland packing	200%
	Limit switch	40%
	(b) For air preheater soot blower	
	Valve disc	100%
	Valve spindle	100%
	Gland packing	200%
	(c) For control panel	
	Fuse and lamp	200%
	Switch	20%
(11)	Blow down tank	
	(a) Glass and gasket for level gauge	200%
	(b) Manhole gasket	200%
(12)	Air, flue duct and fly ash hopper	
	(a) Gasket for manhole	200%
	(b) Bolts and nuts for manhole	200%
	(c) Packing for damper shaft	200%
(13)	Forced draft fan	
	(a) Bearing for fan	One (1)
(14)	Induced draft fan (Not applicable)	
(15)	Gas recirculation fan	complete set each
	(a) Bearing for fan	One (1)

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		Numbers of spare
(16)	Seal air fan	complete set each
	(a) Bearing for fan	One (1) complete set
	(b) Flexible hose (each size)	20%
(17)	Flame detector and television camera cooling air system	
	(a) Flexible hose (each size)	20%
(18)	Piping system for steam generator	
	(a) Gland packing and gasket for valve	50% each
	(b) Control valve diaphragm (each size)	1 piece
	(c) Valve (each rating and size)	2 sets
	(d) Pipe and fitting (each size and material)	2 pieces
	(e) Glass for sight flow	1 set each size
(19)	Instrument air systemm	
	(a) Wrist pin bushing	1 set
	(b) Pair of crank pin bearing shells	1 set
	(c) Pair of connecting rod bolts and nuts	1 set
	(d) Complete valve assembly for cylinder	2 sets
	(e) Piston ring	5 sets
	(f) Packing ringe diaphragm	1 set
	(g) Gasket and O ring	1 set
	(h) V belt	1 set
	(i) Filter cartridge	50%
	(j) Gland packing and gasket for valve	50% each
(20)	Service air system	
	(a) Wrist pin bushing	1 set

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		Numbers of spare
(b)	Pair of crank pin bearing shells	1 set
(c)	Pair of connecting rod bolts and nuts	1 set
(d)	Wrist pin retaining rings	1 complete set
(e)	Scraper rings	1 complete set
(f)	Bearing for compressor	1 complete set
(g)	Complete valve assembly for LP and HP cylinder	1 set
(h)	Piston rings	1 complete set
(i)	Packing rings and gasket	1 set each
(j)	Gland packing and gasket for valve	50%
(21)	Chemical feed system	
(a)	Plunger for pumps	1 set each
(b)	Gland packings	1 set each
(c)	Ball valves	1 set each
(d)	Valve seat	1 set each
(e)	Gasket	1 set each
(f)	Valve packing and gasket	each 50%
(g)	Standard spare parts for recorder (include ink pad, ink, charts, fuses)	1 year
(h)	Level switch	1 set
(22)	Sampling rack system	
(a)	KCI	2 kg
(b)	15A SUS 304 pipe	5 m
(c)	Valve packing	50%
(d)	Thermometer	5 sets
(e)	Pressure reducer	2 sets

		Numbers of spare
(f)	Ion exchange resin	100%
(g)	Standard spare parts for recorder (include ink pad, ink, charts, fuses)	1 year
(h)	Standard spare parts for each analyzer and sensor	One set
(i)	Glass for sight flow	10%

(23) Instrumentation

A. Boiler Control

(a)	Pressure transmitters	1 set each
(b)	Flow transmitters	1 set each
(c)	Temperature transmitter	1 set each
(d)	Level transmitters	1 set each
(e)	EP, PE convertors	1 set each
(f)	Standard spare parts for operation modules and power sources	1 set each
(g)	Standard spare parts for selector station	1 set each
(h)	Standard spare parts for positioners	1 set each
(i)	Standard spare parts for control valves	1 set each
(j)	Standard spare parts for control drives	1 set each
(k)	Standard spare parts for indicators	1 set each
(l)	Standard spare parts for recorders	1 set each
(m)	Standard spare parts for flue gas analyzers	1 set
(n)	Lamps	200%

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	Numbers of spare
B. Burner control	
(a) Standard spare parts for relays, operating modules and power sources	1 set each
(b) Pilot lamps	200 %
(c) Indication lamps	200 %
(d) Fuses	200 %
(e) Control switches	1 set each
(f) Limit switch	1 set each
C. Other instruments mounted on BTG board and auxiliary control panel	
(a) Standard spare parts of recorders (lamp, fuse, pen, etc.) and indicators	2 sets each
(b) Chart and ink pad for recorder	2 year
D. Local control	
(a) Standard spare parts for transmitters (pressure, temperature, flow, level)	1 set each
(b) Standard spare parts for controllers (pressure, temperature, flow, level)	1 set each
(c) Pressure switches	1 set each
(d) Control switches	1 set each
(e) Lamps for operation indication and annunciator	200 %

APPENDIX-1

TABLE-1

Heavy Fuel Oil Analysis

			% by weight	
Conradson carbon	(C)	% wt	20	Max
Hydrogen	(H2)	% wt	11.3	Max
Sulphur	(S)	% wt	3.5	Max
Oxygent + Nitrogen	(O2 + N2)	% wt	2.5	Max
Ash		% wt	0.1	Max
Sediments		% wt	0.25	Max
Kinetic visosity at 50°c		cSt	400	Max
Specific gravity at 15/4°C			0.99	Max
Water volume		% wt	1.00	Max
Flash point		°c	66	Max
Pour point		°c	35	Max
Vanadium		ppm	150	Max
Sodium		ppm	50	Max
Heating value		Kcal/kg	10,000	Min

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APPENDIX-I

TABLE-2

Natural Gas Typical Analysis

	Z by volume	
	Use for perf. calculations	Variation
Methane (CH4)	93.5	90 - 96
Ethane (C2H6)	0.9	0.5 - 1.5
Propane (C3H6)		
Butane (C4H10)	0.4	0.2 - 1.0
Complex (C_nH_{2n+2})		
Carbon dioxide (CO2)	0.2	0.0 - 5.0
Nitrogen (N2)	3.2	3.0 - 5.0
Net calorific value kJ/m3 (STP)	34,740	33,000 - 35,000

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PART II

SECTION III

TURBINE AND AUXILIARY EQUIPMENT

SECTION III. STEAM TURBINE AND AUXILIARY EQUIPMENT

CONTENTS

These specifications are prepared for one (1) unit and shall be applied for both Unit 1 and Unit 2.

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1. STEAM TURBINE

1.1 SCOPE OF SUPPLY

The Contractor shall supply the steam turbine with the all major components and complete accessories, but these will not be limited to the following.

(1) Turbine

- (a) Turbine
- (b) Sole plates
- (c) Foundation bolts, nuts, sleeves and shims
- (d) Embedded materials (bench marks, jacking posts, etc.)
- (e) Sub-sole plates or ram pack method material
- (f) Name plate
- (g) Grating for platform

(2) Electro-hydraulic governor control system (EHC)

- (a) Turbine speed regulating system (TSR)
- (b) Load control system (LC)
- (c) Load limiting system (LL)
- (d) Overspeed protection system (OSP)
- (e) Turbine speed-up system (TSC)
- (f) Valve transfer system (VTR)
- (g) Valve test system (VT)
- (h) Power/load unbalance protection system (PLU)
- (i) Initial pressure regulating system (IPR)
- (j) Low pressure turbine bypass system (LPTB)
- (k) Trouble shooting function (TSF)

(3) Protection system

- (a) Main stop valves

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(b) Combined reheat valves

(c) Emergency trip devices

Emergency governor

Thrust failure protection device

Vacuum trip device

Low bearing oil pressure trip device

Vibration protection device

Lp turbine exthoust temperature high trip device

(d) Extraction steam reverse current and stop valves

(e) Vacuum breaker

(f) Atmospheric relief diaphragm(s)

(g) Initial pressure regulator

(h) Turbine exhaust water spray system

(4) Lubricating and hydraulic oil system

(a) Main oil tank

(b) Oil cooler

(c) Main oil pump

(d) Relay dump valve

(e) Auxiliary oil pump and AC motor

(f) Turning gear oil pump and AC motor

(g) Emergency oil pump and DC motor

(h) Jacking oil pump and motor (if required)

(i) Vapor extractor and motor for main oil tank

(j) Oil conditioner

(k) Vapor extractor and motor for oil conditioner

(l) Oil filter pump and motor

(m) Turbine oil storage tank (one (1) for two (2) units)

(n) Oil transfer pump and motor (one (1) for two (2) units)

(o) Oil driven booster pump

(5) Turning equipment

(6) Gland steam seal system

(a) Regulator

(b) Gland steam exhaust blowers and motors

(c) Gland steam condenser

(d) Steam seal diverting valve

(7) Turbine supervisory instruments

(a) Speed and control valves recorder

(b) Eccentricity recorder

(c) Vibration recorder

(d) Casing expansion recorder

(e) Differential expansion recorder between casing and rotor

(f) Turbine metal and oil drain temperature recorder

(g) Rotor position indicator

(8) Turbine instrumentation

(9) Piping, valves and hanger supports

(10) Insulation and metal lagging

(11) Painting

(12) Lubricating oil (flushing oil and initial charge oil)

(13) Special tools and standard tool sets

(14) Grating and platforms

(15) All other equipment and materials for complete setting of the steam turbine and accessories

1.2 GENERAL INFORMATION

1.2.1 APPLICABLE STANDARDS AND CODES

The steam turbine shall be designed and constructed in accordance with the requirements of Clause 6 of "Applicable Standards and Codes" specified in Section I of Part I.

1.2.2 OUTLINE

(1) The power plant shall be of the reheat type, and the steam turbine shall be of the two (2) or three (3) cylinder type.

(2) The steam turbine shall be installed inside the main power house.

(3) The steam turbine shall be, to the extent possible, of the manufacturer's standard construction and design to allow economical continuous service with low maintenance cost.

(4) The scope of supply of steam turbine and auxiliary equipment shall cover items from the main stop valves inlet and combined reheat valves inlet to the valves of the final high pressure feedwater heater and high pressure turbine exhaust nozzles.

(5) The steam turbine low pressure ends shall be arranged for bottom exhaust, and shall be provided with connections to condenser expansion joints, if required.

(6) The steam turbine shall operate in conjunction with a regenerative feedwater heating cycle consisting of low pressure feedwater heaters, a deaerator and high pressure feedwater heaters.

(7) The machine external components shall have enclosure covering and housings of attractive appearance, good accessibility and functional use.

(8) The steam turbine and accessories shall be designed and constructed so as to be suitable in all respects to the conditions of operation.

(9) The steam turbine generator foundation shall be of reinforced concrete and constructed by the Contractor of Lot-I. The Contractor of turbine shall submit the necessary information for the steam turbine generator foundation to the Engineer for approval.

(10) The lubricating oil system shall have sufficient capacity for the steam turbine generator bearing oil, hydraulic oil and generator seal oil. Oil storage system shall be composed of one (1) tank and one (1) oil transfer pump.

(11) The steam turbine shall be operated from the EHC panel on the BTG board in the central control room.

(12) The governing system shall be provided with EHC.

(13) The gland seal system shall be of steam seal type, and exhaust blowers and gland steam condenser shall be provided. The initial seal steam during the turbine start up shall be supplied from the high pressure auxiliary steam source.

(14) The turbine and generator rotor support system shall be of manufacturer's standard design and of the type having at least five (5) year of proven operation.

(15) The turbine shall be able to operate for at least 30 minutes on power house load in case of tripping of electric power system.

(16) The turbine shall be able to operate continuously without any trouble, even if the frequency of the electric power system fluctuates within 47 Hz to 52 Hz.

1.2.3 DESIGN DATA

1.2.3.1 STEAM TURBINE

(1)	Installation	Indoor
(2)	Type	Reheat-condensing, tandem compound, double flow turbine
(3)	Number	One (1) set
(4)	Rated capacity	200 MW
	Economical continuous rating (ECR)	Rated output of 200 MW, at rated steam condition and exhaust pressure 60 mmHg abs., with make up 0%
(5)	Maximum continuous rating (MCR)	Proposed output not less than 105% of rated capacity at rated steam condition, maximum guaranteed throttle flow, and exhaust pressure 60 mmHg abs., with make up 0%
(6)	Capability	Turbine-generator shall be capable to operate at 100% rated output, at exhaust pressure 90 mmHg abs., with make up 3%
(7)	Throttle steam conditions (at main stop valves inlet and combined reheat valves inlet)	169 kg/cm^2g (main steam pressure) 538/538^{o}C
(8)	Speed	3,000 rpm

(9)	Number of extraction	Seven (7) extractions

1.2.3.2 GENERATOR

(1)	Type	Synchronous generator
(2)	Rated capacity	250,000 KVA
(3)	Phase	Three (3)
(4)	Frequency	50 Hz
(5)	Power factor	0.8
(6)	Short circuit ratio	0.5 or more at rated capacity

1.2.3.3 STEAM GENERATOR

(1)	Installation	Outdoor
(2)	Type	Top support, oil fired reheat, drum, forced or natural circulation
(3)	Superheater outlet and reheater outlet steam condition	Decided by the Contractor
(4)	Fuel oil	Refer to fuel oil characteristics listed in Clause 9 Design Conditions, Section I, Part I Technical General Condition

1.2.3.4 GROUND AND FLOOR LEVEL

Each floor level shall be referred to the Owner's Drawings, however, final decision shall be made considering Contractor's specific design.

1.2.3.5 MAIN POWER HOUSE DIMENSION

The dimensions shall be referred to the Owner's Drawings, however, final decision shall be made considering the Contractor's specific design.

1.2.4 PERFORMANCE AND GUARANTEE

(1) The equipment shall operate safely and reliably and without undue maintenance or operator attention.

The guarantees shall be such as can be met in daily operation under all specified operating conditions.

(2) The steam turbine with accessories and auxiliaries shall be guaranteed to perform as specified in Clause 4, Section I.

(3) Heat balances

(A) The Contractor shall submit complete turbine heat balance sheets for each of the following outputs.

Turbine generator maximum output - at 60 mmHg.abs.

100% of rated capacity at 90 mmHg.abs., 3% make up

100% " at 60 mmHg.abs., 0% "

75% " " " "

50% " " " "

minimum load " " "
(≤25% of rated capacity)

(B) Each heat balance shall be calculated on the following bases.

(a) Throttle steam condition: 169 kg/cm^2g.
538/538°C

(b) All extractions shall be in use.

(c) Gland steam leak off shall be returned to the

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surface condenser.

(d) Steam source for the air ejector shall be from high pressure auxiliary steam header for all loads, and the condensate shall be returned to the surface condenser.

(e) The drain from steam coil air preheater shall be returned to the low pressure heater drain tank.

(f) Superheater and reheater attemperator water shall be supplied from intermediate stage of the boiler feed pump or its discharge line.

(g) Pressure loss in extraction piping, including valves and fittings, from the turbine bleed steam outlet to the feedwater heater connection shall be assumed as 5% of the absolute extraction connection pressure.

(h) Unless specifically stated, pressure drop shall be assumed to be zero.

(i) Temperature of condensate leaving the surface condenser shall be assumed to be that corresponding to the surface condenser saturation pressure.

(j) Power changes of the boiler feed pump and enthalpy gains shall be considered.

(k) Power changes of the condensate pump and enthalpy gains shall not be considered.

(l) Piping heat losses shall be neglected.

(m) Figures and calculations shall be based on the latest "JSME Steam Table". (1980 edition)

(n) Terminal difference of the feedwater heaters and their drain coolers shall be of the Contractor's specifications.

(C) The Contractor shall submit heat balance sheets of the above conditions. H_2 gas pressure, mechanical and electrical loss of generator, and mechanical loss of turbine shall be indicated in the sheet for each load.

(4) Auxiliary power

The net plant heat rate shall be guaranteed based on operation of the following steam turbine auxiliaries.

(a) Vapor extractor for main oil tank

(b) Oil filter pump

(c) Gland steam exhaust blower

(d) Circulating water pump

(e) Condensate pump

(f) Sea water booster pump

(g) Bearing cooling water pump

(h) Make up water transfer pump

(i) Boiler feed pump

(j) LP heater drain pump

(k) Other required equipment for proper operation

1.2.5 TESTING

The Contractor shall at least execute the following tests, and shall submit the test results to the Owner and the Engineer. The test items marked "*" below shall be carried out in the presence of the Engineer.

1.2.5.1 SHOP TEST

(1) Turbine

(a) Material test of casing, rotor, nozzle, blade, MSV, CV, combined reheat valve, turbine bypass valve, etc.

(b) * Heat indication test of rotor

(c) * Non-destructive test of casing, rotor, nozzle, blade, MSV, CV, CRV, turbine bypass valve, etc.

(d) * Hydrostatic test of casing, MSV, CV, CRV, turbine bypass valve, etc.

(e) * Dynamic balancing test of complete rotor (including overspeed)

(f) Protection device test

(g) * Turbine assembly

(h) * EHC system

The Owner will attend the shop test for the rotor dynamic balance and EHC system, etc., specified in Clause PA.6.

(2) Accessories (pumps, blowers and heat exchangers)

(a) Material test

(b) Hydrostatic test

(c) Dimension check

(d) Performance test

(e) Vibration test

(f) Noise check

(g) Overhaul inspection

1.2.5.2 FIELD TEST

(1) Turbine

(a) Centering check

(b) Alignment and leveling check

(c) Clearance check during assembling

(d) Tightening records of turbine casing and major valve bolts

(e) Oil flushing

(f) Overspeed test

(g) Interlock test and unit interlock test

(h) Dump test

(i) Bearing inspection

(j) Load swing test

(k) Performance test

(l) Continuous operation test (30 days)

(2) Accessories (pumps and blowers)

(a) Alignment check

(b) Motor running test (isolated)

(c) Pump running test

(d) Vibration check

1.3 TECHNICAL INFORMATION

1.3.1 TURBINE

(1) Casing

(a) Casings shall be designed simple and free from thermal cracks on inner or outer casings.

(b) Casings shall be drilled for thermocouples to indicate metal temperatures in the casing and the steam chest. Thermocouples shall be provided and brought out to a convenient terminal block.

(c) The joints of the casing shall be metal to metal. Larger size bolts shall be arranged for tightening by heating.

(d) Running balancing weights shall be able to be adjusted without overhauling the casing.

(e) Bolts and nuts for casing insulation shall be provided, and nuts shall be welded before the final annealing of the casing.

(f) The turbine exhaust opening shall be located below the turbine, opening downward and designed for a strength welding connection without the use of flanged or bolted components.

(g) The turbine foundation bolts shall be provided in consideration of reaction force and moment due to turbine lead pipes, extraction pipes and crossover pipe.

(2) Internal parts

(a) The rotor shall be made of single piece alloy steel

forging.

(b) The critical speed value of complete rotor assembly shall be in sufficient variance from the rated speed.

(c) The rotor shall be capable of operation at any speed up to 110% of rated speed, and shall be sufficiently strong enough to withstand any stress that may result from transient speeds up to 120% of the rated speed without damage to the rotor.

(d) Blades shall be made from suitable bar, block or forged materials.

(e) Blades shall be fitted to the rotor in accordance with the manufacturer's excellent engineering practices.

(f) The last stage blades shall be thoroughly protected from drain attack erosion and/or corrosion.

(g) The first stage blades shall be designed so as not to crack under thermal shock.

(h) Blades shall be designed in accordance with the manufacturer's standards, and tie wires shall be adopted, if required.

(i) Blades shall be designed to retain excellent efficiency, high temperature strength and reliability even during vibration.

(3) Bearing

(a) Seal for all bearings shall be furnished to prevent oil and vapor leakage along the rotor.

(b) The bearings shall be of the self-aligning type and split to permit removal of the upper half for inspection.

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(c) The bearings shall be accessible for inspection without removal of the casings.

(d) The bearings shall be designed to be free from any vibration trouble, such as oil whipping.

(e) Thrust bearing shall be designed carefully with adequate thrust intensity so as to be able to operate the turbine at any load.

(4) Coupling

The coupling connecting each turbine and generator rotor shall be of the solid type and arranged so that it can be readily disconnected. Coupling connection between turbine and generator shall apply reamer bolt.

(5) Crossover piping with expansion joints shall be provided.

1.3.2 ELECTRO-HYDRAULIC GOVERNOR CONTROL SYSTEM

The Contractor shall provide the degital type electro-hydraulic governor control system, and the system shall include, but not be limited to, the following items.

(a) Turbine speed regulating system (TSR)

(b) Load control system (LC)

(c) Load limiting system (LL)

(d) Overspeed protection system (OSP)

(e) Turbine speed-up system (TSC)

(f) Valve transfer system (VTR)

(g) Valve test system (VT)

(h) Power/load unbalance protection system (PLU)

(i) Initial pressure regulating system (IPR)

(j) Trouble shooting function, maintenance tool (TSF)

This system shall include, but not be limited to, the following instruments and devices.

(a) Transmitters, etc.

(b) Sensors (pressure switches, limit switches, etc.)

(c) Detecting elements (electro-magnetic pickups, etc.)

(d) Operating modules (for control, calculation, monitoring, etc.)

(e) Man-machine communication devices (for CRT console, panel, printer etc.)

(f) Actuating devices (including regulating devices)

(1) Design Specifications

(a) Type of control equipment

Electro-hydraulic governor control system (Low oil Pressure

type)

(b) Signal range

Electric signal:	4-20 mA DC
	1-5 V DC
	Contact ON/OFF
	Pulse
Pneumatic signal:	0.2 - 1.0 kg/cm^2g

(c) Power source

Electric power source:	DC 220 V
	AC 220 V 50 Hz
	PMG by manufacturer (if required)
Instrument air source:	7.0 kg/cm^2g
Control oil:	Control oil by turbine manufacturer

(d) This control system shall be so designed as to enable the following functions during start up of the turbine.

. Valve transfer

. Control and limit of load

. Regulation of speed and protection against overspeed

. Valve testing

. Low pressure turbine bypass control

. Trip test during operation

. All other necessary functions

(e) The characteristics of speed regulation shall be linear and/or non-linear, and shall be made changeable during operation of the EHC.

(f) This control system shall be provided with a backup

and redundancy system for high reliability.

(g) This control system shall be designed so as to transmit trip signal when any serious trouble arise in the system.

(h) MTBF of this system shall be more than 10^5 hours of design.

(2) Technical information

(a) The control console for operation and valve test shall be provided on the BTG board.

(b) The control system shall be designed on the basis of the "fail-safe" and "foolproof" concept.

(c) The control system shall be provided with a DC relay circuit for tripping the turbine in the event of any serious trouble in this system.

(d) The control system shall permit smooth changeover to and from manual mode and automatic mode operations.

(e) The control system shall be furnished with at least one (1) backup system.

(f) The system shall be protected against power source failure and other troubles in the sensors, operating modules and actuating devices.

(g) All operating modules shall be mounted in the system cabinet in the computer room.

(h) All transmitter signals shall be indicated on both local and system cabinets.

(i) All accessories and necessary pertinents shall be provided.

(j) All piping, tubing and wiring shall be provided.

(k) All communication signal devices shall include, but not be limited to, alarm annunciators, plant interlocks and ABC.

(l) All instruments necessary for manual and remote control of the turbine described in the following paragraph (3) shall be provided on the BTG board.

(m) The trouble shooting function and maintenance shall be so designed as to permit on-line and off-line maintenance.

(n) The Contractor shall provide the special tools and standard tool sets for the control system.

(o) This system shall comply with the design standards in Clause 3.1 of "Instrument and Control Apparatus" and Clause 2.1 "Panels and Boards" in Section II of Part I.

(p) The trouble diagnosis device shall be furnished with indicator lamps and all necessary pertinents.

(q) Each standby back up operating module shall be provided for each operating module of the same type, and shall be installed in the system cabinet.

(r) All instruments and devices shall be provided with covers for protection against damage.

(s) All control signals shall be protected from noise heat stress.

(3) All control systems shall be designed based on the requirements specified herein.

(a) Turbine speed regulating system

This system shall be provided to control generator output power by speed regulation.

(b) Load control system

(i) This system shall be designed so that the generator output

power can be controlled based on the demand signals from ABC or through manual operation.

(ii) This system shall be furnished with the following.

. Turbine follow control (main steam pressure control)

. Turbine output set

. Turbine output changing rate set

(c) Load limiting system

The system shall be furnished with the following.

. Automatic following function

. Manual load limiting function

(d) Overspeed protecting system

The overspeed protecting system shall be furnished with the following.

. Backup overspeed protection

(e) Turbine speedup system

. Turbine speed control unit from 0% to rated speed with cold, warm, hot, and very hot start mode

. The system shall be furnished with turbine speed set, speed acceleration rate and speed hold unit on the console

. Speed regulation for synchronization

(f) Valve transfer system

The system shall be furnished with the following functions.

. Valve transfer (changeover) from main stop bypass valve to turbine control valve, and from turbine control valve to main stop bypass valve

(g) Valve test system

This system shall be provided with the following functions at central control room and local mounting board.

(i) The testing devices for main stop valves, control valves, and combined reheat valves shall have a automatic testing function including the necessary interlock.

(ii) Each valve shall be able to be tested at the local mounting board.

(h) Power/load unbalance protection system

The system shall be protected against overspeed due to the imbalance between power and load.

(i) Initial pressure regulating system

The system shall be protected against decrease of main steam pressure.

1.3.3 PROTECTION SYSTEM

(1) General

The Contractor shall provide the steam turbine with emergency tripping device and other protection systems.

(2) Main stop and combined reheat valves

(a) A hydraulically operated main stop and combined reheat valves shall be provided for shut off steam from coming into the steam turbine.

(b) The main stop and combined reheat valves shall have provisions for testing the valve while the plant is in operation.

(c) Solenoid trip limit switches and the adequate number of contacts for interlocking at the open and closed ends shall be provided.

(d) The main stop and combined reheat valves shall be provided with steam strainers, coarse mesh elements for normal operation and fine mesh elements for initial start.

(e) The strainers shall be made of stainless steel punching mesh.

(f) The main stop and combined reheat valves shall be provided with the necessary devices for attaching temporary blowing out steam piping prior to starting the steam turbine.

(3) Emergency governor

(a) The emergency governor to close the main (emergency) stop and combined reheat valves/reheat stop and intercept valves and control (governor) valves, and to close the extraction relay dump (bleader trip valve) valve when the turbine speed reaches about 10% over the rated speed shall be provided.

(b) The emergency governor shall be provided with devices of manual tripping of the governor and of manual resetting when the speed falls to less than the rated speed.

(c) The governor shall be of the type that can be tested during normal operation without tripping the turbine.

(4) Emergency trip device

(a) Thrust failure protection device

(i) Oil relay equipment to trip the steam turbine, when the turbine rotor position is abnormally changed, shall be provided.

(ii) Switches shall be provided for annunciating an impending failure of the turbine thrust bearing.

(iii) Additional switches shall be provided for alarm and trip of the thrust bearing failure.

(iv) The thrust failure protection device shall have the testing function so as to enable tests to be carried out during turbine running, and shall be designed so as to enable the results of tests to be checked by the indicator.

(b) Vacuum trip device

(i) The vacuum trip device shall be provided to close the main stop and combined reheat and control valves when the turbine exhaust pressure raises above the set limit.

(ii) The vacuum trip device shall include solenoids for trip and a reset to be operated from the central control room.

(iii) Low bearing oil pressure trip device

This device shall be provided to trip the turbine when lubricating oil pressure drops below the set value.

(5) Vacuum breaker

(a) The steam turbine shall be provided with DC motor or a solenoid valve operated vacuum breaker located on the operating floor.

(b) The vacuum breaker shall be provided with a water seal reservoir for keeping the tightness of the valve.

(c) The water seal reservoir shall be provided with make up piping from the condensate line.

(d) The vacuum breaker shall be provided with a small bypass valve for adjusting the turbine exhaust pressure.

(6) Extraction steam reverse current and stop valves

(a) Reverse current and stop valves for all extraction steam lines shall be provided.

(b) The reverse current valves shall be closed when the steam turbine is tripped and when the feedwater heater

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level rises abnormally.

(7) Atmospheric relief diaphragms

The atmospheric relief diaphragms shall be located in the turbine exhaust casing.

(8) Initial pressure regulator

(a) The regulator shall be equipped with a automatic adjustment by which the steam inlet pressure to be maintained can be adjusted.

(b) The shut off valve shall be provided in the regulator control system so that the regulator can be made inoperative during start up.

(9) Turbine exhaust water spray system

(a) This device shall be provided complete with spray nozzles, controller, automatic air operated spray water shut off valve and all interconnecting piping between the nozzles and the spray water shut off valve.

(b) Opening conditions of spray valve shall be indicated in the central control room.

(c) Spray water shall be led from the condensate line.

1.3.4 LUBRICATING AND HYDRAULIC OIL SYSTEM

(1) General

(a) A complete lubricating and hydraulic oil system shall be furnished for the steam turbine and generator.

(b) The oil system shall be carefully considered in view of operation, maintenance and safety.

(c) The system shall be designed for use of lubricating oil available in the purchaser's country.

(2) Main oil tank

(a) The main oil tank shall be installed on the ground floor or mezzanine floor.

(b) The main oil tank shall be of sufficient capacity so as not to cause overflow even if all oil in the system returns to the tank.

(c) The main oil tank shall be of welded construction.

(d) The main oil tank shall be furnished complete with level indicator, high and low level alarm switches, strainers, drain, overflow, manhole, oil pumps, vapor extractor, valves and piping.

(e) The interior parts of tank shall be treated with two (2) coats of rust inhibitive paint.

(f) The main oil tank shall be provided with anchor bolts and nuts and operating gallery.

(g) One (1) set of centrifugal blower type vapor extractor shall be installed on the main oil tank, and shall be locally operated. The bypass piping shall be installed on exhaust piping of the vapor extractor to maintain

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natural ventilation during tripping.

(3) Oil pumps

(a) The main oil pump shall be of the turbine rotor driven type.

(b) The oil educator or the oil booster pump driven by an oil turbine receiving high pressure oil from the main shaft driven oil pump with a capacity capable of supplying boosted oil to main oil pump suction together with sufficient oil for lubrication shall be furnished.

(c) The AC motor driven auxiliary oil pump with a capacity capable of supplying sufficient oil for lubricating and for the hydraulic and seal system shall be furnished.

(d) The DC motor driven emergency oil pump with ample capacity to protect the turbine generator bearing from damage at the time of blackout of AC power source shall be furnished.

(e) The AC motor driven turning gear oil pump with ample capacity to supply sufficient oil for lubricating and seal during turning of the turbine shall be furnished.

(f) All motor driven oil pumps shall be installed on the main oil tank.

(g) Each oil pump shall be provided with suction strainer.

(h) Pressure switches for automatic sequential starting with test device of motor driven oil pumps shall be provided. Additional pressure sensing switches shall be provided to indicate operation of the motor driven oil pumps and alarm of low oil pressure.

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(i) The start and stop of motor driven oil pumps shall be controlled in the central control room.

(j) The oil pressure regulating system shall be designed to control bearing and hydraulic oil pressure within the design values.

(k) The pressure transmistters and remote indicator shall be furnished for monitoring of bearing and hydraulic oil pressure.

(l) Each pump shall be furnished with a motor. The motors shall be in accordnace with Clause of "Standard of Motor" in Section II, Part I.

(m) Jacking oil pump shall be furnished, if necessary.

(4) Oil coolers

(a) Two (2) oil coolers each with 100% capacity shall be provided.

(b) Each oil cooler shall have sufficient capacity to cool the entire oil supply to equipment when oil is supplied with maximum cooling water temperature at the worst condition.

(c) The oil cooler shall be of the "straight" or 'U'-tube type.

(d) The tube material shall be of the Contractor's standard.

(e) Oil piping to and fro the oil coolers shall include a double three way valve to switch the oil flow from one cooler to the other smoothly without affecting the system.

(f) A single handwheel or lever shall position both valves simultaneously.

(5) Relay dump valve

(a) An oil operated air pilot dump valve shall be furnished for operation of the extraction steam reverse current valves.

(b) The valve shall be complete with all necessary oil piping.

(c) An additional manual test valve shall be furnished to check individual extraction steam reverse current valves.

(6) Sight flow indicator and thermometer

(a) Each turbine generator rotor bearing shall be provided with an illuminated sight flow indicator and direct mounted thermometer.

(b) Each thermometer shall be provided with a stainless steel removable socket (thermo-well).

(7) Oil conditioning equipment

(a) Oil conditioning equipment shall be installed beside the main oil tank. Filter type oil conditioning equipment is preferable.

(b) The oil conditioning equipment shall be furnished to remove water, suspended solids, moisture and other undesireable matter from the oil.

The moisture in the oil shall be maintained less than 0.05%.

(c) The equipment shall consist of a cellulose cartridge type pressure filter with an oil filter pump, vapor extractor, necessary pressure, temperature, flow and level indicators, flow switch, piping, drain and

sampling cocks and auto water extractor.

(d) The capacity of equipment shall be designed 20% of the turbine generator lubricating oil flow.

(e) An oil filter pump shall be furnished complete with motor, integral bypass relief valve, shaft coupling, and common base plate.

(f) The oil filter pump shall be of the rotary gear type.

(g) The oil conditioning equipment shall be locally operated.

(h) All equipment shall be furnished with foundation bolts and nuts.

(8) Turbine oil storage tank

(a) The turbine oil storage tank shall be installed outdoors.

(b) The tank shall be a two compartment unit in which each compartment shall be large enough to hold 105% of the total lubricating oil needed for turbine generator equipment.

(c) The two compartment units shall comprise one clean oil storage unit and one dirty oil storage unit.

(d) Each compartment shall be equipped with a glass protected oil gauge, inlet connection to tank truck car, drain clean out, deep suction, floating suction, vent and fill connections and manhole with removable cover.

(e) The interior parts shall be treated with two coats of rust inhibitive paint.

(f) The tank shall be provided with foundation bolts and nuts.

(9) Oil transfer pumps

(a) The pump shall be installed outdoors beside the turbine oil storage tank.

(b) One (1) pump shall be provided.

(c) The pump shall be of the positive displacement rotary gear type, and shall be of sufficient capacity to fill the main oil tank in 60 minutes.

(d) The pump shall develop sufficient head to pump oil from the turbine oil storage tank through the oil conditioner and return it to the main oil tank or the oil conditioner.

(e) The pump shall be furnished complete with a motor, integral bypass relief valve, shaft coupling, coupling guard, common base plate and foundation bolts and nuts.

(f) The pump shall be locally operated.

(10) Oil piping

(a) All oil piping shall be of carbon steel with steel welded fittings and, to the extent possible, arranged to run below the operating floor level.

(b) The number of flanged joints shall be kept to a minimum, and screw joints shall not be used.

(c) Every precaution shall be taken to prevent danger of pipe rupture and oil leaks.

(d) Duplex piping to flow high pressure hydraulic oil through inside pipe and low pressure oil drains through outside pipe shall be adopted wherever possible for

safety purposes.

(e) The oil piping shall be adequately supported and braced to prevent vibration.

(f) The oil piping shall be segregated from hot portion and, wherever necessary, the oil lines shall be shielded.

(g) All oil piping shall be shop pickled with suitable inhibitor and properly preserved and sealed for shipment and storage prior to installation.

(h) The valves shall be of cast steel or forged steel and of the welded connection type.

(i) The blow off valve of main oil tank, etc., shall be able to tightly close the double valves, and shall have a cap downstream of the pipeline.

(j) The exhaust piping of vapor extractor shall be installed up to the top of the main power house roof.

(k) All necessary piping and materials for oil flushing operation shall be supplied by the Contractor.

(l) All oil piping shall be provided with facilities to prevent fire in the oil pan installed below oil control actuator, flange joint, etc.

(m) Oil transfer piping shall be provided with connection piping including stop valves for future extension, if required.

1.3.5 TURNING EQUIPMENT

(1) The AC motor driven or oil hydraulic driven automatic tripping turning equipment shall be furnished complete with oil piping and valves as well as the necessary interlocks to prevent the turning system from operating until proper lubricating oil pressure has been established. The Owner prefers the AC motor driven type.

(2) The turning system shall be provided with the means to manually engage the device with the turbine rotor.

(3) The turning system shall automatically disengage when the turbine generator speed rises above the turning speed.

(4) All required control switches, push buttons and indicating lights for turning equipment operation shall be furnished on the BTG board in the central control room.

(5) The zero speed detector shall be furnished and detector indicating lamps shall be mounted on the BTG board.

(6) Housings and safety guards shall be provided for all moving parts of the turning equipment.

1.3.6 GLAND STEAM SEAL SYSTEM

(1) The steam turbine shall be provided with steam seal packing to prevent steam leakage to the atmosphere or air leakage into the steam turbine.

(2) A gland steam regulator shall automatically control steam pressure to the gland seal over the entire load range.

(3) The regulator shall be of the oil relay type.

(4) The gland exhausting system shall include a gland steam condenser and two (2) exhaust blowers of which one shall have 100% capacity.

(5) The gland steam exhaust blowers shall be of the centrifugal blower type.

(6) The gland steam condenser shall be of the horizontal surface cooling type and cooling water shall use condensate.

(7) The tube material of condenser shall be of stainless steel.

(8) All interconnecting piping among the steam turbine, the gland seal regulator and the gland steam condenser shall be furnished including relief valve, control valves, pressure gauges, strainers, drain trap and instruments, and shall be provided with hanger supports.

(9) The system shall have provisions for manual operation when the regulator is out of order.

(10) Drain piping shall be provided between the gland steam condenser and the surface condenser.

(11) The sealing steam for turbine start up shall be supplied from high pressure auxiliary steam and necessary piping shall be provided. The supply valve and the regulator bypass valve shall be motor operated valves which can be operated from the

central control room.

(12) The stop and check valves shall be installed at the outlet of exhaust blower.

(13) The exhaust piping of exhaust blower shall be installed up to the roof of the main power house, and shall be covered with heat insulation material for heat protection.

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1.3.7 TURBINE SUPERVISORY INSTRUMENTS (TSI)

(1) The turbine supervisory instruments shall consist of, but not be limited to, the following items.

(a) Inking recorder for shaft eccentricity, turbine speed, MW and control valve position, turbine speed acceleration and shaft vibration amplitude

(b) Printing recorder for shell expansion shaft position and differential expansion

(c) Digital indicators with selector switch for turbine speed, MW each selected shafts and for maximum vibration amplitude on the BTG borad

(d) Detectors, amplifier, signal conditioner, etc., for above items (a), (b) and (c) recorders and indicators

(e) Turbine acceleration indicator for start up period

(f) Printing recorder for each bearing temperature and oil drain temperature from each bearing

(g) Printing recorder for steam temperature casing (shell) and flange metal temperature (chest inner and outer surface, other necessary points)

(h) Thermocouples for steam temperature, casing (shell) and flange metal temperature (chest inner and outer surface, other necessary points)

(2) Sensor for computer input signal shall be provided and included in the above turbine supervisary instruments.

(3) The recorders shall be mounted on the auxiliary board. The color of the case shall be black.

(4) The recorder for vibration amplitude shall be of the

continuous recording type.

(5) Vibration amplitude shall be detected on shaft. Alarm contacts for vibration amplitude, eccentricity and differential expansion shall be provided.

(6) All alarm and trip setting data shall be submitted to the Engineer.

(7) The TSI cabinet shall consist of amplifier, signal conditioner, signal monitor, alarm Unit, etc. The cabinet shall be installed in the control equipment room which shall be air conditioned.

(8) The cabinet shall be of the self-standing vertical type.

(9) The channel base shall be provided and shall have bolts and nuts encased in anti-vibration rubber.

(10) The color of cabinet will be decided by the Owner.

(11) Electric power of 220 V for DC and 110 V for AC shall be fed to the system from the power source.

(12) The thermocouple for casing (shell) metal temperature shall be extended to the junction box for connection of external wiring.

(13) Each recorder shall be in accordanace with Clause 3.1 of "Instruments and Control Apparatus" in Section II of Part I.

1.3.8 TURBINE INSTRUMENTATION

The Contractor shall provide the steam turbine together with the all instruments and required apparatuses, but these shall not be limited to the followings items.

(1) Remote indicators

The following recorders, computer inputs and/or indicators shall be provided. Required transmitters and detecting elements shall be provided.

(a) Turbine supervisory instruments

(b) Turbine bearing metal and oil drain temperature (including generator bearings)

(c) Turbine inlet main steam pressure and temperature

(d) Hot and cold reheat steam pressure

(e) First stage steam pressure

(f) Hot and cold reheat steam temperature

(g) Bearing oil and lubricating oil pressure and temperature

(h) Steam seal manifold pressure

(i) Hydraulic oil pressure

(j) Metal temperature of MSV, CV, CRV and casings

(k) Turbine speed, MW.

(l) Turbine exhaust pressure and temperature

(2) Local indicators

(a) Thermometers

All bearing oil drains (including generator)

Thrust bearing oil drains

Oil cooler oil inlets and outlets

Exhaust hood (with alarm contact or thermostat)

Steam seal manifold

Bearing supply oil

(b) Pressure guage

Bearing oil

Hydraulic oil

Steam seal manifold

Main oil pump suction

Oil booster pump

Exhaust hood

1.3.9 TURBINE LEAD PIPING

(1) Turbine lead piping between the main stop valve and the turbine casing shall be provided, and hanger support of the main stop valve, if required, shall be supplied.

(2) The materials of piping shall be alloy steel to match the steam design temperature. The piping design shall be in conformity with Clause 1.1 of "Power Plant Piping" in Section II of Part I.

(3) The stress calculation shall be carried out by taking into account the main steam piping.

1.3.10 DRAIN PIPING AND VALVES

(1) All necessary drain traps shall be installed on the extraction steam piping, the drain piping for the gland steam condenser and the condenser of the steam jet air ejector.

(2) The upstream drain of main stop valve shall be connected to the boiler blowdown tank. Other drains shall be connected to the surface condenser.

(3) Each drain shall be provided with double drain valves.

(4) Drain secondary valves before and after the main stop valves, casing drain and other high pressure drain valves shall be motor operated and operable from the central control room.

(5) The drain piping after drain secondary valves shall be covered with heat insulation material for heat protection.

(6) All necessary hangers and supports shall be supplied.

(7) The piping and valve designs shall be in conformity with Clause 1.1 of "Power Plant Piping", and Clause 1.3 of "Valves and Specialities" in Section II of Part I.

1.3.11 HEAT INSULATION AND METAL LAGGING

(1) General

(a) The steam turbine shall be provided with heat insulation materials for covering the hot surfaces of the turbine casing and piping including the main stop valve, reheat stop valve, intercept valve, turbine bypass valve, turbine lead piping and all steam piping.

(b) The insulation above the operating floor shall be covered with metal lagging.

(c) Other information for insulation shall be in conformity with Clause 1.12 of "Insulation" in Section II of Part I.

(2) Insulation

(a) Turbine casing

The turbine casing shall be insulated with insulating blocks.

All horizontal joints of the turbine casing shall be covered with easily removable type insulation.

The heat insulation of turbine casing shall be, to the extent possible, of the molded type for re-use.

(b) Piping and valves

The hot surface of valves and piping shall be insulated with block and molded segmental type calcium silicate insulating material. The surface of insulating material shall be covered with aluminum jackets.

(c) The cover insulation of main stop valves, reheat stop

valve intercept valve and LP turbine bypass valve shall be of removable type.

(3) Metal lagging

(a) Welded steel plate lagging for the turbine shall have sound deadening insulation, be factory fabricated and ready for field installation.

The steel plate lagging shall be provided in block sections, if required.

(b) The lagging shall be arranged for easy removal for inspection and repair of the turbine, and shall be adequately ventilated.

(c) The lagging shall extend beyond any opening within the turbine generator foundation.

1.3.12 PAINTING

All equipment and pipings shall be painted by the Contractor in accordance with Clause 1.13 of "Painting" in Section II, Part I.

1.3.13 SPECIAL TOOLS AND STANDARD TOOL SETS

The following special tools and standard tool sets shall be supplied by the Contractor.

(A) Lifting sling for turbine casing and rotor

(B) Rotor lifting beams

(C) Rotor supports or assembly stand

(D) Oil jacks

(E) Bolt heaters and their distribution panels

(F) Bolt elongation gauges for heat tightening

(G) Bearing lifting supports

(H) Straight edge and water pot leveling tool with plastic tube

(I) Guide bolts for each turbine casing and bearing boxes (if applicable)

(J) Other standard tools, such as special spanners, heavy duty hammers, etc., necessary for assembling or overhauling of steam turbine.

1.3.14 OPERATING GRATING

The Contractor shall provide operating gratings (platforms) for operation and easy maintenance of steam turbine.

2. SURFACE CONDENSER

2.1 SCOPE OF SUPPLY

The Contractor shall provide the surface condenser with all components and complete accessories, but these shall not be limited to the following.

(1) Condenser with complete accessories

(2) Expansion joints for turbine exhaust connection

(3) Expansion joints for circulating water piping inlet and outlet

(4) Continuous tube cleaning system

(5) Debris filter

(6) Foundation bolts, nuts and sleeves

(7) Structural framing and supports for extraction piping

(8) Drain and vent piping and valves

(9) Instruments

(10) Painting

(11) Operating galleries

(12) Special tools and standard tool sets

Remark: Condenser manufacturers shall have a experience of manufacturing of condensers for 200 MW and above capacity steam turbine generator units with titanium tubes, which have been in successfull operation for at least five (5) years.

2.2 GENERAL INFORMATION

2.2.1 APPLICABLE STANDARDS AND CODES

The surface condenser shall be designed and constructed in accordance with the requirements in Clause 6, "Applicable

Standards and Codes" specified in Section I of Part I.

2.2.2 OUTLINE

(1) The surface condenser shall be designed for simplicity of field installation and ease of cleaning, maintenance and inspection.

(2) The surface condenser shall be of the horizontal surface type with internal cooling section divided into two (2) water boxes.

(3) The surface condenser construction shall have the capacity to sufficiently pass turbine exhaust steam, feedwater heater drain, gland steam regulator drain, turbine casing drain, steam air ejector drain, gland steam condenser drain, steam coil air preheater drain, other miscellaneous drains, etc.

(4) The design shall be in accordance with the latest edition of "Standard for Steam Surface Condenser of the Heat Exchanger Institute" and this specification.

(5) The surface condenser shall be located beneath the turbine exhaust, and shall be designed for a minimum width and for installation within a reinforced concrete turbine generator foundation with tubes at right angle to the turbine rotor.

(6) The surface condenser shell shall be supported from the bottom with an expansion joint between the turbine exhaust casing and the condenser hood. If bottom spring supporting type is applied, an expansion joint between the turbine exhaust casing and the condenser hood may be

eliminated.

(7) A design to prevent erosion and corrosion of condenser shall be considered by taking into account material selection and construction.

(8) One side of the water boxes shall be able to be cleaned, inspected or repaired while the condenser is under operation.

(9) The condenser level control system shall maintain the predetermined level in hot well. Hot well level shall be controlled by supplying and returning condensate from and to the make up water tank. The make up water transfer pump shall be manually operated.

Two (2) make up water pumps shall be provided. Both make up water pumps shall be able to operate in parallel running.

(10) The surface condenser shall be designed to accommodate high temperature steam and drain to be received without thermal stress, drain attack, vacuum trip, etc.

(11) Continuous self-cleaning system (ball-cleaning system) shall be provided for automatic tube cleaning during operation.

(12) Self cleaning debris filter shall be installed on the inlet side of the condenser water box.

2.2.3 DESIGN DATA

(1) Surface condenser

(a)	Type	Single shell, divided water box, horizontal, surface type
(b)	Number	One (1) set

(c)	Design heat duty	Heat duty at turbine rating load operation
(d)	Design exhaust pressure	60 mmHg.abs. (not more than 90 mmHg.abs. with maximum cooling water temperature)
(e)	Cleanliness factor	90%
(f)	Dissolved oxygen in condensate	0.01 cc/liter
(g)	Tube size and thickness	To be decided by the Contractor
(h)	Hot well capacity	To be decided by the Contractor

(2) Circulating water

(a)	Water source	Sea water
(b)	Temperature	Maximum 33 ^{o}C Design 30 ^{o}C
(c)	Maximum water velocity in tube	2.3 m/sec.
(d)	Sea water analysis	Refer to Clause 8 of "Site Conditions" in Section I of Part I

2.2.4 PERFORMANCE

(1) The surface condenser shall perform as shown in the "Tenderer's Data Sheet".

(2) The surface condenser shall maintain the design exhaust

pressure at 60 mmHg.abs. with inlet circulating water temperature of 30 °C under heat duty at ECR condition.

(3) The performance curves shall be submitted to the Engineer for approval and shall cover the following conditions.

(a) Inlet circulating water temperature of 18 °C, 22 °C, 26°C, 30°C and 33°C.

(b) Turbine exhaust condition of 100%, 75% and 50% load

(c) One (1) circulating water pump operation and two (2) pump operations

(4) The Contractor shall submit the calculation sheets to the Engineer for approval.

2.2.5 TESTING

(1) The Contractor shall execute the following shop tests and submit the test and inspection reports to the Owner and the Engineer.

(a) Material test

(b) Non-destructive test

(c) Dimension check

(d) Hydrostatic test

(2) The Contractor shall execute the following field test of the condenser and shall submit the inspection and test reports to the Owner and the Engineer.

(a) Alignment check of tube plate and support plates

(b) Water fill up test

(c) Performance test

2.3 TECHNICAL INFORMATION

2.3.1 MATERIALS

The following materials of construction shall satisfy the minimum requirements for the operation conditions specified.

(1)	Shell plate and hot well	Carbon steel (JIS G3101 or equivalent)
(2)	Tubes	
	Main condensing zone	Titanium
	Air cooling zone	Titanium
(3)	Tube sheets	Titanium or Titanium clad steels
(4)	Tube support plates	Carbon steel
(5)	Water boxes and covers	Carbon steel with interior protected by 3 mm thick neoprene lining
(6)	Expansion joint (between turbine exhaust)	Stainless steel or rubber

2.3.2 SHELL

(1) The shell shall be of all welded construction, and bolting shall be permitted only at access manholes.

(2) The thickness of shell shall include a corrosion allowance, and shall be reinforced to withstand the atmospheric pressure imposed on the shell.

(3) The bracing and reinforcing shall be adequate to prevent deflection and shell vibration.

(4) Any bolting exposed to the condenser interior shall be stainless steel or other acceptable non-corrosive material.

(5) Diaphragm plates or expansion joints shall be provided to

absorb the differential expansion between the shell and the tube bundle.

(6) The steam inlet hood shall be of such a size and design as to obtain optimum distribution of steam over the entire tube surface.

(7) The hinged access manholes shall be installed on the shell and the steam inlet hood.

(8) The nozzle and other connections of the number and size required shall be provided on the shell, and all drains and other returns to the surface condenser shall be manifolded where possible.

(9) The manifolds shall be installed separately and by grouping income drain lines as to be convenient for operation, avoiding any back flow through each drain line.

(10) The surface condenser shall have ample flushing facilities to receive the feedwater heater drain and all other drains.

(11) The surface condenser shall be supported from support feet on the shell bottom.

2.3.3 HOT WELL

(1) Minimum distance between the normal operating level and the bottom tube shall not be less than 400 mm.

(2) The hot well shall be equipped with a strainer and proper baffling to prevent swirls.

(3) The hotwell shall be equipped with level guage so as to indicate a hotwell level at all depths of storage, and shall be equipped with the level switches and alarm contact.

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2.3.4 TUBES

(1) The tubes shall be standard straight length.

(2) The tubes shall be expanded at the inlet and outlet ends and be welded to the tube sheets or fixed by an appropriate method after prior approval from the Engineer.

(3) Tube inlet portion shall be properly shaped for smooth entrance of cooling water.

(4) The tubes in exhaust impingement zone shall be provided with adequate protection against impingement damage with minimum thickness of 0.7 mm.

2.3.5 TUBE SHEETS

(1) The tube sheets shall be bolted to the shell and be independent from the water boxes.

(2) The tube sheets shall be designed to permit the tubes to be installed straight.

(3) The tube sheets shall be drilled, and reamed to receive the tube.

2.3.6 TUBE SUPPORT PLATES

(1) The tube support plates shall be designed to permit tubes to be installed straight and adequately inclined for drainage.

(2) The spacing of the tube support plates shall be consistent with good practice so as to minimize vibration during all operating conditions.

(3) Edges of the tube holes in the tube support plates shall be chamfered to facilitate tube insertion, and shall be made smooth to prevent tube damage.

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(4) The plate thickness design shall include corrosion allowance.

2.3.7 WATER BOXES

(1) The water boxes shall be of the divided type.

(2) The water boxes shall be of good hydraulic design and provide uniform water distribution and optimum entrance conditions to the tubes.

(3) The water box shall be provided with one circulating water inlet or outlet connection, and each connection shall be provided with rubber expansion joint.

(4) The condenser tubes shall be removable without breaking the inlet or outlet circulating water connections.

(5) Each water box shall be provided with quick-opening, hinged type manholes.

(6) Each water box shall be provided with drain valves, vent valves, priming connections and instrumentation connections.

(7) The water boxes shall be provided with permanent lugs for lifting and handling.

(8) Ladders with rubber lining shall be provided inside of each water box.

(9) The corrosion resistant bolts, gaskets and all other necessary mounting details for the water boxes, covers and manhole covers shall be provided.

2.3.8 EXPANSION JOINT

(1) Stainless steel or rubber type expansion joint shall be provided at the steam turbine exhaust connection to absorb expansion or contraction of the condenser and turbine.

(2) The joint shall be designed to withstand internal pressure and full vacuum without damage.

(3) The joint shall be provided with stainless steel cover plates to protect expansion bellows or belt from impingement of exhaust steam.

2.3.9 BUTTERFLY VALVES

(1) Butterfly valves at inlet and outlet piping of water box for shut off shall be furnished.

(2) Butterfly valves shall be of the motor operated type.

(3) The design of motor operated butterfly valves shall be in conformity with Clause 1.1, "Valves and Specialities" in Section II of Part I.

2.3.10 INSTRUMENTS

(1) The surface condenser shall be provided with the following instruments.

(a) Level gauge glass

(b) Level switch for alarm

(c) Level transmitter with remote indicator

(d) Pressure gauge (including manometer)

(e) Pressure transmitter with remote indicator

(f) Thermometer

(g) Level controllers and control valves

(h) Condenser tube leak detectors

(i) Level switches for water boxes

(j) Flow meter for make up water

(2) The instruments shall be in conformity with Clause 3. "Instruments and Control" in Section II of Part I.

2.3.11 PAINTING

(1) After thorough cleaning of the interior surface of condenser and removal of mill scale, rust, oil, grease, etc., the interior surface of condenser shell shall be painted to prevent rust during transportation and erection.

(2) The above painting shall be removed before assembling the condenser tubing.

If the above paint is not harmful for service operation, it may be left as coating.

(3) The painting for exterior surface of condenser shall be in conformity with Clause 1.13, "Painting" in Section II of Part I.

2.3.12 SPECIAL TOOLS AND STANDARD TOOL SETS

The following special tools shall be supplied by the Contractor.

(1) Tube expander

(2) Complete tool sets to remove the tubes

(3) Tube cutter

(4) Tube leak inspection light

(5) Necessary materials and supports for hydrostatic test

(6) All other special tools considered necessary by the manufacturer

(7) Pins hole detector

(8) Cleaning guns with the water header, rubber tube, brushes, valves, etc., for tube washing

2.3.13 OPERATING GALLERIES

The following operating galleries with stairs shall be supplied by the Contractor, and shall be of a dismantling type.

(1) In the rear and in front of condenser water box

One (1) set each

(2) Other necessary ones for valves, and all necessary pertinents and facilities

One (1) set each

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3. AIR EJECTOR

3.1 SCOPE OF SUPPLY

The air ejector shall be provided the following components with complete accessories:

(1) Steam Jet Air Ejector

(a) Ejector with coolers

(b) Manometer

(2) Starting Air Ejector

(a) Ejector

(b) Silencer

(3) Foundation Bolts

(4) Drain and Vent Piping, Valves and Traps

(5) Instruments

(6) Insulation

(7) Painting

(8) Special Tools and Standard Tool Sets

(9) Lifting Lug

3.2 GENERAL INFORMATION

3.2.1 APPLICABLE STANDARDS AND CODES

The air ejector shall be designed and constructed in accordance with the requirements of Clause 6 of "Applicable Standards and Codes" specified in Section I, Part I.

3.2.2 OUTLINE

(1) Two (2) steam jet air ejectors shall be installed to eject the leaked or deaerated air in the turbine cycle. The steam jet air ejector shall be of twin type, and one element shall be

always in service while the other shall be for stand-by.

(2) The inter and after condensers shall be installed with the steam jet air ejector, and the ejector steam shall be condensed by the condensate, and returned to the surface condenser.

(3) One (1) starting air ejector shall be installed to build up the condenser vacuum before turbine starting.

(4) The ejector steam shall be supplied from the high pressure auxiliary steam source.

(5) The design shall be in accordance with the "Standard for Steam Surface Condenser of the Heat Exchanger Institute" and this specification.

3.2.3 DESIGN DATA

(1) Steam jet air ejector

(a)	Installation	Indoor
(b)	Type	Twin element, two stages with inter and after condensers
(c)	Number	One (1) set
(d)	Capacity	"HEI" standard
(e)	Operating steam	High pressure auxiliary steam
(f)	Cooling water	Condensate

(2) Starting air ejector

(a)	Installation	Indoor
(b)	Type	Single element, single stage
(c)	Number	One (1) set
(d)	Capacity	"HEI" standard
(e)	Operating steam	High pressure auxiliary steam

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3.2.4 PERFORMANCE

(1) The steam jet air ejector and the starting air ejector shall perform as shown in the "Tenderer's Data Sheets".

(2) A performance curve for the air ejector shall be submitted to the Engineer for approval.

(3) The Contractor shall submit the calculation sheet to the Engineer for approval.

3.2.5 TESTING

(1) The Contractor shall execute the following shop tests, and shall submit the test and inspection reports to the Engineer:

(a) Material test

(b) Dimension check

(c) Hydrostatic test

(d) Performance test

(2) Field test

The Contractor shall execute the following field tests, and shall submit the test and inspection reports to the Engineer:

(a) Hydrostatic test

(b) Performance test

(c) Noise inspection of starting air ejector

3.3 TECHNICAL INFORMATION

3.3.1 STEAM JET AIR EJECTOR

(1) The materials shall be as follows.

(a)	Suction chambers	Carbon steel
(b)	Steam nozzle	Stainless steel
(c)	Diffuser	Carbon steel
(d)	Shell and water box of condenser	Carbon steel

(e) Tube sheet — Carbon steel

(f) Tubes — Stainless steel

(2) The following accessories shall be furnished with the air ejector.

(a) Steam piping, stop valves and relief valves

(b) Hand operated throttle valves on each ejector stage

(c) Loop seal arrangement for inter condenser

(d) Drain trap assembly for after condenser

(e) Indicating type air meter

(f) Thermometers and pressure gauges as required

(g) Foundation bolts

(3) The air ejector elements shall be mounted on inter and after condensers.

(4) Condensate from the after condenser shall be returned to the surface condenser through a drain trap.

(5) A loop seal or special drain trap shall be furnished for returning the condensate from the inter condenser to the surface condenser.

(6) The relief valve shall be furnished to leave excessive pressures in the inter and after condensers.

(7) Suitable air flow meter and all necessary valves and pipings between the air flow meter and the air ejector shall be furnished for mounting on the air ejector.

(8) The air flow meter shall be stainless steel trimmed.

3.3.2 STARTING AIR EJECTOR

(1) The starting air ejector shall be a single stage, steam jet, non-condensing type.

(2) The materials shall be as follows:

(a)	Suction chamber	Carbon steel
(b)	Steam nozzle	Stainless steel
(c)	Diffuser	Carbon steel

(3) Exhaust piping of starting air ejector shall be installed up to 3 m above the main building roof.

(4) Noise at exit opening of starting air ejector exhaust pipe shall be in accordance with Clause 3.11. (3) of "Noise" in Section I.

3.3.3 INSULATION

(1) The outer surface of air ejector and condenser shall be insulated.

(2) The insulation shall be in conformity with Clause 1.12, "Insulation" in Section II of Part I.

3.3.4 SPECIAL TOOLS AND STANDARD TOOL SETS

The Contractor shall provide the special tools and standard tool sets for the air ejector.

4. PRIMING VACUUM EQUIPMENT

4.1 SCOPE OF SUPPLY

The Contractor shall provide the priming vacuum equipment with all components and complete accessories, but these shall not be limited to the following.

(1) Priming vacuum pump and motor

(2) Water tank

(3) Control box

(4) Foundation bolts and nuts

(5) Piping and valves

(6) Instruments

(7) Painting

(8) Special tools and standard tool sets

(9) Lifting lugs

4.2 GENERAL INFORMATION

4.2.1 APPLICABLE STANDARDS AND CODES

The priming vacuum equipment shall be designed and constructed in accordance with the requirements of Clause 6 of "Applicable Standards and Codes" specified in Section I, Part I.

4.2.2 OUTLINE

(1) The equipment shall be provided to remove liberated air from the condenser water boxes during operation of plant, and to be used for priming of the circulating water system during start up.

(2) The equipment shall consist of vacuum pump, motor, water tank, control panel, valves, piping and other accessories, and these shall be mounted on a common base plate.

The piping material shall be of stainless steel, or equivalent.

(3) The priming vacuum equipment shall be operated locally, and shall be able to start automatically in case of lowering of water level in the surface condenser water boxes.

4.2.3 DESIGN DATA

(1) Vacuum pump

(a)	Installation	Indoor
(b)	Type	Rotary, water sealed type
(c)	Number	One (1) set
(d)	Capacity	Required capacity for priming the circulating water system within two (2) hours

(2) Water tank

(a)	Type	Vertical cylindrical
(b)	Seal water	Cooling water

4.2.4 PERFORMANCE

(1) The priming vacuum equipment shall perform as shown in the "Tenderer's Data Sheet".

(2) The Contractor shall submit performance curves of pump to the Engineer for approval.

(3) The Contractor shall submit the calculation sheet to the Engineer for approval.

4.2.5 TESTING

(1) The Contractor shall execute the following shop tests and submit the test and inspection results to the Owner and the Engineer for approval.

(a) Material test

(b) Dimension check

(c) Hydrostatic test

(d) Performance test

(e) Vibration check

(f) Noise check

(g) Disassembly and inspection

(2) The Contractor shall execute the following field tests and submit the test inspection results to the Owner and the Engineer for approval.

(a) Assembling inspection

(b) Motor test (isolated)

(c) Performance test

(d) Vibration check

(e) Noise check

4.3 TECHNICAL INFORMATION

4.3.1 VACUUM PUMP

(1) The vacuum pump shall be of the rotary, water sealed type.

(2) The main part materials shall be as follows, while other parts materials shall be suitable for use with circulating water and vapor.

(a)	Casing	Cast iron
(b)	Rotor	Bronze cast

(c) Shaft Stainless steel

(3) The vacuum pump shall be provided with a drain trap for suction line, inlet check valve, strainer, solenoid shut off valve and isolation valves.

(4) The water separator or U-seal piping shall be installed at connection piping between the condenser water boxes and the vacuum pump to shut off the circulating water to vacuum pump.

(5) The vacuum pump shall be operated locally.

(6) The vacuum pump shall be directly connected to its motor driver through a coupling, and shall be provided with coupling guard.

(7) The motor shall be in conformity with Clause 2.2 of "Electric Motor" in Section II of Part I.

4.3.2 WATER TANK

(1) The water tank shall be installed to store the seal water of vacuum pump, and shall be provided with a float valve to control tank water level.

(2) The tank shall be provided with a glass gauge, solenoid shut off valves, drain valves, drain piping and all necessary connections.

(3) The material of tank shall be of anti-corrosive type, and shall include rubber lining.

4.3.3 CONTROL BOX

The control box shall be provided, and shall be installed near the pump.

4.3.4 PAINTING

Painting shall be carried out in conformity with Clause 1.13 of "Painting" in Section II of Part I.

4.3.5 SPECIAL TOOLS AND STANDARD TOOL SETS

The Contractor shall provide the special tools and standard tool sets for the priming vacuum equipment.

5. CIRCULATING WATER PUMP

5.1 SCOPE OF SUPPPLY

The Contractor shall provide circulating water pump with all components and accessories, but these shall not be limited to the following.

(1) Circulating water pump and motor

(2) Lubricating water system

(3) Base plate

(4) Foundation bolts, nuts and sleeves

(5) Discharge valve

(6) Rubber expansion joint

(7) Instruments

(8) Painting

(9) Special tools and standard tool sets

(10) Operating floor around motor

(11) Valves, piping, control boxes, cables and accessories

5.2 GENERAL INFORMATION

5.2.1 APPLICABLE STANDARDS AND CODES

The circulating water pumps shall be designed and constructed in accordance with the requirements of Clause 6 "Applicable Standards and Codes" specified in Section I of Part I.

5.2.2 OUTLINE

(1) Two (2) 50% capacity circulating water pumps shall be installed, and shall supply cooling water to the surface condenser and the bearing cooling water heat exchanger.

(2) The circulating water pumps shall be installed in the circulating water pump intake pit.

(3) Each circulating water pump shall be designed to be controlled at the central control room. The discharge valve of each circulating water pump shall be motor operated and sequentially connected to the circulating water pump motor.

(4) The lubricating water of circulating water pump journals shall be of self lubricating system and, in case of emergency trip and starting, bearing lubricating water shall be supplied from the service water line (fresh water).

(5) Two (2) circulating water pumps shall be operated for normal service operation.

(6) The circulating water pump shall be constructed so as to be simple for assembly, inspection and overhaul.

(7) The circulating water pump shall be designed so that reverse rotation caused by reverse water flow from operating pumps through the discharge piping and back through an idle pump will not cause damage to any of the components of the pump and motor.

5.2.3 DESIGN DATA

(1) Circulating water pump

(a) Installation	Outdoor (in the circulating water pump intake pit)
(b) Type	Vertical, mixed flow type
(c) Number	Two (2) sets
(d) Fluid	Sea water

(e)	Lubricating water	Self lubrication; Service water for back up supply
(f)	Rated capacity	50% each
(g)	Total head	To be decided by the Contractor
(h)	Shut off head	To be decided by the Contractor
(i)	Pump efficiency	not less than 85%
(j)	Pump speed	To be decided by the Contractor
(k)	Pump discharge pipe diameter	To be decided by the Contractor
(l)	Pump pit level	operating foor level EL +5000mm bottom level of pit EL -5200mm

The Contractor shall submit all design data to the Engineer for approval.

(2) Motor

The specifications shall be decided by the Contractor.

5.2.4 PERFORMANCE

(1) The circulating water pumps shall perform as shown in the "Tenderer's Data Sheet".

(2) The circulating water pumps shall be able to operate satisfactorily without cavitation, pitting, excessive vibration or noise in both single and parallel operation.

(3) The circulating water pump shall be able to operate at 120% flow of pump rated capacity in case of one pump operation.

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(4) The circulating water pumps shall have low shut off head, low required horsepower at shut off, and maximum efficiency at approximately the rated design conditions.

(5) The Contractor shall submit performance curves in single operation and parallel operation to the Owner and the Engineer for approval.

(6) The Contractor shall submit the calculation sheet to the Owner and the Engineer for approval.

5.2.5 TESTING

(1) The Contractor shall execute the following shop tests and submit the test and inspection results to the Owner and the Engineer. The test items below marked "*" shall be carried out in the presence of the Engineer.

(a) Material test

(b) *Dimension check

(c) *Performance test

(d) *Vibration check

(e) *Noise check

(f) *Disassembly and inspection

(g) Hydrostatic test

(2) The Contractor shall execute the following field tests and submit the test and inspection results to the Engineer.

(a) Alignment check

(b) Motor running check (isolated)

(c) Operation check of protection relay

(d) Pump running test

(e) Vibration check

(f) Noise check

5.3 TECHNICAL INFORMATION

5.3.1 CIRCULATING WATER PUMP

(1) Materials

The material of main part shall be as follows, while materials of other parts shall be suitable for use with sea water. Moreover, the material shall be protected by cathodic protection.

(a)	Impeller	Stainless steel (ASTM CF8M or equivalent)
(b)	Suction bell mouth	2% Ni cast iron
(c)	Impeller bowl	Stainless steel (ASTM CF8M or equivalent)
(d)	Diffuser casing	2% Ni cast iron, with surface hardening treatment on inlet portion of diffusers
(e)	Shroud, liner and ware ring	Stainless steel
(f)	Discharge columns and elbow	2% Ni cast iron
(g)	Shaft	Stainless steel (ASTM CF8M or equivalent)
(h)	Bearing	Cutless rubber or proved design material

(2) Construction of pump

(a) The impellers shall be of the mixed flow type.

(b) The impellers shall be cast in one piece.

(c) The bell mouth and impeller bowl shall be cast with smooth interior and exterior surface, free from blow holes, sand holes and all other faults.

(d) The bowls shall be designed to withstand not less than 1.5 times the pump shut off pressure or 1.5 times pressure at the rated capacity, whichever is greater.

(e) The columns shall be provided with flanged joints to permit disassembly.

(f) The thickness of the casings shall include corrosion allowance.

(g) The discharge elbow shall be flanged.

(h) The shaft shall be of sufficient diameter to transmit the full load torque requirements of the pump.

(i) The shaft couplings shall be designed to transmit the full load torque required to operate the pump.

(j) All bearings shall be of cutless rubber or other proven design material backed with stainless steel shaft sleeves.

(k) The bearings shall be of sufficient number to prevent whip.

(l) The rubber or proven design material bearings shall include flushing grooves in the bearing.

(m) The bearing spacing shall be such that no vibration will occur.

(n) The pump and motor shall be provided with heavy structural steel base plate, supporting beams, beam supports, sole plate, etc., as required.

(o) Temporary material shall be provided on the pump pit slab for protection at the time of installation of pumps and motors.

(p) All inner and outer surfaces of 2% cast iron shall by applied with tar-epoxy resin coating.

(q) Cathodic protection system shall be considered for protection of base metal adjacent to noble one.

5.3.2 MOTOR

(1) The motor shall be of the outdoor type.

(2) The motor shall be designed to withstand the forces of reverse pump rotation.

(3) The thrust bearing shall be incorporated in each motor.

(4) If water cooled thrust bearing is applied, the cooling water shall be supplied from the bearing cooling water line. The discharge of cooling water shall be returned to the bearing cooling water line, and necessary valves and pipings of motor bearing cooling shall be provided. The flow switch shall be installed on discharge line of cooling water, and abnormal water flow decrease shall be indicated in the central control room.

(5) The motor shall be in conformity with Clause 2.2 of Electric Motor" in Section II of Part I.

(6) Replacement of motor lubricating oil shall be made easy.

5.3.3 LUBRICATING WATER SYSTEM

(1) Water for pump bearing lubrication shall be supplied from its pump discharge when the pump is in normal operation.

(2) If the above lubricating water pressure is not sufficient, a lubricating water pump shall be installed. The lubricating water pump shall be sequentially connected to the circulating water pump.

(3) The duplex type strainer shall be provided for filtering the lubricating water.

(4) Each pressure gauge shall be installed at the inlet and outlet of strainer.

(5) In case of stop and starting, lubricating water shall be supplied from the service water line (fresh water). The solenoid valve shall be installed at the service water line, and sequentially connected to the circulating water pump.

(6) Flow switch, flow gauge and pressure gauge shall be installed at the lubricating water line. Insufficient water flow shall be indicated at the annunciator of the central control room to protect the bearing cooling system.

5.3.4 DISCHARGE VALVE

(1) The discharge valve of pump shall be of motor-driven butterfly type.

(2) The discharge valve shall be motor driven and connected sequentially to each pump, and shall be monitored at the BTG board in the central control room.
It is preferable that the discharge valve has three functions of shut-off, flow control and check valve as a multiple valve.

(3) The valve operating equipment shall be equipped with the limit torque switch, position switch and valve position indicator.

(4) The valves shall be able to be operated manually.

(5) The supporting structure of valve casing shall be installed with foundation bolts.

(6) The valve design pressure shall be designed to meet the maximum pressure of pump shut off pressure.

(7) The valve diameter and flange size shall be the same as that of the discharge of circulating water pump.

5.3.5 RUBBER EXPANSION JOINT

(1) The rubber expansion joints shall be installed at the pump discharge.

(2) The design pressure of rubber expansion joint shall be more than the pressure at pump shut off pressure.

(3) The Contractor shall submit the data sheets to the Engineer for approval.

5.3.6 PAINTING

(1) The pump casing shall be coated with tar epoxy resin before shipping.

(2) Painting for motor and accessories shall be in conformity with Clause 1.13 of "Painting" in Section II of Part I.

5.3.7 SPECIAL TOOLS AND STANDARD TOOL SETS

The Contractor shall provide the special tools and standard tool sets for the circulating water pump. Particularly, special tools for centering work shall be supplied.

5.3.8 INSTRUMENTS

The following instruments shall be provided.

(1) Pump pressure gauges

(2) Differential pressure gauges, flow switches, solenoid

valves and local control boxes for lubricating water system

(3) Thermometer with alarm contact

6. CONDENSATE PUMP

6.1 SCOPE OF SUPPLY

The condensate pump shall be provided with all components and accessories, but these shall not be limited to the following.

(1) Condensate pump and motor

(2) Suction strainer

(3) Expansion joint

(4) Base plate

(5) Foundation bolts, nuts and sleeves

(6) Instruments

(7) Painting

(8) Special tools and standard tool sets

6.2 GENERAL INFORMATION

6.2.1 APPLICABLE STANDARDS AND CODES

The condensate pumps shall be designed and constructed in accordance with the requirements of Clause 6 of "Applicable Standards and Codes" in Section II of Part I.

6.2.2 OUTLINE

(1) Three (3) half capacity condensate pumps shall be provided. Two condensate pumps shall be for normal operation. All condensate pumps shall be operable in parallel running.

(2) Each pump shall be controlled at the central control room, and shall have a automatic stand-by start circuit.

6.2.3 DESIGN DATA

(1)	Installation	Indoor (ground floor)
(2)	Type	Vertical, multi-stage turbine, pit-can type
(3)	Number	Three (3) sets
(4)	Fluid	Condensate
(5)	Capacity (each pump)	60% flow of MCR condensate flow
(6)	Pump speed	not more than 1,500 rpm
(7)	Pump efficiency	not less than 75% at rated capacity
(8)	Driving motor	Indoor, vertical guarded open drip proof type
(9)	Pump discharge valve	Motor operated

* Note: Min. 60% of MCR condensate flow shall be delivered in case of one pump operation.

6.2.4 PERFORMANCE

(1) The condensate pumps shall perform as shown in the "Tenderer's Data Sheet".

(2) The condensate pumps shall be able to operate without cavitation, pitting, excessive vibration or noise.

(3) The condensate pumps shall be able to satisfactorily operate either independently or in parallel.

(4) The condensate pumps shall have extracting performance for condensate under all loads of the surface condenser.

(5) The Contractor shall submit the estimated performance curves showing head, horsepower, required NPSH and efficiency to the Engineer for approval.

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(6) The Contractor shall submit the calculation sheets to the Engineer for approval.

6.2.5 TESTING

(1) The Contractor shall execute the following shop tests and submit the test and inspection results with the procedures to the Owner and the Engineer for approval.

(a) Material test

(b) Dimension check

(c) Performance test

(The test shall be carried out in the presence of the Engineer)

(d) Vibration check

(e) Noise check

(f) Disassembly and inspection

(g) Hydrostatic test

(2) Field test

The Contractor shall execute the following field tests before and after the erection, and shall submit the test and inspection results to the Owner and the Engineer.

(a) Alignment check

(b) Motor running test (isolated)

(c) Pump running test

(d) Vibration check

(e) Noise check

6.3 TECHNICAL INFORMATION

6.3.1 CONDENSATE PUMP

(1) Materials

The materials shall be as follows.

(a) Casing - Cast iron and cast steel

(b) Outer barrel and discharge head - Carbon steel

(c) Impeller - Stainless steel

(d) Shaft - Stainless steel

(2) Construction

(a) The pump shall consist of an outer barrel suction and discharge connection, and an inner suction consisting of rotating parts, stage pieces and supporting pieces.

(b) The first stage impeller level shall be decided based on the required NPSH.

(c) The pump shall be installed with the suction connection below the base plate and the discharge connection above the base plate.

(d) The pump shall operate without excessive vibration, cavitation, noise or leaks.

(e) The pump shall be designed for continuous operation at 10% minimum of the rated flow without undesirable strain.

(f) All bearings shall be of the sleeve type, and pump axial thrusts shall be resisted by a thrust bearing located in the driving motor.

(g) The shaft coupling between the pump shaft and the motor shall be of the rigid adjustable type.

(h) The water sealed stuffing box shall be provided for sealing against condenser vacuum.

(i) Suitable vent connections shall be provided for venting the pump casing and discharge head to the surface condenser.

(j) Relief valve shall be provided for protection of suction barrel from over pressure.

6.3.2 MOTOR

(1) The motor shall be of the guarded open dripproof type.

(2) The thrust bearing shall have a thrust capacity in excess of the total thrust loading imposed by the pump and motor rotors at all starting or operating conditions.

(3) The thrust bearing shall be self-lubricated.

The motor shall be in conformity with Clause 2.2 of Electric Motor" in Section II of Part I.

6.3.3 STRAINER

(1) The strainer shall be provided at each pump suction.

(2) The strainer shall be of single element.

(3) The strainer shall be designed to be cleaned without overhauling, and the washing water piping shall be installed and connected to the condensate line for back washing.

(4) The strainer shall be provided with coarse mesh element for normal operation and fine mesh element for trial operation.

(5) The material of strainer shall be stainless steel.

6.3.4 EXPANSION JOINT

(1) The expansion joint shall be provided at each pump suction.

(2) The expansion joint shall be made of rubber or equivalent.

6.3.5 PAINTING

(1) The inside of pump cans shall be temporarily painted with rust inhibitive paint prior to shop test and shipment. This paint shall be thoroughly cleaned before field operation.

(2) The outside of pump cans beneath the base plate shall be coated with tar epoxy resin.

(3) The painting for other parts shall be in conformity with Clause 1.13 of "Painting" in Section II of Part I.

6.3.6 SPECIAL TOOLS AND STANDARD TOOL SETS

The Contractor shall provide the special tools and standard tool sets for the condensate pump.

6.3.7 INSTRUMENTS

The following instruments shall be provided.

(1) Pump suction and discharge pressure gauges.

(2) Pump suction strainer differential pressure gauges with contacts for alarm.

7. FEEDWATER HEATER

7.1 SCOPE OF SUPPLY

The feedwater heaters shall be provided with all components, accessories and auxiliaries, but these shall not be limited to the following.

(1) Low pressure feedwater heaters

(2) High pressure feedwater heaters

(3) Drain tank and pumps

(4) Relief valves

(5) All foundation bolts, supports and structural materials

(6) Instruments

(7) Insulation

(8) Operating galleries (if required)

(9) Painting

(10) Monorails for lifting (if required)

(11) Special tools and standard tool sets

7.2 GENERAL INFORMATION

7.2.1 APPLICABLE STANDARDS AND CODES

The feedwater heater shall be designed and constructed in accordance with the requirements of Clause 6 of "Applicable Standards and Codes" specified in Section I of Part I.

7.2.2 OUTLINE

(1) Number of feedwater heaters shall be seven (7) in minimum, including deaerator.

(2) The low pressure feedwater heaters and the high pressure feedwater heaters shall be of the horizontal closed U tube type.

(3) The heating steam shall be extracted from the extraction nozzles of the steam turbine.

(4) Feedwater heaters shall be provided with the drain cooling zone, condensing zone and desuperheater zone according to their performance requirements.

(5) The drain from the high pressure feedwater heater shall be cascaded to the deaerator, and the drain from the low pressure feedwater heaters shall be cascaded to the drain tank. All feedwater heaters shall have back up drain line for low load operation and emergency.

(6) The feedwater heaters shall be designed in accordance with the latest edition of the "HEI" code, "STANDARDS for CLOSED FEEDWATER HEATERS".

(7) A system for "Prevention of Water Induction" shall be provided, referring to "Recommended Practices for the Prevention of Water Damage to Steam Turbine used for Electric Power Generation," ASME Standard No. TWDPS-1, Part 1, Fossil Fueled Plants.

(8) Two (2) drain pumps and one (1) tank shall be provided to collect drain from all low pressure feedwater heater drain lines and steam air preheater drain line.

7.2.3 DESIGN DATA

(1) The low pressure feedwater heaters shall be as follows.

(a)	Type	Closed U-tube, horizontal mounting
(b)	Number	One (1) set each
(c)	Design water flow	Required flow for MCR

(d)	Steam pressure at heater	Per turbine design considering pressure drop from turbine to heater connection
(e)	Steam enthalpy	Per turbine design
(f)	Water velocity in tube	not more than 2.1 m/sec.

(2) The high pressure feedwater heaters

(a)	Type	Closed U-tube, horizontal mounting
(b)	Number	One (1) set each
(c)	Design water flow	Required flow for MCR
(d)	Steam pressure at heater	Per turbine design considering pressure drop from turbine to heater connection
(e)	Steam enthalpy	Per turbine design
(f)	Water velocity in tube	not more than 1.9 m/sec.

(3) Drain pumps

(a)	Installation	Indoor (ground floor)
(b)	Type	Holizontal, centrifugal
(c)	Number	Two (2)
(d)	Fluid	Heater drain
(e)	Capacity	100%
(f)	Seal	Gland packing

(4) Drain tank

(a)	Installation	Indoor (ground floor)
(b)	Type	Vertical, cylindrical
(c)	Number	One (1) set

(d) Capacity 100%

7.2.4 PERFORMANCE

(1) All feedwater heaters and drain pumps shall perform as shown in the "Tenderer's Data Sheet".

(2) The Contractor shall submit the calculation sheet to the Engineer for approval.

(3) The Contractor shall submit his countermeasures for erosion/corrosion of carbon steel tubes.

7.2.5 TESTING

(1) The Contractor shall execute the following shop tests and submit the test and inspection results to the Owner and the Engineer for approval.

(a) Material test

(b) Welding procedure inspection

(c) Dimension check

(d) Hydrostatic test

(e) Non-destructive test

(f) Performance test for drain pump

(g) Vibration check for drain pump

(h) Noise check for drain pump

(i) Disassembly and inspection for drain pump

(2) The Contractor shall execute the following field tests and submit the test and inspection results to the Owner and the Engineer for approval.

(a) Alignment check during assembling.

(b) Hydrostatic test for shell side, and channel side

(c) Performance test

(d) Vibration check

(e) Noise check

7.3 TECHNICAL INFORMATION

7.3.1 FEEDWATER HEATERS

(1) The materials of the feedwater heaters shall be as follows.

(a) Channel cover

Low pressure heater - Carbon steel

High pressure heater - Forged steel

(b) Shell - Carbon steel or low alloy steel

(c) Tube

LP heater - Stainless steel

HP heater - Carbon or low alloy steel

(d) Tube sheet

Low pressure heater - Carbon steel

High pressure heater - Forged steel

(e) Support plate - Carbon steel

(2) Channels

(a) The channels shall be provided with covers or access manholes which shall be removable without disturbing the piping connections.

(b) The channels for low pressure feedwater heaters shall be of fabricated or forged steel construction, and shall have covers attached with flanged and bolted joints.

(c) The channel for high pressure feedwater heaters shall be of the forged steel construction. The channel type shall be of the breech-lock, pressure-seal, or hemispherical head type.

(3) Shell

(a) The shell of feedwater heaters shall be of all welded construction.

(b) The lifting lugs shall be provided on the shell.

(c) The shell shall be marked to show the cutting line near the channel end for shell removal.

(d) At shell cutting line, a stainless steel burning ring shall be provided inside the shell for protection of the tubes.

(e) The supports, rollers and rails shall be supplied with the heaters for removal of the shell.

(f) The feedwater heater shells shall be made removable without breaking the steam and drain connections.

(g) The shell of low pressure feedwater heater shall be flanged and bolted for bundle removal.

(4) Tubes

(a) The tubes shall be of U-type.

(b) All baffles and support plates in the tube bundle shall be securely held in place by tie rods and spacers, or equivalent construction.

(c) The tube bundles shall be made removable from the shell or the shell shall be made removable from the tube bundle.

(d) The tube bundles shall be designed to avoid direct impingement of incoming shell side fluids.

(e) The flow passages for distribution of fluids into the tube bundle shall be designed to minimize tube vibration.

(5) Tube sheets

Tube hole edges shall be chamfered on the shell side, and each hole shall be provided with a minimum of two grooves (in case tubes are fixed by expanding).

The H.P. heater tubes shall be joined to the tube sheets by welded joints.

The design of tube to tube sheet joints shall be subjected to approval by the Engineer.

(6) Baffles and support plates

(a) All steam and drain return openings in the heater shells shall be properly baffled to prevent impingement damage to the heater tubes and the heater shell.

(b) All drain return baffles and surrounding shell interior areas shall be adequately protected with stainless steel construction.

(c) All burrs of tube holes shall be removed to prevent damage to the tubes.

(7) Venting

(a) Non-condensible gas outlets shall be provided on each heater.

(b) The feedwater heaters shall be provided with a properly sized vent orifice constructed integrally with the vent connection.

(c) The high pressure feedwater heaters shall be vented to the deaerator, and the low pressure feedwater heaters shall be vented to the surface condenser.

(8) Drains

The drain connections shall be provided to drain all low points and pockets on the shell and tube side not otherwise drained by nozzles.

(9) Connections

(a) The high pressure feedwater heaters shall be provided with N_2 gas connections on the shell and tube sides.

(b) The feedwater connections of the low pressure feedwater heater shall be flanged, and the feedwater connections of remaining feedwater heaters shall have welded ends.

(c) All steam and condensate drain connections shall have welded ends.

(d) All piping connections shall be located so that the heater shell can be removed without disconnecting piping.

(e) All butt welding connections of 65 mm diameter or more shall be bevelled at shop. Welding connections 50 mm diameter or less shall have socket welded ends.

(f) Necessary piping connection for flushing shall be provided.

(10) Relief valves

(a) The relief valves shall be of the closed bonnet type and suitable for design temperature and pressure conditions.

(b) Each shell side relief valve shall be sized to pass 10% of design feedwater flow.

7.3.2 DRAIN PUMPS AND TANK

(1) The drain pumps shall be able to operate in all operation conditions of the plant.

(2) The drain tank shall have the balancing pipe to the LP No. 1 heater.

7.3.3 INSTRUMENTS

(1) The feedwater heaters, and drain pumps and tank shall be provided with the following instruments.

(a) Level gauges

(b) Pressure gauges

(c) Level controllers and control valves

(d) Level switches for the extraction steam reverse current valve, stop valve shut off and drain valve

(e) Level switches for annunciator and interlock

The Heater Service System including heater inlet steam valves and outlet drain valves with sequencial, automatic operated service switches shall be installed on the auxilialy board.

(2) The steam inlet, feedwater inlet, feedwater outlet and drain outlet piping shall be provided with the required temperature gauges, pressure gauges and temperature sensors for computer.

(3) All instruments mentioned above shall be in conformity with Clause 3.1 "Instrument and Control Apparatus" in Section II of Part I.

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7.3.4 INSULATION

(1) The outer surface of feedwater heaters, drain pumps and drain tank shall be insulated with block type calcium silicate insulating material.

(2) The surface of insulating material shall be covered with the aluminum jackets, except for the drain pumps.

(3) Detailed information of insulation and aluminum lagging shall be in conformity with Clause 1.12 of "Insulation" in Section II of Part I.

7.3.5 CLEANING

The interior surface of each shell shall be protected as follows.

(a) All interior surfaces, including baffles and supports, shall be cleaned using steel grit.

(b) The protective coating shall be a water soluble rust preventive material, and shall be painted before shipment.

(c) After fabrication is completed and before shipment, the interior shall be cleaned and thoroughly dried, after which all connections and openings shall be adequately covered and sealed to prevent the entrance of dirt or moisture during ocean shipment and prior to erection. High pressure feedwater heaters with steel tubes shall be sealed with N_2 gas for tube protection.

7.3.6 SPECIAL TOOLS AND STANDARD TOOL SETS

The Contractor shall provide the special tools and standard tool sets for the feedwater heater.