



RAJASTHAN RAJYA VIDYUT UTPADAN NIGAM LTD.

**2 x 660 MW, SUPER-CRITICAL THERMAL POWER STATION
STAGE –V, UNIT 7 & 8 AT SURATGARH, RAJASTHAN**

**SPECIFIC TECHNICAL REQUIREMENTS FOR BTG AND
AUXILIARIES**

SPECIFICATION NO. TCE.5750A-H-500-01

**VOLUME – III
PART A**



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SPEC.NO. TCE.5750A-H-500-001	TATA CONSULTING ENGINEERS LIMITED			VOLUME IIIA
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VOLUME IIIA
SECTION - C

**RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage- V,
Unit # 7 & 8 at Suratgarh, Rajasthan**

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SPECIFIC DESIGN REQUIREMENTS

(SG AND ITS AUXILIARIES)

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<u>DESIGN REQUIREMENTS</u>		
1.0		
1.1	<u>General</u>	
1.1.0	The steam generators shall be designed for maximum continuous rating (SGMCR capacity) and for the parameters specified in Data Sheet-A1 of Volume II and shall be suitable for burning the specified coal. Bidder shall offer super critical once through steam generator of proven design.	
1.1.1	The steam generators and their auxiliaries shall be designed for outdoor installation. Steam Generator can be Single pass (Tower type) or two pass type.	
1.1.2	The steam generator unit shall be capable of operating on sliding pressure mode. The load range for the sliding pressure unit operation shall be from 35% turbine generator maximum continuous rating (TGMCR) to 90% TGMCR and constant pressure mode operation between 90% TGMCR to 100 % SGMCR. The evaporator of steam generator shall be suitable for variable pressure operation from sub critical to supercritical pressure range	
1.1.3	Steam generator shall be designed to meet the Indian Boiler Regulations (IBR) requirement. Wherever IBR is not specific about material, design, manufacture, inspection and testing requirements, ASME or equivalent reputed international code shall be used.	
1.1.4	The technical requirement shall be compiled from most stringent conditions resulting burning range of coals and range of operating conditions like 100%SGMCR, HP heaters out of service, sliding pressure operation etc.	
1.2.0	<u>Steam Generator Structure</u>	
	The steam generator structure shall be designed to support all loads located on the structure including the load transferred from the furnace buck stays seismic and wind loads. In addition, other loadings may be introduced on the structure from piping, enclosures, adjacent structures and equipment. Loading due to wind and seismic condition shall be computed based on IS: 875 and IS: 1893 respectively.	
1.2.1	<u>Furnace</u>	
1.2.1.1	The furnace shall be designed such that the heat release rates shall not exceed the values specified in Data Sheet-A1 of this volume at 100% SGMCR condition. The distance between centre line of bottom most coal burner and furnace hopper working point shall be not less than 3 meters. The configuration of the furnace shall be such that flame impingement on any section of the furnace is avoided over the entire load range.	
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1.2.1.2	The furnace shall be designed for a pressure as indicated in Data sheet-A1, Volume-II, to withstand pressure regimes without permanent deformations. The furnace shall be made of gas tight welded membrane walls and the tube panels bent, where required for openings of wall blowers, observation ports, access doors and instruments. To minimize the wear of membrane walls, geometry that causes notch effect shall be avoided.	
1.2.1.3	The furnace walls shall be either spiral wound and vertical tubes or vertical rifle tubes, as per the manufacturer's practice. Bending radius for tubes shall be as large as possible and minimum 1.5 times of external diameter. Thickness of tubes shall be minimum 0.6mm more than calculated value as per IBR to account for erosion and corrosion. Suitable extra margins shall be provided for tubes coming in the area of soot blowing.	
1.2.1.4	The furnace shall have hopper bottom with stainless steel seal plates suitable for connection to ash hopper. A suitable sealing arrangement shall be provided for connecting to water impounded dry bottom ash system. The clear width of the hopper throat shall not be less than 1100mm. The height of furnace bottom shall be minimum 10 meters or above from the ground level depending on the hopper volume requirement and for accommodating bottom ash handling system.	
1.2.1.5	All openings of wall blowers, observation ports, access doors and instruments shall be designed to prevent infiltration of air into the unit.	
1.2.1.6	Suitable allowance shall be provided for all the waterwall tubes to counter the erosion conditons.	
1.2.2.0	<u>Casing</u>	
1.2.2.1	A gas tight enclosure shall be designed for the entire steam generator from the lower furnace to the economiser exit. In areas where welded wall construction is used, no skin casing is required, but skin casing of steel plates shall be used for all enclosures and behind all wide spaced tubes where refractory is used. Frames shall be furnished around all openings in the steam generator. The thermal insulation and lagging shall be provided for all the equipment/plant for the conservation of heat, maintenance of operating temperatures and protection of the personnel. The pent house shall be provided with suitable ventilation system or cooling fans etc.	
1.2.2.2	Furnace Wall Evaporator and Steam System	
12.2.2.1	The system shall be designed for a continuous operating capability as specified in Data Sheet-A1 of this volume. Bidder shall clearly bring out the design features that individual evaporator tubes to have uniform temperature distribution, to minimize the peak tube metal temperature, unit temperature variation between adjacent enclosure tubes and prevent departure from nucleate boiling in evaporator sections. The Bidder shall also	
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indicate about the precautions to be taken. 12.2.2.2 The furnace wall system shall be of materials specified in the Data Sheet-A1 of this volume. The Bidder shall enclose a required calculation sheet for tubes, pipes and headers, stating dimensions, material, tolerance, design pressure and design temperature, design tension, operating pressure and operating temperature as well as fatigue factors and necessary wall thickness. 12.2.2.3 The furnace wall system shall be made of seamless tubes. A careful and safe fixing and suspension of tubes and tube banks shall be available to prevent misalignment and rubbing during operation. Design details shall be included in the Bid document. 12.2.2.4 Suitable allowances shall be provided for all the water wall tubes and steam tubes to counter the erosion conditions. 12.2.2.5 The furnace support system shall be so designed to transfer the weight of the entire furnace to the structural steel so as to accommodate inherent movement and expansions during operation without imposing any constraints. Further, construction of furnace walls shall be no way create differential thermal expansion on the furnace wall tubes. The bidder shall furnish details of furnace support system including systems of transfer of furnace wall loads and construction of steam generator support system in his bid. 12.2.2.6 The furnace walls shall be equipped with buck stays arranged at suitable spacing to take up the forces due to positive and negative gas pressure expansions. The furnace buck stays design pressure shall be as specified in Data sheet A1 of this volume. Suitable wear bars shall be provided above the furnace bottom hopper to avoid tube leakages because of falling of slag. If wear bars are not provided, then enough margin in thickness of tubes shall be provided to avoid damages due to fall of lumps of slag. 12.2.3 Separators, Storage Tank and Circulating Pumps 12.2.3.0 A water–steam separator system shall be provided with an adequately dimensioned collecting vessels and cyclone separators for use during steam generator start- up and low loads.		
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12.2.3.1	The water / steam separators shall be arranged at the evaporator outlet and shall be so sized to ensure adequate steam separation. The water /steam mixture shall be fed into the separators by connecting pipe work which shall enter tangentially around the circumference at an inclined angle to ensure mixture moving spirally downwards and the water/steam separation is done by means of applied centrifugal force .The water shall be led downwards to the collecting vessel and the steam escapes centrally upwards to the connections towards the first superheater stage.	
12.2.3.2	A certain water level shall be maintained in the collecting vessel during low load operation and the surplus water volume must be drained off. The draining of the water shall be controlled.	
12.2.3.3	The water received in the separators shall be re-circulated to the economizer inlet via glandless hermitically sealed re-circulation pump .The water level in the collecting vessel shall be maintained by the provision of control valve(s) at the outlet of the re-circulation pump. Suitable arrangement shall be incorporated to provide adequate NPSH to the pump under all operating conditions during operation. At higher loads the re-circulation pump shall not be in operation and the entire flow from the evaporator is directed to the superheater. It shall also be possible to start the steam generator without the circulation pump.	
12.2.3.4	The bidder shall provide detail construction features of the re-circulation pumps offered.	
12.2.3.5	To assure the adequate cooling of the furnace tubes of the evaporator during start-up or in low load operation, a minimum flow rate of approximately 35 % TGMCR shall be maintained.	
12.2.3.6	Since during the normal operating range the separator and the associated system are not in operation, an appropriate warm- up system shall be provided to switch over to the operation with separators, in case of such requirements.	
12.2.3.7	Bidder shall furnish complete details of start- up and low load operation system with separators and drain system and shall also provide detailed flow diagrams for the system offered.	
12.2.4	Atmospheric Flash Tank	
12.2.4.0	To facilitate start-up of the steam generator, an atmospheric flash tank shall be provided. The flash tank shall receive excess water from the separator during start-up. The flashed steam shall be led to the atmosphere through a silencer above the boiler roof and the remaining condensate shall be led into a condensate collection tank. The condensate from the condensate collection tank shall then be transferred to the condenser by the provision of 2X100% condensate transfer pumps for minimizing the make-up water requirement.	
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12.2.4.1 The flash tank shall also receive other start-up drains from: a) Economiser system b) Superheater system c) Reheater system d) Soot blower system e) Oil heating system f) Mill steam system 12.2.4.2 The flash tank shall be adequately sized to take care of the total drain in the complete steam generator and power cycle piping system. 12.2.5 Superheater (SH) and Reheater (RH) 12.2.5.0 The superheater and reheater shall be of proven design, made of seamless tubes and shall be designed to maintain superheat and reheat steam temperatures at superheater and reheater outlet over the entire steam temperature control range (i.e. from 50%TGMCR to 100% BMCR rating for SH and 60% TGMCR to 100% SGMCR rating for RH) under the following conditions. (The SH and RH shall continue maintain rated steam temperatures under extreme operating conditions like HP heaters out of service, SGMCR condition and HP/LP bypass operation. The tubes shall be drainable to the maximum extent.) 12.2.5.1 With the steam generator heat absorption surface condition varying from clean up to normally expected and permissible fouling limits. 12.2.5.2 With minimum possible use of de-superheating spray. 12.2.5.3 With permissible and normally expected unbalance or stratification in flue gas flow. (Temperature difference between left and right sides inside furnace not more than 10 degC.) 12.2.5.4 With all specified mode of fuel burning. 12.2.5.5 Only the proven material for long periods of operations for the required pressure and temperature conditions shall be adopted. Suitable allowances in tube thickness shall be provided considering erosion due to fly ash, laden flue gas. Bidders shall furnish satisfactory explanations with the list of experience for the materials of construction of SH and RH tubes used.		
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Maximum material grades to be used in one tube bank shall be limited to three (3). Suitable shrouding or wear protection shall be provided for the tubes coming in the area where the flue gas takes a severe bend viz., LTSH top tube bends etc. to avoid erosion. 12.2.5.6 Clearances between the tube elements shall be convenient for cleaning and maintenance. 12.2.5.7 For horizontal tube bundles the arrangement shall be such as to permit free expansion without constraints. 12.2.5.8 The superheater and reheater elements shall be arranged to ensure the uniform steam distribution and minimum steam temperature variation across the width of the steam generator at all operating conditions and loads. Bidder shall indicate the expected temperature variation. 12.2.5.9 The attemperators are to be of spray type fitted with an inner removable lining, so arranged that the lining could be removed readily without recourse to extensive cutting of the construction welds. Ample provision shall be allowed to enable internal inspection of the vessel by means of the intrascope. Complete superheater and reheater temperature control system with necessary piping, block, control, isolation, drain, vent, check valves and instrumentation and controls shall be provided. 12.2.5.10 In case of RH temperature control is by means of damper control of the flue gases or gas recirculation, the bidder shall furnish list of such installations where the systems installed by the Bidder are in operation. 12.2.5.11 The superheater and reheater supports or hangers exposed to hot gases within the setting shall be of a heat-resistance material suitable for long life under the service condition. 12.2.5.12 Auxiliary steam tap-off connection for soot blowing shall be either from intermediate superheater header or from cold reheat line or from auxiliary steam header. In case the steam is tapped off from the cold reheat line or from auxiliary steam header, Bidder shall furnish a list of installation where such systems are in vogue and also the same shall be reflected appropriately in the turbine cycle heat balance diagrams. Suitable allowance shall be provided for the super heater and reheater tubes to counter the erosion condition. 12.2.6 <u>Economiser</u> 12.2.6.1 It shall be ensured that the economiser design pressure exceeds the steam generator design pressure by an amount of at least equal to the pressure drop (friction and static) through the economiser at the 100% SGMCR condition. Economiser design shall take into account the gas temperature		
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and dust loading. 12.2.6.2 The economiser shall be of non-steaming and bare tube type. The tube banks shall be of in line design. The design of the economiser shall be such that the tube elements can be easily replaced when necessary. Suitable allowance shall be provided for economizer tubes to counter the erosion. In order to achieve high boiler availability, all tubes in the economiser, HP superheaters and reheaters shall be easily replaceable. Bidder shall submit the procedure for the replacement for the PURHSER/ENGINEERS review during the engineering. 12.2.6.3 An adequate number of access doors shall be provided above and below the tube banks for inspection and maintenance. Ash collection hoppers shall be provided in the bottom of economisers. 12.2.6.4 Suitable allowance shall be provided for the economiser tubes to counter the erosion (1mm above IBR requirement). Suitable shielding / cassette baffles shall be provided in the leading tube banks to avoid erosion. 12.2.7 <u>Headers</u> 12.2.7.0 All headers in high temperature gas path shall be located outside the gas path except few headers of LTSH, economiser etc. 12.2.7.1 The hand hole openings in headers shall be so located as to provide suitable access to maintenance. All hand hole plates shall be designed for seal welding. A minimum number of header hand holes required to facilitate cleaning and inspection of the headers shall be provided. 12.2.7.2 The header vents, drains, pressure gauges, steam and safety valve connections shall be of weld-end type. Instrument tappings as required including test connections shall be provided. 12.2.7.3 All tubes or attachments to headers shall be full strength welded. No rolled or rolled and seal welded joints shall be used. 12.2.7.4 All headers shall be thoroughly cleaned and be free of scale by shot blasting on the inside. All connections of pipes to headers shall be made by means of welding transition piece between headers and piping. Pipe and header end covers shall not be of flat type design without prior approval from the PURCHASER/ENGINEER. 12.2.7.5 All valves that require operation during start-up or shutdown of the steam generator shall be electric motor operated, except if specifically stated otherwise. All motor actuators shall be designed to meet the torque requirement due to maximum differential pressure. In addition to these motorised valves, any other service which calls for motor operation shall be		
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motorised and those motorised valves shall be listed in the bid. 12.2.7.6 Drains from all headers, gauge glasses and integral piping of steam generator shall be terminated into one or more drain collection headers and finally shall be fed to atmospheric flash tank. 12.2.7.7 Field welds in large diameter thick walled headers or pipes shall be avoided to the extent possible 12.2.7.8 Preservation of SG either by N₂, dry air or treated water shall be considered by the Bidder. 12.2.7.9 The requirement of dry air / treated water and its qualities for filling shall be indicated in the Bid. The preservation system shall include all the piping, valves, vents and drains, pipe supports and instruments etc. to make the system complete 12.2.8.0 <u>Air and Flue Gas System</u> 12.2.8.1 The air and flue gas system shall be designed to meet the requirements from start-up to 100% SG MCR conditions as indicated in Data Sheet-A1 and for range of the fuel characteristics specified in Data Sheet - A2 & A3 of Section-C of Volume-II. The entire flue gas system including the SG flue gas passes shall cope with the explosions and /or implosions, which might occur even at typical or extreme conditions. 12.2.8.2 The air and flue gas system shall be a balanced draft system and shall consist of two (2) 50% capacity axial blade pitch controlled FD fans, two (2) 50% capacity axial blade pitch controlled PA fans, two (2) 50% capacity Axial ID fans with blade pitch control mechanism. The blade material shall be suitable for inlet dust burden corresponding to Indian raw coal. The blades may be hard coated if necessary. However the blades shall be able to function without erosion at an inlet dust burden corresponding to outlet particulate emission of 120 mg/Nm³. 2 x 50% capacity trisector rotary regenerative air preheater (RAPH), with associated drive motors (with three inputs gear box-Two for electric and one for pneumatic), cold air, hot air, tempering and flue gas ducting and dampers to handle the steam generator requirements. Alternatively BIDDER may offer 2 x 50% bisector RAPH for primary air system and 2 x 50% for secondary air system, separately. The air preheater shall be provided with air motors with air receiver for coasting down operation. The air receiver capacity shall be such that during black out condition the air receiver shall be able to supply adequate air for safe shutdown of RAPH. 2 x 50% Steam coil air preheaters (SCAPH) shall be provided in the bypass air duct (FD fan) so that same can be used if required. Condensate from SCAPH can be led to atmospheric tank (provided for startup purposes of boiler and collects drainage of evaporator)		
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12.2.8.3	The air preheaters shall be of regenerative type with vertical main shaft, counter flow, enclosed in a gas tight insulated casing. The design shall ensure that the air preheaters shall be capable of operating for extended periods of time without pluggage of flow areas between heating element plates. Suitable lube oil system, thrust bearing, pumps, valves, coolers etc shall be provided.	
12.2.8.4	All the element sections shall be basketed with cold end elements suitable for replacement.	
12.2.8.5	Provision shall be made for ease of adjustment of seals externally without need for working from inside. Auto seal arrangement may be envisaged for both axial and radial seals.	
12.2.8.6	An adequate number of access doors for inspection and maintenance and observation ports with vapour proof lighting shall be provided.	
12.2.8.7	The structure shall be strong and light in weight and shall be sufficiently flexible to operate without difficulties under conditions of large temperature gradients through the rotor in the axial direction.	
12.2.8.8	The heat transfer plates used in different layers shall be of different material combination depending upon suitability to withstand extremes of temperature condition. Use of corrosion resistant materials shall be considered to avoid corrosion at the back end.	
12.2.8.9	A suitable structural steel framing for handling the heater element basket shall be provided. This shall include a trolley beam extended beyond the platform to enable lowering of elements to the ground floor. A hoist and trolley shall also be furnished.	
12.2.8.10	The air heater design shall be such that on-load cleaning by suitable steam soot blower is feasible. The location of the blower shall be on the flue gas side. For offload cleaning, water washing spray nozzles on an extended fixed arm on both hot and cold ends shall be provided along with required supply piping, valves etc.(supply to be tapped from Owner's service water system). The locations can be either on air or flue gas side. Provision for fire fighting system in the Air pre-heater shall be provided both on air and gas side and on cold and hot ends, along with required piping, valves etc, fire sensing devices(to be connected to fire fighting system. Facility of Hoppers at the bottom shall be provided for collection and disposal of ash with necessary RF level switches, approach plat forms etc..	
12.2.8.11	The general design requirements for the fans shall be as follows: a) The fan shafts are to be carried in bearings on either side independent of the casings. The overhung impellers shall be avoided	
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as far as possible however if overhung impeller are used the vendor shall take care to design the shaft so that the vibrations are within the applicable limits of code. The rotor shall be overspeed tested to atleast 10% above the maximum operating speed and shall be dynamically balanced. b) The first critical speed of the rotor shall be well above the operating speeds (by at least 15%). c) All constants speed fans shall be designed for under frequency operation upto 47.5 Hz without any reduction in its performance. The fan/motor bearings shall be of heavy duty self aligning type and shall be designed to take the loads due to dead weight, unbalance and thrust of the motor assembly. d) Forced oil lubrication system (if offered) for the fans and motors shall consist of 2 x 100% oil pumps each with motor, 2 x 100% oil coolers and filters; one (1) oil tank and electric heater with thermostat etc. e) The flow induced pulsation should be avoided by suitable design of fan and connecting duct work. f) Suitable design of shaft sealing shall be provided to prevent ingress of atmospheric air. g) Each bearing shall be provided with an oil bath to prevent bearing damage in case of complete loss of plant auxiliary power when the fans must coast down without power. Forced outages resulting from a failure of the oil circulating system shall be minimised by sizing the oil reservoir in bearing housing to be capable of maintaining lubrication for extended periods without the system in service. The fan bearings shall be provided with temperature elements and thermometers for bearing temperature measurement as stipulated elsewhere in the specification. Each fan bearing shall be provided with oil level indicator / flow sight glass and a screwed drain plug. Adequate sealing arrangement shall be provided at each end of the bearing housing to prevent leakage of lubricating oil. h) Flexible coupling shall be used between the prime mover and the fans. i) Silencer shall be provided at the inlet of FD and PA fans with weather hood and inlet screen and acoustic baffles. j) The fans shall be capable of maintaining balanced draft conditions in the furnace with any one or both PA fans, any one or both FD fans, any one or both ID fans in operation while burning fuel as specified. The characteristics of all fans included in this system shall be suitable for parallel operation over the entire load range. Suitable		
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materials for the most conceivable stringent working conditions shall be used for manufacturing viz., High strength aluminium alloy for fan blades, sheet steel for casing, cast iron or welded steel for base plate etc for PA and FD/ID fans(if axial ID fan is provided). When radial type backward curved vaned ID fan is used, then blade material shall be of high wear steel plates with renewable wear liners. Air flow measuring devices shall be provided at suitable points Viz., inlet to Mills (PA fan), secondary air ducts etc. The fans critical speed shall sufficiently away from operating speed (115% of maximum operating speed). Natural frequency of fans components and should sufficiently away from fans operating speeds. The fans shall be statically and dynamically balanced and shall be checked and further adjusted at site if necessary. shall be checked The fans component design shall be such that the components can withstand torsional stresses three times the normal full load motor torque. The shaft material shall be 15MO3 or better. 12.2.8.12 The air and flue gas system design shall be as below: a) The MCR of the fans shall be so determined that with the steam generator in the normally fouled-up condition, all electrostatic precipitator (ESP) sections in operation and the electrical system frequency at 50 Hz., the steam generator shall meet 100% SG MCR condition with sufficient controllability over furnace draft. However the best efficiency point of fans shall be closure to 100%TGMCR condition. The fans characteristics shall be compatible with pulverised coal system resistance and SG operation at various loads. b) The BIDDER shall furnish the PA, FD and ID fans operating curves (head vs. flow) indicating efficiency lines, steam generator resistance line for normally fouled conditions both at 50 Hz, and 47.5 Hz., showing the MCR and test block points. c) An adequate number of interconnecting, isolating and control dampers with suitable drives shall be provided on all cold air, hot air, seal air and flue gas ducting before and after the equipment on these system ducting to permit proper operations. The frames of the dampers shall be rigid and self supported. The control dampers shall be pneumatically operated and isolation dampers shall be electrically operated. Alternatively Bidder can supply electrically operated control dampers if it is cost effective. Bidder shall submit the basis of selection in their Bid d) The velocities in flue gas ducts between the steam generator outlet and ESP inlet shall be sufficiently high to prevent dust deposition on the duct floor. However velocity shall not be more than 13 m/sec		
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before ESP and 16m/sec after ESP. e) The design of all flue gas ducts, air ducts and the wind box shall be compatible with furnace design pressure. f) The gas and air ducts shall be designed for wind loads as specified for the steam generating unit proper and their own weight including fly ash load which may get deposited at the duct bottom, insulation and lining. The top of the ducts shall be crowned to ensure proper drainage. However velocity shall not be more than 14 m/sec to 16m/sec. g) Bidder shall indicate the velocities in flue gas ducts and in the steam generator and shall also indicate the maximum velocity limits. h) The duct work shall be free to expand, but it shall be rigid against wind and seismic disturbances. Adequate provision shall be made for all expected expansion or contraction. Acoustic insulation shall be used on air and gas ducts to restrict the noise level as per the MOEF requirements. i) All gas and air ducts shall be designed to ensure uniform distribution of gas and air flow to the various portions of the unit. The design shall be such that turbulence and resistance are minimised particularly in the proximity of fans and air-heaters. j) All gas and air ducts consist of turning vanes / baffle plates, stiffening devices, expansion joints, interior bracings, access doors and brackets, support structures and hangers as necessary. Duct work should take in to consideration any future addition of FGD plant near chimney. The design of ducting should consider wind loads, dead weights of material, lining, insulation etc., ash accumulation in case of horizontal ducts, expansion joint reaction. The suggested material of construction is ASTMA36 for duct plates, vanes, structural shapes, ASTM A53 for pipe struts, trusses, ASTM A307 for erection bolts etc. k) Access and inspection doors of suitable size shall be provided at suitable locations. l) Aerofoils shall be provided in the air ducts for the measurement of total air flow. m) Locking devices shall be provided to permit locking of the dampers in both open and shut positions. n) The inlet dampers for ID fans shall be located in horizontal duct of main inlet duct to avoid fly ash build up on closed dampers.		
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o) The air preheater, economiser and duct hoppers shall have provision for removal of fly ash during maintenance period when the steam generator is out of operation. To facilitate such fly ash removal, BIDDER shall provide a 100% gas tight isolation gate near the hopper bottom. p) Electrically operated single plate guillotine type isolation dampers along with drives shall be provided as specified in Data Sheet-A11. The inlet dampers for ID fans shall be located in horizontal duct of main inlet duct to avoid fly ash build up when in closed position 12.2.8.13 All necessary regulating and isolating dampers shall be provided for the efficient and convenient operation of the steam generator. The BIDDER shall furnish a list of all dampers, their purpose and torque rating etc. together with the details of actuators and accessories for remote control. Powered dampers shall also have provisions for manual operation during emergency / maintenance along with graduated local position indicator. 12.2.8.14 The single plate dampers shall be of heavy duty construction. All dampers/louvers shafts shall be rigidly constructed to prevent bending, vibrations and distortion. They shall be balanced about the bearing shaft axis. They shall be designed to withstand the operating air/flue gas temperature without distortion. The spindles shall be adequately sized and bearings suitably insulated to protect over-heating. The construction shall be such that the shaft bearings are mounted outside the damper box channel and arranged for convenient inspection. Stuffing boxes shall be provided on all damper blade shafts. As far as possible single plate construction shall be adopted to minimise leakages. 12.2.8.15 The dampers shall be capable of effectively stopping the flow in the closed position and while in full open position shall cause minimum pressure drop. Special attention shall be given to the design of sealing arrangement of isolating dampers to ensure that they provide a positive shut off when closed. Open and Close positions shall be clearly marked on each damper. 12.2.8.16 As a minimum power operated gas tight dampers shall be provided i.e., guillotine type dampers at hot air duct inlet to mills, inlet & outlet of ESP stream, Before and after ID fans, inlet of APHs on flue gas side, discharge of PA fans, discharge of FD fans, and at inlet & outlets of APHs on air side. Guillotine type dampers shall provide in horizontal ducts only to avoid ash build up in ducting. 12.2.8.17 Pressurisation fans to achieve 100% sealing shall be adopted for dampers at ID fans discharge, APHs air side outlet dampers and mill inlet dampers.		
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12.2.8.18	The dampers in flue-gas paths shall be so located that the build-up of grit behind the damper blades is reduced to a minimum. Manual operation facility shall be provided for all dampers.	
12.2.8.19	The attachment of all louvers to the damper spindles shall be by means of key fitting. All bearings for spindles or damper operating gear shall unless approved to the contrary, be arranged for efficient grease lubrication. Grease lines of copper/steel shall be run from all greasing points on each damper to a convenient and easily accessible location adjacent to the respective damper and terminated with suitable clamps and grease nipples on a steel frame to facilitate easy lubrication.	
12.2.8.20	All damper actuators and the complete link mechanism connecting the dampers and their actuators shall be furnished. The linkage mechanism shall be so designed that the actuators can be mounted on a gallery or floor level and shall be subject to the PURCHASER`S approval.	
12.2.8.21	Outlet dampers of seal air fans, scanner air fans and emergency dampers of scanner air shall be pneumatically operated suitable for remote manual operation. All pneumatic operated inter-locked dampers actuators shall be provided with D.C. solenoid valves.	
12.2.8.22	All dampers shall be arranged to facilitate local manual operation from a gallery or floor level. The operating gear shall be fitted with a graduated indicator and shall be designed such that the damper may be retained in any position. The isolating dampers shall, in addition be fitted with locking devices to permit locking in the fully open and shut positions.	
12.2.8.23	Power operated gas tight isolation dampers along with their drives shall be provided at locations required for carrying out internal repair and maintenance.	
12.2.8.24	The dampers shall have guaranteed gas tightness efficiency (on flow) of not less than 99.98%.	
12.2.8.25	The damper shafts shall be rigid and shall have side bearing plates. Horizontal shafts shall be supplied wherever possible.	
12.2.8.26	Manual damper operation shall be accomplished by hand-wheels accessible from platforms attached to the ductwork support steel.	
12.2.8.27	If grease lubrication is required grease connection shall be accessible.	
12.2.8.28	The flue gas duct layout shall be designed considering the following aspects: a) The change of direction of flue gas duct shall be gradual to avoid ash collection at the bottom of the duct and also to prevent erosion by local concentration of fly ash. b) The number of direction changes of the flue gas duct shall be	
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minimal to minimise the ash collection points. c) However, the air preheater, economiser and duct hoppers shall have provision for removal of fly ash during maintenance period when the steam generation is out of operation. The hopper bottom shall be blanked with a blind chute suitable for unloading fly ash from all the above mentioned hoppers. 12.2.9.0 <u>Dust Precipitation and Collection System (Electrostatic Precipitator)</u> 12.2.9.1 One electrostatic precipitator (ESP) shall be provided for the steam generator and shall be designed to limit the dust concentration to 50 mg/Nm³ at ESP outlet with the specified range of coal firing and with one field out of service. The ESP shall be located after the APH. All the fields of ESP shall be normally in service. However, the number of fields shall be selected in such a way that with one field out of service, ESP should be able to limit the dust concentration within 50mg/Nm³, even with the worst fuel firing and the specific collection area and no. of fields shall be suitably selected. 12.2.9.2 The electrostatic precipitator shall be complete with supporting structural frames, collecting and discharge electrodes, shaft insulators, bush insulators, independent rapping system for collecting and discharge electrodes with automatic rapping controls, high voltage transformers, rectifiers, bus sections with sectionalising and grounding switches and controls, fly ash collecting hoppers with accessories etc. An Energy Management System (EMS) shall be provided to optimise the power consumption. The Bidder shall furnish the details of EMS. 12.2.9.3 For personnel protection, key interlocks shall be provided to prevent the opening of any inspection and/or access doors until after de-energising of all high voltage equipment that can be reached and/or made contact with, through the inspection and/or access door. 12.2.9.4 Each hopper shall be provided an arrangement to facilitate emergency poking. The hoist with supporting structure/beams to permit easy removal of each transformer-rectifier from its operating position to grade level shall be provided. 12.2.9.5 The rapping system shall be designed for selective remote automatic or manual operation at adjustable intervals. Necessary rapping arrangement with controls shall be provided for perforated gas distribution plate at inlet to the ESP. 12.2.9.6 Adequate number of motor operated guillotine dampers shall be provided by the Bidder at inlet and outlet of each section of ESP for their effective isolation to carry out internal repair and maintenance of the isolated		
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ESP section while steam generator is on load. These dampers shall also be furnished with electrical drives for remote/local operation. Absolute gas tightness of the isolation shall be ensured at the seals. 12.2.9.7 The dust collection hoppers at all strategic locations along the flue gas path and those below the ESPs shall have a minimum storage capacity of 8 hours at 100% MCR conditions of the steam generator with worst coal. The hoppers shall have electric heating arrangement to prevent ash sticking to the walls of the hoppers. 12.2.9.8 Access doors of suitable size and shape, platforms and corresponding interior walkways of suitable width shall be provided on each side of the casing before and after each of the fields in series at the bottom and mid point elevations of the collecting electrodes in order to facilitate maintenance and inspection of each of the fields. They shall be mounted on extended frames to provide for finishing off outside insulation. 12.2.9.9 Emitting electrodes of rigid type (barbed type) or spring type may be considered 12.2.9.10 Each hopper shall be provided with heating system, to prevent arching of ash during cold conditions. 12.2.9.11 If the MANUFACTURER'S standard design is such that the roof is pierced with rapper rods, high voltage support insulators, or other components which would require that external insulation, weather-proofing, be installed he shall provide a penthouse/weather enclosure to be erected on precipitator roof. If not, he shall provide aluminium gutters, transformers and a 100 cm high 2-rail safety handrail. 12.2.9.12 Penthouse/weather enclosures shall have proper ventilation system with suitable covering over head of the transformer rectifier sets, controls etc., to keep the temperature within acceptable limits under all operating conditions. 12.2.9.13 The BIDDER shall supply hoist to permit easy removal of each transformer-rectifier from its operating position to grade level. ESP rapping equipment shall be arranged to operate in a manner which remove dust from the discharge and collecting electrodes in a relatively continuous manner in order to eliminate stack puffs. Independent rapping systems shall be provided for discharge and collecting electrodes with independent control systems, to minimise local re-entrainment. 12.2.9.14 The rapping system shall be designed for selective remote automatic or manual operation at adjustable intervals without interface between vibrations caused by excessive raps. Necessary rapping arrangement with controls shall be provided for perforated gas distribution plate at inlet and outlet from the ESP.		
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12.2.9.15	The electrical insulation of ESP shall be so designed that the internals of each field may be readily replaced by removing the appropriate roof section, without disturbing the high voltage electrical suspension system.	
12.2.10.0	<u>Fly Ash Removal</u>	
12.2.10.1	All points of natural dust deposition including that in second pass below the air preheaters and ESP shall be provided with hoppers of proper shape and size to effectively and efficiently collect the fly ash. The ash hoppers shall be of welded steel construction. The hoppers shall be suitably insulated on the exterior.	
12.2.10.2	Each ash hopper shall be provided with a dust tight sealed hinged inspection door and an access door of suitable size. The hoppers shall be provided with the required outlet connections.	
12.2.10.3	The size of the hopper is so designed that it will collect maximum ash with lowest calorific value of coal.	
12.2.10.4	Void	
12.2.11.0	<u>Fly Ash Hoppers</u>	
12.2.11.1	The ash hoppers shall be designed for an ash density indicated in the data sheet. All bracing and stiffening shall be on external side of hopper. No internal bracing, stiffening, etc. shall be utilised.	
12.2.11.2	The hopper shall be of pyramid shape with plate angle of around 70° and valley angle shall be 60 to 65°, with an access door on each side of baffle.	
12.2.12.0	<u>Electrical System of ESP</u>	
12.2.12.1	<u>Transformer Rectifier Equipment</u>	
12.2.12.1.1	These shall be suitable for outdoor installation. Transformer-rectifier assemblies shall be designed for electrostatic precipitator service and shall be for single-phase energisation with silicon rectifiers connected for pulsating negative polarity double, half-wave operation. Means shall be provided for changing to full wave operation, if found desirable, for any reason through external switching. The access door to the links, required for changing the high voltage connections, or the high voltage switch operating mechanism or cover shall be arranged for locking	
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with a padlock. Key interlocking shall be provided on access door or cover to the links required for changing the high voltage connections, or the high voltage switch operating mechanism to prevent access while the transformer-rectifier is energised. 12.2.12.1.2 Primary taps shall be included on the transformer. Transformer shall have electrostatic shielding between primary and secondary windings and shall have suitable shielding of the high voltage coil to accomplish proper voltage division in the transformer when unit is subjected to surge conditions encountered in electrostatic fly ash precipitator application. 12.2.12.1.3 Each output leg of each transformer-rectifier set shall serve one bus section and both bus sections served by each transformer-rectifier set shall be in the same field. 12.2.12.1.4 Transformer rectifier assemblies shall be mounted in a heavy gauge welded steel tank designed for a minimum of 0.5 Kg/cm² test pressure and full vacuum. Insulating and cooling medium shall be non-flammable insulating fluid. Unit shall be adequately sealed to prevent contamination of insulation and cooling medium. Outdoor type construction shall be used except for the high voltage bushings which shall be enclosed by the bus duct. 12.2.12.1.5 All silicon rectifier cells shall be conservatively rated for compatibility with maximum circuit load and demand requirements. 12.2.12.1.6 If required suitable low-loss impedance shall be included in the high voltage circuit to limit circuit capacitance discharge current to values compatible with current rating of the rectifying elements used. 12.2.12.1.7 Supporting insulators shall be located in heated compartments that are maintained above the dew point of the flue gas. They shall be located out of the dirty gas stream. These shall be protected from weather by either a common top housing or individual compartments. A steel shroud below the insulator may be provided which will further inhibit dust diffusion. Each compartment shall be pressurised and ventilated by heated filtered air furnished by one or more motor driven blowers. Contactors and strip heaters with control thermostats for heating the air, blower motors, and blower motor contactors and control for each compartment as required, for complete automatic/manual operation with alarm contacts for high and low temperatures and loss of pressure shall be provided. The filters shall be of the washable type, adequately sized for use in dusty atmosphere. 12.2.12.1.8 If strip heaters are used, the wiring to the strip heater terminals shall be nickel-plated copper with 600 volt teflon-glass insulation. 12.2.12.2.0 <u>Control Cubicles for ESP</u>		
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12.2.12.2.1	Automatic control cubicles shall be furnished for indoor mounting. The automatic controls shall have full control from 10% of the power set rating to full rating.	
12.2.12.2.2	The control system should be capable of - Evaluating sparking by intensity and wave shape. - Regulate power at the threshold of sparking. - Break a power arc within around ten (10) millisec of its occurrence. - Automatically control the arc response so that power is restored within around one hundred twenty (120) millisecs. - Modify the current wave shape permitting greater power input prior to reaching spark over threshold.	
12.2.12.2.3	The BIDDER shall furnish complete control and interlock system to automatically regulate, monitor and provide for safe operation of the ESP.	
12.2.12.2.4	Provision shall be made in each cubicle for auto-manual operation. The control circuit shall be so arranged that when the latter switch is in manual position the ESP control room operator shall be able to control the electrical performance of the ESP by means of a control switch, potentiometer or variable transformers. When the switch is in the auto position, the automatic regulator unit located in the control cubicle shall control the performance of the ESP in accordance with its requirements and settings of the regulator. Manual adjustments of high voltage set points shall be provided.	
12.2.12.2.5	Adequate numbers of indicating instruments shall be provided on the control cubicles for the purpose of correct monitoring of the performance of ESP and accessories.	
12.2.12.2.6	Sufficient numbers of alarms shall be provided on the control cubicles.	
12.2.12.2.7	Rapper control system for each bus section or pairs of bus sections served by a single transformer-rectifier shall: - provide manual adjustments of the timing and frequency of operation) and the rapping intensity from the control cabinets, - provide rapper diagnostic system including miniature indicating) lights, digital indicators, etc.	
12.2.12.3.0	Motors	
12.2.12.3.1	Drive motors of the rapping mechanism for collecting and discharge electrodes and fans shall comprise 415V, 3 phase, 50 Hz, rated direct-on-line induction motors with IP-55 enclosure. In general, motors shall conform to Specification as specified elsewhere in this specification.	
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12.2.12.3.2 The BIDDER shall optimise gas flow pattern and distribution in the precipitator sections. The storm water drain piping shall be provided upto the grade level for ESP. 12.2.13.0 <u>Start-up / warm-up and Support oil system</u> 12.2.13.1 The start-up/warm-up and flame stabilization oil system shall be as described under Warm up oil system shall be designed for burning light diesel oil (LDO). This system design capacity should be sufficient to raise steam parameters of the steam generator to meet auxiliary steam for fuel oil heating / atomising in the shortest possible time to enable quick changeover to HFO firing. However, this system shall have minimum capacity of 7.5% of MCR rating of one steam generator. LDO will also be used as flushing medium for flushing out fuel oil pipe lines and headers during long unit outages. This system can be common for two SG units and shall consist of two (2) 100% capacity LDO (1 working + 1 standby) pressurising pumps(rotary positive displacement with relief valves), suction strainers, compressed air atomised burners, LDO and air piping, valves and fittings, instrumentation, safety and control systems. The LDO Pressurising pumps shall be located in Fuel Oil Pump House (FOPH). The LDO burners with high energy arc igniters shall be of air atomised type with air serving as burner cooling media and made of corrosion resistant material (resistant to LDO with materials like sodium, vanadium, sulphur, chlorides etc.) 12.2.14.0 <u>Support Oil System</u> 12.2.14.1 The support oil system shall use Heavy Fuel Oil (HFO) as specified for startup/warm up and flame stabilization. 12.2.14.2 The fuel oil burning system shall consists of 2 x100% pressuring pumps(rotary positive displacement with relief valves) for each unit (1 working + 1 stand by), suction piping, valves and fittings, filtration units, fuel oil heaters and two (2) matching pressure filters, steam atomized burners, fuel oil safety and burner shut off valves, fuel oil pressure and temperature control valves, fuel oil metering units, fuel oil atomising and blow-off steam headers at burners, atomising steam pressure control valves, piping and valves necessary for bypass and isolation, fuel oil burner header recirculation control valve, recirculation piping with valves upto the fuel oil tanks, as identified in the enclosed sketch. The fuel oil pressuring pumps shall be located in FOPH.		
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12.2.14.3	The oil burning system shall be designed for 22.5 % SG MCR rating. The fuel oil burners shall be positioned to provide initial warming / start-up and support to any of the coal burners at low loads for flame stabilisation as and when required. Fuel oil burner arrangement shall be such that one fuel oil burner is provided between two coal burners so that any mill could be lighted up without any limitation on the cutting in sequence of coal mills over the entire load range.	
12.2.14.4	The HFO burners with high energy arc igniters shall be of steam atomised type with steam or air serving as burner cooling media and made of corrosion resistant material (resistant to HFO with materials like sodium, vanadium , sulphur , chlorides etc.) All pumps, strainers and/or pump strainer assembly units shall be provided with drip pans.	
12.2.14.5	Drain oil connection and pumping system shall be provided in steam generator area and in fuel oil pump house. An oil drain header of size not less than 150 NB shall be provided to collect drain oil from pans, strainers, pumps, pipes, etc. and return the same to the drain oil tank. The drain header shall be laid just above the ground and shall be generously pitched towards the drain tank. All oil drain lines shall have a size not less than 25 NB and shall be electrically traced (self temperature controlling heating elements). The drain oil pump suction and delivery lines shall have a size not less than 25 NB and shall be electrically traced (self temperature controlled heating elements). The drain oil tank shall be provided with heating coil and accessories/instruments.	
12.2.14.6	The HFO pipe lines shall be steam or electrically heat traced for easy flow. For electrically heat tracing system self temperature controlling heating elements shall be used.	
12.2.14.7	The suction and discharge filters, the fuel oil pumps and the fuel oil pipes shall be equipped with electric heat tracing (self temperature controlled heating elements). The atomising / blow off steam system and steam oil heaters will be supplied with auxiliary steam from auxiliary steam system.	
12.2.14.8	Screw type pressurizing pumps (if provided) shall be provided with a spring loaded relief valve and it shall be built-in with the pump, the discharge end of the valve being connected to the pump's suction side. The relief valve shall be capable of allowing the full discharge of the pump through it. The relief valve set pressure shall be adjustable. The pressurising oil pumps and the fuel oil pipes shall be equipped with electric heat tracing.	
12.2.14.9	System shall be designed to zero wastage of oil i.e. collecting all the leakage oil & pumping back to tank	
12.2.15.0	<u>IGNITION SYSTEM</u>	
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12.2.15.1	High Energy Arc (HEA) igniters shall be provided to ignite LDO and HFO. One HEA igniter for each fuel oil gun shall be provided. The igniter system offered shall be of well proven design of reputed make.	
12.2.15.2	Ignition system shall be complete with all electrical gadgets viz., transformer control cabinets, igniters, cabling, etc. to make the system complete by itself and shall be integrated with BMS.	
12.2.15.3	Adequate number of flame scanners shall be provided for fuel oil and coal firing. Two (2) 100% one AC and one DC motor driven scanner air fans shall also be provided for the flame scanner cooling.	
12.2.15.4	The oil burner shall be of well proven make in service and the design shall provide accurate fuel and air ratio control, thorough mixing of fuel and air at all loads and shall avoid flame impingement on the steam generator tubes/ducts.	
12.2.15.5	Minimum turn down ratio of 4:1 shall be provided. The burners shall be remotely operated and the entire operation of purging steam and fuel oil sequencing, steam blow-off shall be automatic after the initial command. Adequate number of position indicating contacts for integration into burner management system (BMS) shall be provided.	
12.2.15.6	The air fuel ratios around the burners shall ensure low NOx emission. The BIDDER shall furnish details of the system proposed to be adopted by him for NOx emission control.	
12.2.15.7	The flexible hoses (armoured type) shall be provided for oil and steam connections.	
12.2.15.8	The burner shall be arranged for automatic advancement and retraction under interlock conditions. The servo drives shall be pneumatically operated, the station compressed air being available for this purpose.	
12.2.15.9	The oil burners shall be provided with their discriminating flame sensing devices so that the admission of oil may be automatically shut off and oil gun withdrawn in case of flame failure. The flame sensing devices shall be self contained and shall be unaffected by dirt, oil film and ambient conditions. The oil firing scheme shall incorporate automatic purge interlock to facilitate restarting after such conditions. Automatic ignition system to initiate the flame in the furnace shall be included. However facility for the manual operations shall also be provided. Ignition system shall be complete with ignitors suitable for ignition of heavy oil directly. Necessary piping, valves, control and instrumentation and all other equipment necessary for the completeness of this system shall be provided.	
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12.2.15.10	The oil firing system shall include all connections and provision for instruments and devices required for supervision and interlocking with all associate auxiliaries during purging, start up operation and shut down.	
12.2.16.0	Oil Heaters 2x100% capacity steam coil heaters shall be designed to suit the rated capacity of the pumps and shall be capable of heating the HFO to the required temperature. For the purpose of sizing the heaters it shall be assumed that the oil inlet temperature to heaters is 30 °C.	
12.2.17.0	<u>COAL PULVERIZING AND FIRING SYSTEM</u>	
12.2.17.1	The coal burning system shall be designed to meet the requirement of steam generator at 100% SG MCR conditions specified in Data Sheet-A1 of Vol II. The system shall be designed in compliance to NFPA (USA) requirements for the complete safety of plant, equipment and personnel.	
12.2.17.2	The coal pulverising and firing system shall consist of medium speed coal mills with drives, Gravimetric coal feeders with drives, coal isolation gates at bunker outlet, feeder inlet, coal piping with flexible couplings from mill outlets to coal burners, coal burners with shut-off gates and drives, air registers with drives, coal mill hot air and coal / air discharge isolation gates and drives, two (2) x 100% seal air (SA) fans complete with air ducting to all coal mills/feeders, isolation, interconnecting and control dampers on seal air ducting as required, insulation, supports and hangers etc.	
12.2.17.3	The BIDDER shall note that the minimum stable load without fuel oil support for pulverised fuel burning system shall not be more than 40% of steam generator MCR load.	
12.2.17.4	The number and capacity of coal mills/coal burners shall be selected based on the following: - With one mill as standby and other mills running at 85% of their MCR, the system shall be able to meet 100% coal firing rate using worst coal. Also, with two mills as standby, 100% TGMCR shall be met using design coal. - Minimum three mills shall be in operation for load range of 60% TGMCR to 100% SGMCR. - Each coal mill shall be provided with a separate gravimetric coal feeder and its capacity shall not be less than the capacity of the coal mill	
12.2.17.5	The coal mills shall be designed for direct firing and to pulverise raw crushed coal available from the coal crusher.	
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12.2.17.6	The coal mills and bunker bays shall be arranged on the steam generator left and right sides. Alternatively front or rear mill combinations can also be considered. Bidder shall ensure equal distribution of the pulverized fuel among the burners from the coal mill in order to have low NOx.	
12.2.17.7	Forced oil lubrication system for the coal mills and motors shall consist of 2 x 100% oil pumps each with motor, 2 x 100% oil coolers and filters etc. with necessary piping and valves.	
12.2.17.8	The BIDDER shall quantify the operating hours between major overhauls of the coal mill and the coal throughput in tonnes, when handling worst coal.	
12.2.17.9	Dampers shall be provided on coal pipes at mill outlet, on cold air and seal air ducts and gates on hot air to coal mills. These dampers shall be pneumatically operated where as gates shall be electrically operated.	
12.2.17.10	To prevent coal dust entering the atmosphere and/or the mill bearings, seal air shall be supplied and for the purpose 2 x 100% seal air (SA) fans shall be provided. Sealing air (SA) fans shall deliver air into a common seal air header from where each coal mill and feeder set shall be supplied with the seal air.	
12.2.17.11	For drawing coal samples (iso kinetic sampling of coal) for testing the fineness of the ground coal, a minimum of four tapping points at right angles to each other shall be provided on the straight length of pipe at each coal mill outlet. Compressed air purging connections shall be provided at the tapping points to clear the opening prior to sample collection.	
12.2.17.12	Two coal isolation gates shall be provided at each bunker outlet. The gates shall be of dust-proof, rack and self-cleaning type pinion with all parts in contact with coal of minimum type 410 weldable stainless steel. The gate at the outlet of the bunker shall pneumatically / electric motor operated (designed to operate in bunker full condition) where as, the gate nearer the feeder shall be manually operated.	
12.2.17.13	The down spout from feeder outlet to mill inlet shall be provided with pneumatically / electric motor operated isolation gate. Two isolation gates shall also be furnished in each coal burner pipe one nearer to the coal mill and the other nearer to the furnace / wind-box (if applicable) for facilitating on-line maintenance work of coal piping/coal mill. The gate nearer to the coal mill shall be pneumatically / electric motor operated, and the gate followed by that shall be manually operated.	
12.2.17.14	The coal feed pipe from the coal mills to the coal burners shall be of wear resistant, weldable steel and of minimum thickness not less than 12 mm on straight length and 20 mm (but not less than one and a half times the straight pipe thickness) at outer radius of bends. The bends shall be basalt lined or ceramic lined to prevent erosion. The design and layout of the coal	
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pipes shall be such that there will be uniform coal air mixture distribution among all coal burners and the velocity of coal air mixture shall not fall below critical fallout velocity. The maximum permissible design stress shall be 67% of yield strength. 12.2.17.15 Each pipe between bunker outlet and feeder inlet shall be provided with a flanged filler piece for connection of an angle type diverter chute to permit emergency dumping of coal from the bunkers. One carbon steel diverter chute connection piece with flanged outlet shall be furnished. 12.2.17.16 A dresser or equal coupling shall be provided on each feeder inlet to permit bunker and feeder expansion movements. The inner ring shall be of stainless steel. 12.2.17.17 Adequate and suitably located poke holes shall be provided to clear the feed pipes to the mills when they get choked. 12.2.17.18 The coal firing system shall have a minimum turn down ratio of 2.5:1. The fuel oil shall be used for flame stabilisation at low loads. The coal burning system shall be designed to achieve optimum combustion with twenty (20) percent excess air measured at the RAPH inlet. The burners shall be designed to ensure smooth variation of fuel flow with out affecting air fuel ratio, with optimised air fuel ratio for NOx control. Each coal burner shall be connected to one separate coal pipe with power operated gate valve at the inlet of burner. The high temperature areas shall be made of aloe steel and the design should ensure that no deposits or distortion takes place. The angle at confluence of primary air from burner and secondary air shall be such that the inherent carbon monoxide produced is removed by scrubbing action with out any significant reduction in air velocities. The burner wear parts shall be made of high abrasion resistant materials. 12.2.17.19 Air fuel ratios around the burners shall ensure low NOx emission. The BIDDER shall furnish details of the system proposed to be adopted by him for NOx emission control. 12.2.17.20 Isolation gates shall also be furnished in each coal burner pipe at the wind-box for facilitating on-line maintenance work of coal piping/coal mill. The isolation gates shall be furnished with electric drives having double pole double throw limit switches, at the full open and full closed position, for integration into burner management system (BMS), steam generator control and protection logic system (SGCPLS) and other control systems. 12.2.17.21 The coal feeders shall be of gravimetric belt type suitable for handling moist sticky coal. The feeder shall have microprocessor based, electronically controlled variable speed drive for the accurate regulation of the coal feed rate. The coal weighing shall be automatic and highly accurate. The feeder shall have provision for reverse rotation to facilitate bunker emptying. The design shall comply to the requirements of NFPA. The feeders shall have		
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access doors for quick maintenance, spray water and purge air facility. Bidder to supply gravimetric belt type raw coal feeder with VFD drives. 12.2.17.22 The BIDDER shall furnish schematics of coal milling system and primary air system to fire coal with his bid documents. 12.2.18.0 <u>Soot Blowing System</u> 12.2.18.1 The soot blowing system shall consist of motor operated steam soot blowers of the rotary and retractable type, with drives, pressure reducing, isolation and relief valves, steam traps, thermal drain valves, complete piping, supports and hangers, insulation, motor control centers and soot blower instrumentation and control system. The system shall be of self-draining type. Bidder may consider selective operation Soot blowing system (DDCMIS controlled or “Smart soot blowing system” -lower consumption of steam and less erosion, Micro processor based, control based on changes in heat flux on water walls) for cleaning water walls and sequential type soot blowing for SH, RH and other areas, and furnish the details of the same along with his bid. 12.2.18.2 The soot-blowers shall be suitable for remote automatic sequential / selective soot blowing and local operation. 12.2.18.3 A sufficient number of soot blowers shall be provided to clean the heat transfer surfaces effectively. Adequate number of blowers shall be provided in the furnace and convection zone. These shall be furnished with all necessary mechanical and electrical ancillaries. 12.2.18.4 The steam pressure required for the soot blowing shall be obtained by tapping steam from intermediate superheater header through a pressure reducing control valve on the main supply line. A motor operated isolation valve shall be provided upstream of the pressure reducing control valve. Manually operated isolation valves on steam supply line shall be provided for isolation of each elevation of furnace blowers. These shall be designed for full flow operation as well as for tight shut-off. An adequate number of motorised thermal drain valves shall be included to facilitate the warm-up of the complete piping system before the start of the soot blowing operation. The drain valves shall have no bypass lines. Temperature detectors on drain lines shall be provided to ensure satisfactory warming up and initiation of the soot blowing programme. 12.2.18.5 All the soot blowers shall be of proven design. They shall be of specific type capable of removing different types of ash accumulating in different areas. 12.2.18.6 The soot blowers shall be of the self draining type. 12.2.18.7 The soot-blowers shall be suitable for remote automatic sequential/selective		
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soot blowing and local operation. Emergency hand crank shall be provided for each soot blowers. Furnace wall blowers shall have the facility of angular travel adjustment. 12.2.19.0 Auxiliary Steam System 12.2.19.1 Auxiliary steam system shall consist of one (1) auxiliary pressure reducing station (PRS) and a desuperheater on the steam line tapped off from the main steam cold reheat line .An alternative source from CRH line can also be used. The system shall be complete with the pressure reducing valves, bypass valve and isolation valves; safety relief valves, drains, steam traps; quick closing block spray valve; desuperheaters; steam temperature control valves, bypass valve and isolation valves; complete piping, supports with hangers, insulation; and instrumentation and control. Pressure control valves shall be selected in such a way that it would be possible to regulate the steam flow based on demand under all operating regimes. The main header can be divided in to two headers i.e. one high temperature / high pressure header and one low temperature / low pressure header. CONTRACTOR shall furnish the basis of the same during detailed engineering for approval. 12.2.19.2 The spray water for desuperheating station shall be supplied from boiler feed pump discharge or interstage tap-off. The CONTRACTOR shall provide pressure and temperature control valves to meet the requirements of auxiliary steam system. The interconnection between auxiliary steam systems of both the units shall also be provided with separate isolating valves on both the sides and with required steam trapping equipment. 12.2.20.0 Refractory and Insulation 12.2.20.1 The refractory shall be selected appropriately at various locations in the furnace (viz., bottom ash hopper, burner zone, goose neck, cage roof, pent house etc.) considering the gas temperature, oxidising /reducing atmosphere and erosion. CONTRACTOR shall substantiate the basis of selection of refractories in the bid document. 12.2.20.2 Thermal insulation and cladding shall be provided for the entire steam generator, flue gas / air ducting, etc. The insulation selected shall meet the requirement specified. 12.2.20.3 The steam generator shall be provided with 1.2mm corrugated aluminum cladding and the ducts shall be plain aluminum cladding of 1 mm thickness		
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12.2.21.0	Chemical Dosing System	
12.2.21.1	It is proposed to adopt All Volatile Treatment (AVT) during startup. During start up, Ammonia dosing is envisaged in the condensate to maintain pH. Oxygenated treatment (OT) will be adopted during steady state operation. Ammonia will be dosed to the condensate system to maintain pH and gaseous oxygen to both condensate and feed water system to maintain residual oxygen. Accordingly, each steam generator shall be provided with separate chemical dosing system.	
12.2.21.2	Ammonia dosing system shall be provided to ensure chemical conditioning of condensate/ feed water for controlling the alkalities. The ammonia solution shall be injected in to the condensate at the condensate extraction pumps discharge.	
12.2.21.3	The system shall consist of one solution preparation tank and one solution dilution tank (if required) , 2X100% dosing pumps complete with suction / discharge valves, Y type suction strainers , pressure gauges etc., dosing pump discharge header sectionalizing valves and complete piping with isolating and non- return valves as required.	
12.2.21.4	Each tank shall be complete with motorized agitator, overflows and drain connections, inlet / outlet isolating valves and side mounted level gauge / level switch with connecting isolating valves.	
12.2.21.5	Oxygen (O ₂) dosing system shall be provided to inject oxygen in the main condensate. Bidder shall provide necessary oxygen bottles, manifolds, piping, necessary valves. All the bottles will be placed at a common place for two SGs each.	
12.2.21.6	Other treatments as per SG manufacturer's recommendations shall also be supplied.	
12.2.21.7	Bidder shall include the oxygen cylinders required to cater 15 days of dosing requirement	
12.2.22.0	<u>Bidders shall furnish details of chemical dosing treatments and dosing system</u>	
12.2.22.1	Air Preheater Washing System Complete air preheater washing system shall be supplied by the contractor. System shall include tank, 2x100% pumps, piping, valves etc. Service water required for washing shall be supplied at inlet to the tank.	
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N₂ System For nitrogen (N₂) blanket and N₂ preservation, suitable connections for N₂ supply shall be provided. The N₂ system shall include all the piping, valves, manifolds, vents and drains, etc to make the system complete. Adequate no of N₂ cylinders for refilling, preservation, blanketing shall be provided. The Contractor shall supply N₂ gas till completion of trial operation		
12.2.23.0	<u>SG Filling system</u> 2x100% SG fill pumps for each unit along valves, piping etc. shall be supplied. The SG fill pump shall draw water from the condensate storage tank (CST) and fill the SG unit before start-up. The CONTRACTOR shall provide SG fills connection to the SG unit at economiser, and superheater drain headers. In addition, the fill pump discharge shall be connected to deaerator feed storage tank and ACW storage tank also. The capacity of the fill pump shall be enough to fill the SG unit in about 2 hour's time.	
12.2.24.0	<u>General Design Requirements</u>	
12.2.24.1.0	<u>Vibration and Noise Levels</u>	
12.2.24.1.1	The design of steam generator and its auxiliaries shall ensure maintenance of vibration and noise levels within the limits specified in the following paragraphs over the entire operating range and during load fluctuations.	
12.2.24.1.1	The gas path design shall prevent the generation of excitation forces conducive to resonant vibration. Adequate spacing of heat transfer surfaces shall be provided in the gas path to ensure that within the allowable vibration limits no rubbing between tubes or between tubes and supports occurs. If necessary, baffles may be introduced.	
12.2.24.1.2	ID fans if provided with variable frequency drive, BFPs, Steam turbine generators shall have vibration isolation system (spring mounted) For other constant speed motors and fans conventional block / frame type RCC foundation shall be provided.	
12.2.24.1.3	For Coal mills, ID, FD, PA, and GR fans (if applicable), the vibrations at the bearings shall meet the requirements of ISO 10816 Part 3.	
12.2.24.1.4	Vibration isolators of proven performance shall be provided by the BIDDER for preventing transmission of vibrations from one equipment to the other neighbouring equipment and structures. If vibrations isolation system is not envisaged, then a system shall be provided such that the vibrations shall be within the allowed limits	
12.2.24.1.5	The ducting shall be adequately stiffened to absorb pressure pulsations. Guide vanes shall be provided at bends as required preventing turbulence.	
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Fan/blower induced duct vibrations shall be avoided. 12.2.24.1.6 The measured noise level produced by any rotating equipment shall not exceed the stipulations laid by MOEF. 12.2.24.1.7 The noise produced in valves and piping associated with handling compressible and incompressible fluids shall be attenuated to 90 dBA by the use of low noise trims, baffle plate silencers/line silencers, acoustic lagging (insulation), thick-walled pipe work as and where necessary. All pipes and valves downstream of pressure control valve (including pressure control valve) shall be one schedule higher than needed by pressure considerations to attenuate the noise. For safety relief valves the allowable noise level shall not exceed 115 dBA for one quarter hour or less per day. The BIDDER shall outline the methods adopted to limit the vibration and noise levels within specified values. 12.2.24.2.0 <u>Safety Provisions</u> 12.2.24.2.1 Adequate number of safety valves shall be provided on superheater and reheater headers to safeguard the respective equipment against excess pressure arising out of any emergency. The number and capacity of safety valves shall be as per the Code requirements. All safety valves shall have welded inlet and flanged outlets. 12.2.24.2.2 In addition to the safety valves required by the Code, electromatic relief valve of capacity not less than 10% of 100% SG MCR rating, suitable for remote operation shall be provided on superheater outlet header. The valve shall also be capable of automatic operation on rise in separator pressure to a value corresponding to a pressure setting lower than that of the superheater safety valve. Each valve shall be complete with controller, solenoid, pilot valve and piping with two shut-off valves. 12.2.24.2.3 All steam safety valves shall be provided with adequately sized atmospheric relief to 1.0 m above the steam generator roof. Weather shields shall be provided at points where the relief pipes pass through the roof. It may be noted that only electromatic relief valve, first spring loaded safety valve and start up vents in super heater first spring loaded safety valve on steam separator are to be provided with silencers. 12.2.24.2.4 Staircases on either side of mills, and ESP with walkways and galleries shall be provided so that all areas of mills and ESP are safely and conveniently accessible for operation and maintenance. 12.2.24.2.5 Staircases shall be provided at front and rear of steam generators to quickly approach various floors. All staircases / platforms shall be provided with 2 rail safety handrails of 100 cm high and made of 32 mm GI pipe.		
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12.2.24.2.6	The minimum width of staircase shall be 1000 mm and the minimum width of platforms shall be 750 mm. The minimum width of interconnecting walkway between mill maintenance platform and the steam generator gallery shall be 1200 mm. All platforms and staircases shall be provided with gratings and only operating floor shall be provided with chequered plates.	
12.2.24.2.7	Actuators for remote operation of shut-off gates at the air inlets to coal mills and shut off gates at outlet of coal mills shall be provided to allow positive shut-off in the event of fire in the mills.	
12.2.24.3.0	<u>Control Valves For the System</u>	
12.2.24.3.1	The control valves and accessories shall be designed and tested in accordance with the latest applicable requirements of the code for pressure piping ANSI B 31.1, ASME boiler and pressure vessel code, IBR etc., and also in accordance with requirements of safety and health standards. The start up system control valves and HP&LP bypass control valves shall be of proven type in the same application.	
12.2.24.3.2	The design of valves shall meet the requirements of ANSI for dimensions, material specification and thickness. The sizing shall be suitable for obtaining rated flow with 80% stem travel and minimum flow with 10% stem travel. The valves shall be capable of handling 110 to 120% of rated flow. The valves port outer velocity shall not exceed 8m/s for liquid services, 150m/s for steam and 50% sonic velocity for flashing services. The valves shall be designed to avoid cavitations, wire drawing and flashing on the down stream side. Anti cavitation trim or trim cages shall be provided wherever necessary (CEP recirculation and Deaerator level control services).	
12.2.24.3.3	The valves construction shall be of globe body and straight pattern design, high lift cage guided one piece plugs & quick change trims, flanged and bolted bonnets (or welded bonnets as per manufacturers design), vacuum sealing for valves in service under vacuum conditions, valve characteristics shall match with process characteristics and extended bonnet construction when the temperature of fluid handled is more than 280°C. The valve body rating shall be as per ANSI B16.34	
12.2.24.3.4	The material selection shall be 316 SS with satellite facing for trims and body material suitable to pipe material for non-corrosive, non flashing and non cavitation services , Alloy steel ASTM A217 Gr WC9 valve body and 400 series SS for trim for flashing / cavitation services, 316 SS body and 316SS trim for condensate below 300 °C.	
12.2.24.3.5	The valve testing requirements are NDT and hydrostatic shell test, valve closure and seat leakage tests as per ANSI B16.34, valve and actuator	
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functional tests and CV test as per ISA 75.02		
12.2.24.3.6	All control valves shall be sized such that the valves are controllable over entire operating regime viz. low load to VWO flow condition. The control valves which require to be operated during cold, warm and hot start conditions shall also be controllable during the respective mode of operation. To meet the above requirements if CONTRACTOR provides more than one control valve, the controllable ranges of the control valves shall overlap to ensure bumpless transfer from one control valve to other. The control valves shall not cause noise and the noise level shall be within the permissible limits of 85 dB in A scale at a distance of 1.5 metre. For other requirements of control valve refer relevant C&I sections.	
12.2.24.3.7	Leakage class for the control valves shall be class V / class VI as per ANSI/FCI-70-2- 1976(R1982), depending on metal to metal seat or soft seats.	
12.2.24.4.0	<u>Burner blow out system</u> The fuel oil and atomising steam pressure shall be such that there should not be any oil traces entering the atomising steam system. The BIDDER shall explain in his bid the special features provided on this aspect.	
12.2.25.0	<u>MAINTENANCE REQUIREMENTS</u>	
12.2.25.1	The CONTRACTOR shall provide facilities for carrying out on-load and off-load maintenance of the steam generator and its ancillaries. In general, this should include adequate handling equipment, working space, platforms and safety devices.	
12.2.25.2	Access doors shall be provided to permit access to the furnace, superheater, the area between the tube banks, economiser and any other areas requiring access. Access doors on both sides of the pass shall be furnished. All access doors provided for furnace, ducts, etc., shall be of minimum 450 mm x 450 mm.	
12.2.25.3	Staircases on either side of the steam generator shall be provided. The angle of the staircase shall not be less than 45 degrees with vertical except in very critical areas. Staircases shall also be provided at the rear of the steam generator in the burner zone connecting burner platforms to enable operators to attend burner at other levels	
12.2.25.4	In order to carry out on-load maintenance, it is necessary that the equipment supplied can be readily disassembled, repaired and assembled in the shortest period. It should also be possible to attend to the equipment by a minimum disassembly of parts. The separator drain recirculation pumps shall be provided with adequate space for easy removal of pump	
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parts for maintenance. For RAPH it should be possible to replace cold end elements without disturbing / dislodging other elements / components of the RAPH. Arrangement for cooling the equipment and quick access shall also be ensured. 12.2.25.5 The operating/maintenance platforms around the furnace and equipment shall be very close to the furnace/ equipment casing and the clear gap shall not exceed 150 mm between edge and furnace/equipment casings. 12.2.25.6 Maintenance/access platforms for pulverised fuel, steam, water and oil piping and fittings and for dampers on air and flue gas ducts shall be provided. Access platforms, staircases and walkways with toe boards shall be provided for all the critical equipment viz. Separator drain recirculation pumps ,soot blowers, air preheaters, FD, ID , PA / GR (if required) fans, valves of critical services, transmitter racks, junction boxes, etc. 12.2.25.7 Material handling equipment consisting of monorails, hoists and trolleys (Electric operated) with all other ancillaries including supporting structure as required, shall be provided for FD, ID , PA / GR (if required) fans and fan drives, RAPH ,mills and for steam generator separator drains recirculation pumps. 12.2.25.8 One (1) no. per boiler approved type (Belgium) make furnace inspection and maintenance equipment (similar to sky climber) with two (2) wall coverage shall be provided. 12.2.25.9 A pent house shall be formed above the roof of the steam generator for attending to tubes and headers and thermocouples in this area. It shall be of a hot design having proper insulation of the casing to permit it to expand and contact with the furnace walls. In order to avoid fly ash infiltration, through the space around the tubes coming out from the furnace in this area, all welded seals between furnace gas pass and pent house shall be provided. Opening in the steam generator roof for introduction of cables shall be extended through the pent house in the form of pipe sleeves with caps so that cables could be introduced without entering the pent house. 12.2.25.10 Pent house roof, enclosures at firing aisle platforms shall be covered with pre coated metal sheet. 12.2.25.11 The pent house cooling shall be done by separate ventilation fans with air fans with air inlet openings at opposite ends. The capacity of the fan shall be optimum for safe and fast cooling of the pent house. 12.2.25.12 Arrangement shall be provided to carry out hydro test of CRH and RH coils. 12.2.26.0 <u>Hoists and Trolleys</u> 12.2.25.1 For the equipment which weighs above 1000 kg, electrically		
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operated type of hoists (chain pulley blocks) and trolleys shall be provided. For equipment weighing less than 1000 kg, manually operated hoists shall be provided. All blowers/fans/motors, gear boxes, etc. shall be provided with hoists and trolleys for maintenance purposes. Same specification is also applicable for STG and auxiliaries. ISSUE R1		

SECTION: C2

SPECIFIC DESIGN REQUIREMENTS

(STG AND ITS AUXILIARIES)

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1.0 <u>PERFORMANCE REQUIREMENTS</u> <u>General</u> 1.1 The steam turbine generator units will normally operate as base load units and in parallel with grid. During disturbances in the electrical grid, the units shall be capable of operating in an islanded mode catering to its own house load (about 5 to 6%) with a high pressure / low pressure (HP/LP) bypass system in operation. These disturbances shall not cause tripping of steam generator. <u>Heat and Mass Balance Data</u> 1.2 The steam turbine cycle heat and mass balance data shall be computed on the following basis at 100% TGMCR guarantee point : (a) Pressure drop in extraction steam lines of closed feed water heaters (high pressure and low pressure) shall not be more than 5% of the turbine extraction nozzle steam pressure (suggestive value). (b) Pressure drop in deaerator extraction steam line shall not be more than be 8% of the turbine extraction nozzle steam pressure (suggestive value). (c) Temperature drop in hot reheat line from reheater outlet to steam turbine interceptor stop valve shall not be more than 3⁰C (suggestive value). (d) Overall pressure drop between HP turbine exhaust and IP turbine interceptor valves for reheater circuit shall not be more than 10% of HP turbine exhaust pressure (suggestive value). (e) Required auxiliary steam flow tapped from cold reheat steam line shall be 1% of throttle steam flow. Thus the maximum make-up to cycle shall be 1% of throttle steam flow and the point of introduction of make-up shall be the condenser. 2.0 <u>MECHANICAL DESIGN REQUIREMENTS</u> <u>Introduction</u> 2.1 For the entire plant only those designs and systems shall be used which have been proven in continuous operation for a long time. Innovations and prototypes are not acceptable.		
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2.2	The plant shall have a working life of thirty (30) years. The equipment/components of the plant shall be designed for reliable and trouble free operation over the entire life of the plant. The plant shall be designed to achieve an availability factor of not less than 95% and plant load factor of 85 to 90%.	
2.3	All equipment/systems shall be designed to meet the requirements specified in this Section and in the various Data Sheet-As enclosed.	
2.4	BIDDER shall note that the steam turbine offered will be configured with a Pulverised fuel (PF) type steam generator (SG). In this regard, the BIDDER shall note that steam generator operation requirements during start-up, and operation particularly in respect of the acceptance criteria for steam pressure and temperature fluctuations shall be as per the requirements of SG.	
	<u>Steam Turbine and Accessories</u>	
2.5	<u>General</u>	
2.5.1	The steam turbine and accessories shall conform to the design and duty conditions specified in this specification and the Data Sheet-A1 of this Volume.	
2.5.2	The steam turbine shall be designed to meet the requirements of the latest IEC standard Publication No.45.	
2.5.3	The steam turbine shall be designed for quick start-up rates and to withstand rapid load fluctuations without causing undue thermal stresses and strains in the components of steam turbine. BIDDER shall provide suitable rotor and casing heating devices to meet the quick start-up requirement, if required. The axial clearances shall be carefully selected to allow for large differential expansions between the rotor casing during rapid start-up and shutdown without compromising steam leakage control. Each stage shall be individually aligned to set the clearance during manufacturing. The coupling spans shall be designed with sufficient length to avoid bearing unloading resulting from bearing support height changes or other abnormal causes. The moving end of the turbine / rotor movements / casing movements shall be provided with well proven support and guiding system such that sticking does not occur. Contractor shall furnish the details during detail engineering	
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21.6 <u>Steam turbine casings</u> 2.6.1 Casing shall be designed to withstand the maximum pressure and temperatures to which they are likely to be subjected to in normal service. In addition, the casings shall be designed to withstand 5 percent over rated pressure for short durations. Careful attention shall be paid to preservation of symmetry to maintain thermal balance and to requirements of rigidity and flexibility. The shape and thickness of steam turbine cylinders shall be uniform as far as possible and free from sharp corners or concentrations of material which would cause stress concentrations or distortions. Bidder shall indicate the casing design pressure. 2.6.2 Provision shall be made to take care of the effects of temperature changes on the alignment of rotating parts relative to casing and glands and for free movement of turbine cylinders due to expansion longitudinally and transversely. The design of casing shall be such as to permit inspection of all main bearings without dismantling the casings. The steam turbine casings shall have openings for insertion and inspection of balancing weights. The casing insulation shall be so arranged that it shall be possible to dismantle the casing with minimum removal of insulation. 2.6.3 The steam turbine casings shall be horizontally split at the centreline. Casing with horizontal joints shall be made steam-tight with metal to metal contact and without grooves, gaskets or joint compounds. If the design requires that the cylinder horizontal joint bolts be tightened under hot conditions, necessary bolt heating equipment and accessories with controls shall be supplied. Alternatively a barrel type of construction shall also be acceptable for the HP cylinder. In case of LP cylinder steam tightness at horizontal joint can be provided by suitable seals. Sufficient drainage facility shall be provided for all the casings with temperature sensors for sensing and effective removal water. The LP outer casing shall have pressure relief bursting diaphragms to limit the exhaust hood pressure with in safe margin from design pressure. 2.6.4 The low pressure outer casing shall be sufficiently rigid with stiffeners to withstand the external forces and loads exerted on exhaust hood under all operating conditions. The LP turbine outer casing shall be provided with a manhole on both sides of the turbine. LP casings shall be provided with completely self contained exhaust hood spray system to		
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protect turbine against excessive temperature due windage at no load, low load and HP/LP bypass operation. 2.6.5 The steam control valve block shall be proportional to avoid excessive thermal stresses. The steam control valve block if located external shall be supported independently of the main casing and shall be arranged to accept the piping forces during operation without transmitting these to the casing. The anchoring of the external steam control valve block and the steam turbine cylinder shall be such that both expand in same axial direction. 2.6.6 If heater above reheats point (HARP) cycle is offered for the regenerative feed cycle system with the top most extraction from the HP turbine casing the HP turbine with such construction shall be proven in service. 2.6.7 Thermocouples shall be provided on High pressure (HP) and intermediate pressure (IP) valve blocks and on HP & IP turbine cylinder top and bottom casing to indicate metal temperatures to enable evaluation of thermal stress levels . 2.6.8 Multiple inlet and exhaust branches shall be as far as possible be symmetrically arranged. All pipe connections, in particular main steam, cold reheat, hot reheat and extraction steam piping shall connect to the lower half of the casing wherever applicable so that removal of the top half casing for maintenance and overhaul can be achieved with minimum disturbance to pipes. Bidder shall note that only proven arrangements of connection of piping to the casing and cross-over piping between casings for same turbine model and same turbine configuration are acceptable. Such steam turbine generator shall also be in satisfactory commercial operation. 2.6.9 When jack screws are used as a means of parting contact on faces, the mating face shall be counter-bored to receive the jack screw in order to prevent subsequent scoring due to improper fit caused by marking. Dismantling of casing should possible with minimum removal of insulation, guide rods should be provided to prevent damage during erection and maintenance and bearings inspection should be possible with dismantling of casings. 2.6.10 Bolts, nuts and studs used for turbine casing flanges and main turbine components shall be with milled / rolled threads and of special alloy steel properly treated. Bolts shall be designed to distribute the load evenly on all the threads without stress concentration. All the joints shall have sufficient flexibility to remain tight with rapid changes of temperature.		
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2.6.11 The supports of the turbine on the foundation shall be designed considering the expansion and contraction of the machine during thermal cycling. Axial movements shall be allowed by fixing at one point and central position shall be maintained by fitted keys. Contractor shall provide inspection ports in turbine casing for boroscopic inspection. 2.7 <u>Steam admission valves</u> 2.7.1 The steam turbine shall be equipped with suitable HP and IP stop and governor controlled valves connected to speed governing system, complete with interconnecting piping and supports. It is preferable to provide the steam strainers independent of the stop valves. 2.7.2 The valves shall be: (a) arranged to close automatically when the overspeed governor operates and upon action of various protective devices. (b) equipped with easily removable steam strainers for normal operation and extra fine mesh strainers, if required, for initial operation. However integral strainer with valves are also acceptable provided they have facility for cleaning / replacement during maintenance period. (c) normally held open by servomotor operated with oil from the steam turbine control oil system and closed (against full steam pressure) by spring action. In an event of steam turbine trip or loss of oil, all valves shall close simultaneously. (d) located close to the steam turbine casings so as to keep the volume of residual steam to a minimum. (e) designed to allow blowing out the steam prior to start up and designed to avoid seizure under operating conditions. (f) stable and shall not vibrate and cause any unacceptable noise at high steam velocities. (g) designed to resist erosion due to steam flow. (h) lagged with adequate insulation. 2.7.3 The steam valves shall be thermally insulated to ensure a cooling rate which is similar to that of the related turbine casing.		
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2.7.4	The hydraulic mechanism operating the valves shall be simple and rugged and shall be designed for easy accessibility for inspection and maintenance of the valves. Each valve shall be equipped with a test device to permit complete or partial closing of one valve at a time, even when the unit is operating under full load.	
2.7.5	Provision shall be made for tripping of the turbine from the unit control room and for local manual trip from the steam turbine front pedestal.	
2.7.6	The HP and IP stop valves, if not mounted on the steam turbine casing, shall be connected to the steam turbine by piping flexible enough to avoid transmission of excessive forces and moments to the steam turbine casing. The piping shall be designed to limit the noise level due to flow of steam to within 85 dBA at 1.0m from the outline of the equipment.	
2.7.7	An internal pilot valve, if necessary, shall be provided in each emergency stop valve to enable the main valve to be opened against full steam pressure and to allow fine control of the steam flow during start-up.	
2.7.8	The tripping of all emergency stop valves, both locally and remotely shall be carried out by means of solenoid trip gear operating on DC supply. The solenoid trip gear shall be operable by means of local push buttons and push buttons on the unit control board and also automatically by any of the tripping devices.	
2.7.9	Adequate access to all valves for operation and maintenance purposes by means of permanent platforms and walkways shall be provided.	
2.7.10	The control valves shall have seats with facility to remove / replace them (after prolonged usage and erosion). Valves stem shall be made of wear resistant and oxidation resistant materials to provide reliable operation with a minimum of maintenance work. The NRVs (when provided) shall be fail safe design and suitable for on load testing. They shall be full bore type with minimum pressure drop, shall close during unit trip, shall be of proven design and the material shall be compatible to the material of piping on which it is mounted.	
2.8	<u>Steam turbine rotor</u>	
2.8.1	The steam turbine rotors shall be of forged steel, vacuum treated, heat treated and proportioned so that the critical speeds are away from the operating speed. Alternatively, the rotor could also be of proven welded construction. For each of the HP, IP and LP turbines Bidder shall	
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furnish the information regarding rotor structure, number of stages, blade length and average diameter at inlet and outlet of the turbines. For IP and LP last stages Bidder shall furnish the information regarding blade length, mean diameter and exhaust angle. 2.8.2 HP-IP or IP-LP rotor shall be single solid forging type. Prior to machining of the rotor forging, adequate number of test specimen shall be examined to ensure uniformity of material composition and strength. After machining and heat treating the temporary deflection shall be within the limit of clearances or 50 microns (whichever is smaller) and permanent straightness shall be assured at all operating temperatures. 2.8.3 After the assembly of the blades, each complete rotor shall be balanced for both static and dynamic conditions so that the assembled rotor shall perform satisfactorily under all operating conditions. The critical speed of the combined turbine and generator rotor shall not lie within a range of $\pm 10\%$ of the operating speed of 3000 rpm. However the vibrations shall be within the limits during such operation. 2.8.4 The vibration measured in any direction at the journals of the shaft shall not exceed the specified values when operating at all loads in the operating frequency range. The limits of vibration shall be within the limits as per ISO- 10816 band A for bearing vibrations and ISO- 7919 band A for shaft vibrations 2.8.5 Completed rotor including coupling shall be capable of withstanding without damage the shock loading and excess torque resulting from a generator short circuit. 2.8.6 The steam turbine rotors shall be connected to all other rotors with rigid bolted coupling. Facility for cleaning the turbine casings and rotors shall be provided and procedure for the same shall be furnished by the bidder. Forced cooling system of turbine system shall be provided , so that the turbine block can be cooled during emergency for quick access. 2.9 <u>Steam turbine blading</u> 2.9.1 The design of the steam turbine blades shall ensure high efficiency of energy conversion, without re-compression of the steam at the blade roots. The cross sectional area of the blades shall be adequately sized consistent with low loading, stressing and vibration considerations to ensure a high degree of availability. All nozzles and blades in the steam path shall be made out of corrosion and erosion resistant alloy steel		
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suitable for temperature encountered. All blades shall be securely and adequately anchored to the rotor and blades shall be replaceable at site. The blading shall be of high efficiency design and blade path optimization shall be carried out with the latest CFD tools. The blading shall be designed to minimise blade end leakage. 2.9.2 In the low pressure stages where the moisture percentage and the blade peripheral speeds are high, additional protection against erosion shall be provided. Bidder shall furnish the information regarding the erosion protection of the last blade rows. The method of fixture of the blades to the rotor shall have been satisfactorily proved by long use of operation. Care shall be taken to ensure that the natural frequency of the rotor blades is compatible with the rotational frequency of the machine varying over a range of - 5% to +3%. The blades along peripheral shall be suitably held with shrouding strips in HP stages. L-1 and L-0 LP blades shall be of free standing type. The free standing blades shall be independently tuned to avoid resonance during rotational frequency of -5% to +3%. Bidder shall provide the Campbell diagram for the last rotor blade of the LP turbine. Bidder shall indicate in his offer the percentage of moisture in turbine back -end. In order to prevent erosion and corrosion of the last stage blades of the turbine, the leading edge of the blades shall be protected. The blading shall be capable of operation with out failures and distortions during VWO condition. 2.10 <u>High temperature bolting</u> The design of all bolts subject to high temperature shall have adequate creep strength under all normal operating conditions. Necessary equipment shall be included for tightening turbine casing and steam chest flange bolts and one set of such equipment shall be supplied with necessary electric heating element or gas heating. The design and rating of the equipment shall be such that the bolting or unbolting operations require less time. Provision shall be made on high temperature bolts for direct measurement of imposed strain either due to tightening mechanically or thermally by means of suitable boreholes and by the use of depth gauges. One complete set of this bolt extension measuring equipment shall be provided. 2.11 <u>Bearings</u> 2.11.1 The turbine shall be provided with adequate number of amply proportioned bearings to maintain proper alignment and dynamic stability under all conditions of operation.		
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2.11.2	All bearings shall be spherically seated or other proven type seating, multi wedge and shall be of forced lubricated type, lined with suitable antifriction material. The bearings shall be of horizontally split type and provision shall be available for adjustment and alignment of the rotors. The thrust bearings shall be of the Kingsbury or equivalent tilting multi-pad type which shall withstand all normal and abnormal thrusts in either direction that can be experienced in service under the most adverse operating conditions. Turbine axial thrust to the extent possible shall be neutralised by opposing (double) steam flow, balancing piston features, etc.	
2.11.2	Each bearing oil drain lines shall have thermowells for inserting a thermocouple as well as a thermometer. Each bearing shall also be provided with duplex thermocouples embedded in the bearing babbit. The thrust bearing shall have embedded duplex type thermocouples on thrust (active) as well as surge (inactive) pads. Each bearing shall have the necessary instrumentation of adequate pick ups for remote sensing and monitoring of temperatures and vibrations(both horizontal and vertical) . At least two probes at 45 degrees apart for vibration measurements and also as input to the package of performance analysis diagnostic optimisation (PADO) . Local temperature indicators in bearing oil drains and RTDs for remote sensing shall be provided. All bearings shall be equipped with visual inspection of oil outlet via view glasses. The bearings shall be of insulated type or shall have facility like rotor shaft earthing device to prevent circulation of induced shaft current.	
2.11.3	Means shall be provided to indicate excessive axial movement of the rotor due to failure of thrust bearing, preferably combined with facilities to measure axial movement while machine is running.	
2.12A	Coupling The rotor shall be rigidly coupled by means of integrally forged flanges in effect forming a single shaft system. Fitted bolts with sleeves or any other proven arrangement with anti rotation pins shall be provided to prevent slippage under different operating conditions. The configuration designed shall be suitable for easy effortless dismantling, assembly and realignment and withstand loads and stresses as encountered in various operating conditions and conditions of short circuit etc. sufficient allowance shall be provided for reaming and honing of coupling holes for the entire life of rotors.	
2.12B	<u>Turning gear</u> The steam turbine shall be equipped with an hydraulic motor turning gear or AC motor driven turning gear for rotating the steam turbine rotor	
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at the required speed during a start-up or shut-down. Hand barring gear shall be provided for manually rotating the steam turbine generator unit in an emergency. The motive oil for the hydraulic turning gear shall be supplied from an auxiliary AC motor driven oil pump. The rating of the turning gear motor shall be for continuous operation to enable rotation of the steam turbine rotor while the hot shaft cools down and also for intermittent use during maintenance. 2. A pressure switch shall be provided on the main bearing oil header to provide the necessary interlock for preventing the starting of turning gear until adequate oil pressure has been established. The turning gear motor shall automatically trip on loss of bearing oil pressure. The turning gear shall be capable of being started locally / remote from unit control room. The turning gear shall automatically disengage and latch in a disengaged position when speed increases beyond limit. Manual hand barring facility shall be provided to rotate the rotor system in case of failure of drive motor or hydraulic turning gear. 3. To facilitate the turning gear operation, the shaft shall be lifted by means of jacking oil system. Also, provision to check the rotor lift and the jacking oil pressure before and after lifting of the rotor at each bearing shall be made. The turning gear drive arrangement shall not cause much hindrance with the removing of any part of the machine when dismantling the unit and at the same time easily accessible for any visual inspection/adjustment. The turning gear system shall have all necessary instruments and controls for remote operation. In case of A/c motor driven turning gear, provision shall be made for both local and remote operation. 2.13 <u>Steam turbine gland steam sealing system</u> 2.13.1 External shaft glands and inter stage shaft glands shall preferably be of spring backed labyrinth metallic type which shall allow for any temporary deformations of the rotor shaft without overheating the rotor due to friction. An automatic gland steam pressure regulation valve and de-superheater for temperature control , shall be provided. The choice of seal steam parameters shall be such as to facilitate easy supply of the same under varying operating conditions especially for hot restart. The turbine sealing shall be self sealing type during normal operation and shall require sealing steam supply from external source viz., from a high temperature or low temperature auxiliary PRDS or CRH line. 2.13.2 The steam turbine gland steam sealing system shall automatically control the pressure of the gland sealing steam under all operating conditions through a set of control valves and a desuperheater. During normal operation, the source of sealing steam shall be from the		
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turbine itself. During start-up and low loads, an alternative source of sealing steam shall be provided from the from external source viz., from a high temperature or low temperature auxiliary PRDS or CRH line. with an inlet a pneumatic actuated , modulating control valve , a bypass line with MO control valve , isolating valves etc. Necessary pressure reducing and desuperheating station for further pressure reduction shall also be provided. Another pneumatic actuated , modulating control valve shall be provided in the exhaust line from Header to condenser which maintains the header pressure during normal running of the unit. The switchover from this alternative source to the main source shall be automatically achieved above a certain set value of the load. On failure of impulse air supply, the control valves used in the gland sealing system shall be stay put or shall reach such opening/closing positions and shall continue to supply the glands with steam. Necessary remote operated bypass valves shall be provided and these shall be operable from the control room. The gland steam control valves shall be provided with isolating valves on either side to facilitate online maintenance. 2.13.3 A gland steam condenser sized for full condensate flow and an evacuation system consisting of two full capacity (2 x 100%) AC motor driven exhausters handling gland leak-off steam shall be provided. The gland steam condenser and exhauster shall be sized for condition with severely worn-out labyrinth gland seals of the turbine. System shall be designed to ensure the required minimum condensate flow through gland steam condenser during start-up and other normal/abnormal operating modes. 2.13.4 A standby gland steam evacuation system, shall also be provided. This standby system shall be used during the outage of the gland steam condenser for desuperheating and to exhaust the steam to atmosphere outside the turbine building. 2.14 <u>Steam turbine lubricating oil and control oil systems</u> 2.14.1 The system shall supply oil for the lubrication of the turbine and generator bearings, for actuation of various components of governing and control system, seal oil etc. The control oil system shall be separate from the lube oil system and provided with the same oil supplied from common main oil tank or may use separate oil and/or from separate oil tanks. The grade of oil to be used with complete specification for both control system and lube oil system shall be indicated in the offer. The system shall include sufficient standby equipment to allow any equipment (except turbine shaft driven main oil pump as applicable) to be taken out of service for maintenance without in any way affecting the output of the steam turbine unit. Oil system of each unit shall include the following:		
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<u>Oil pumps</u> 2.14.2 Centrifugal / gear type main oil pump (MOP) directly driven by turbine (if applicable) as per bidder's standard practice to supply control oil, bearing oil, seal oil etc. When the turbine is running at normal speed. The turbine shaft driven main oil pump shall be designed to maintain adequate lubricating oil pressure over the entire operating frequency without auxiliary oil pump cutting in. In addition of above 2x100% AC auxiliary oil pump for start up, shut down of TG unit and as standby to M.O.P. for automatic operation shall be provided. Each pump shall also be capable of startup, shut down of TG unit and stand by to each other for automatic operation to cater the above requirement. OR 2x100% AC oil pump as per bidders standard practice with capacity to cater lube oil for bearings and emergency seal oil requirements (if applicable for bidder design). Each pump shall be capable of startup, shut down of TG unit and stand by to each other for automatic operation to cater the lube oil requirement. Out of these two pumps one pump is to be kept on emergency bus 2.14.4 One (1) full capacity DC driven emergency oil pump, shall be provided to supply lubricating oil to the bearings. The pump shall be of self priming, centrifugal or positive displacement type preferably mounted integral with the main oil tank. The controls of the DC pump shall be fail safe with adequately rated minimum circuit breakers having atleast 100% design margin. The contactors shall be arranged for de-energised to start. 2.14.5 The emergency oil pump shall operate automatically under emergency steam turbine generator unit shutdown conditions and when the bearing oil pressure drops below a preset value. The stopping of the pump shall be manual. 2.14.6 If required, 2 nos.(1 working + 1 standby) AC motor driven oil pumps for control oil systems shall be provided. These pumps shall have auto start facility. If separate auxiliary oil pumps and control oil pumps are envisaged for lubricating and control oil system respectively, the capacity of pumps shall be designed depending upon the requirement. Accumulators and filtration equipment shall be provided to ensure maximum availability of the control fluid system during steady state and transient operating conditions. Fire resistant oil shall be envisaged for control oil.		
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2.14.7 Two full capacity jacking oil pumps: One of these pumps shall be one driven by AC motor (fed from emergency bus) and the other by DC motor, for the turbine and generator jacking oil system along with required piping, valves, safety valve, supports etc.. Oil piping and fittings 2.14.8 For all the lubricating oil inlet piping to the bearings, stainless steel piping shall be used from lube oil cooler outlet. All welded joints must be controlled 100% by means of radiography. All oil piping shall be arranged so that these shall be below or away from the high temperature steam piping or other heated surfaces. Preferably oil lines and steam lines shall be laid on different sides of the steam turbine. The return oil piping from bearings shall be of stainless steel piping and shall be provided with illuminated sight fittings or any other device to see the flow of oil depending upon the standard proven practice of the bidder. 2.14.9 All oil piping shall be encased in a guard pipeline running parallel to turbine axis and ultimately the guard pipeline shall be connected to oil tank. Alternatively, oil pipelines can be led through a concrete canal with suitable slope to the drain pit or collecting vessel. Alternatively proven type pipe-in-pipe concept can be used. <u>Main oil tank</u> 2.14.20 Each steam turbine generator set shall be provided with a main oil tank of adequate capacity. The capacity of the tank shall be so chosen that the full quantity of oil circulating through the system is retained for a controlled time ensuring thereby proper sedimentation and air removal. The capacity of the oil reservoir shall be adequate to contain total volume of the oil in the circuit (lube oil and control oil) and also sufficient space shall be available above "High oil level" to accommodate oil in circuit which will flow back to the tank when the unit trips. It shall be provided with removable type stainless steel strainers or carbon steel basket strainer with S.S. wire mesh and two oil level indicators. Level transmitters (2 Nos) and level switches to be connected to the supervisory control panel annunciation system and overflow type sight flow indicator with symphonic arrester device shall be provided. Two independent connection shall be provided for the tank - one for draining and sampling and the other to facilitate connection to oil purification system. The drainage system shall be foolproof against any mal-operation so as not to allow inadvertent oil drainage under any condition. Drain point shall be located at the geometric centre of the tank with necessary slope.		
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2.14.21 The oil tank shall be vented by two (2) 100% duty AC motor driven vapour extractors. The impellers and casings of vapour extraction fans shall be of material that will not cause sparking should a contact occur between them. The vapour extractor AC motors shall be explosion proof. 2.14.22 All oil vapour vents shall be provided with oil strainer/oil trap arrangements to prevent oil carry over to the atmosphere. Oil vapour fan shall have suction valve for independent operation and maintenance. 2.14.23 All vents shall be taken outside the building above the roof level. Horizontal vent pipe shall have a natural drainage back to the tank and suitable drainage arrangement for any oil build up shall be provided in the discharge piping of the extractors. 2.14.24 Internally, the tank shall be baffled to ensure maximum settling time for the oil. It should also provide adequate residence time for the oil to release the vapours. Apart from baffles, there should be no other equipment located within the tank. Adequate number of bolted covers shall be provided on top surface of the tank for access to each compartment for cleaning purposes and necessary access rungs shall be provided to permit safe and easy access for this purpose. All covers on the top surface of the tank shall be located on raised rims with gaskets. 2.14.25 The tank shall be provided with a full complement of isolating and drain valves, and also with a filling point fitted with a cover. The tank shall also be provided with feature like overflow sight glasses etc. to ensure a minimum oil level is maintained in the main oil tank. 2.14.26 The tank shall be sand blasted / painted internally with a suitable oil, heat and corrosion-resistant paint. In order to avoid welding at site which could damage the tank internal painting, all necessary pipe connections, etc. shall consist of flanged connections welded on the tank. In no case shall the tank be drilled and studs or bolts fitted from the inside of the tank. 2.14.26 The base of the tank shall slope to a common point to facilitate complete draining and an accessible valve with locking facility shall be provided in the drain line. The piping shall be provided from the drain valve to a suitable point from where the oil can be drained into the transfer or drain tank. 2.14.27 Sampling points shall be provided at suitable locations on the oil tank.		
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2.14.28 Switches shall be provided for initiating low level alarms. The switches shall be of the type which are completely sealed at the mounting point, such that leakage of oil through the switch is not possible. A visual oil level gauge shall also be provided and shall be capable of being read local to the tank. 2.14.29 VOID. 2.14.30 Separate duplex 100% capacity filters each shall be provided in the common lubrication oil feed line and jacking oil line. A full flow filter on discharge side of each A.C control oil pump shall also be provided. 2.14.31 The changeover from one filter to the other shall be possible without a reduction in flow or a momentary drop in pressure. The changeover valves shall be interlocked or arranged so that it is not possible to inadvertently cut off the supply of oil to the plant. A differential pressure gauge and differential pressure switch shall be provided on both filters. Adequate provision shall be made for draining and venting the section of filter undergoing maintenance. The degree of filtration shall be consistent with satisfactory operation and wear life of the turbine generator bearings, gears and other lubricated items. 2.14.32 The lubricating oil pressure shall be sensed after each final filter for the purpose of cutting in and cutting out the standby and emergency pumps, and for initiating a low oil pressure alarm at one level, followed by a trip initiation at a lower level. 2.14.33 The lubricating oil filters shall be positioned as close as possible to the feed points of the machine. The pipes from the final filters to the machine connection points shall be fabricated from stainless steel. <u>Oil coolers</u> 2.14.34 Two (2) 100% oil coolers shall be provided for the turbine and generator oil system. The coolers shall be separately mounted self contained type. The coolers arranged to be integral with the lubricating oil storage tank are not acceptable. 2.14.35 The coolers shall be provided with changeover facilities such that under all operating conditions upto full load a changeover of cooler can be effected without throttling the oil supply to the unit. The changeover arrangement shall be such that one cooler cannot be isolated before the second is in service. 2.14.36 Oil coolers shall be designed for cooling the oil with cooling water utilising tubular heat exchange surface, the water side pressure of the oil coolers shall be lower than the lube oil pressure to prevent		
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water leakage into oil side, if there is any tube leakage. A temperature control valve shall be provided at the outlet line , to control the oil temperature , which automatically mixes the cold and hot oils as per the requirement. Alternatively oil cooler can also be of plate type heat exchanger if it is the standard practice of the bidders. 2.14.37 The tube plates shall have provision for differential expansion between the cooler shell and the tube bundle. If a floating tube plate design in the cooler is used, it shall be arranged such that any leakage past the floating plate shall be suitably collected and drained. 2.14.38 The cooler shell shall be constructed of carbon steel and shall be fitted with an air vent at the highest point and a drain valve at the lowest point. 2.14.39 The cooler waterboxes shall be of fabricated steel, the highest point of each waterbox supplied with a vent connection. The relief valve and all drain and air release valves shall be provided with pipe work leading to the nearest convenient drain trench. 2.14.40 The coolers shall be supported such that the waterboxes can be removed without difficulty and adequate access to the tube plates is possible. 2.14.41 The coolers shall be provided with necessary temperature indicators for measurement of oil and water temperatures at inlet and outlet. 2.14.42 Provision shall be made for removal of top cover of water section of oil cooler for facilitating cleaning of oil coolers. <u>Oil purifier</u> 2.14.43 An AC motor driven centrifugal type oil purifier or a static type oil purifier shall be provided for water and sludge removal from the lubricating oil. The purifier shall be provided with an hourly capacity of not less than 10% of the total oil quantity in the lubricating oil system and shall be permanently connected in bypass to the lubricating oil system in such a manner that it can be continuously operated when the turbine generator is either running or shut down. 2.14.44 The purifier shall be fully self-contained on an oil tight base plate and shall be provided with all necessary pipe connections. The material for the rotating parts of the centrifuge shall be high grade stainless steel AISI 316 or equivalent. Other parts in contact with the oil shall be of stainless steel . The casing shall be of cast iron or carbon steel construction. The construction shall be vapour tight.		
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2.14.45 The arrangement of the assembly shall enable easy removal of the collected solid particles within a short time. The rotating parts shall be statically and dynamically balanced. 2.14.46 Suitable interlocks shall be provided to prevent operation of purifier unless necessary pumps are in service. Safety devices shall be provided to alarm and trip the centrifuge in the event of centrifuge sealing failure. Pumps required for purifying unit shall be of positive displacement type with at least 110% of the normal purifier capacity. Each pump shall be provided with adequate relief bypass valve to prevent damage from excess pressure. Necessary indirect heating system shall be provided 2.14.47 Polishing filter The polishing filter shall be capable of filtering moisture and particle above 2 micron. The filtering elements shall not remove inhibitors and other additives from the lubricating oil. The filter shall be designed for the maximum discharge pressure of the pump supplying to the filter. The vessel shall be designed in accordance with ASME pressure vessel code or equivalent. The vessel shall be fitted with a pressure relief valve. <u>Oil piping</u> 2.14.48 For all the lubricating oil inlet piping to the bearings, stainless steel piping shall be used from lube oil cooler outlet. All welded joints must be controlled 100% by means of radiography All oil piping shall be arranged so that these shall be below or away from the high temperature steam pipes or other heated surfaces. Preferably oil lines and steam lines shall be laid out on different sides of the steam turbine. The return oil piping from bearings shall be provided with illuminated sight fittings or any other device to see the flow of oil depending upon the standard proven practice of the bidder. 2.14.49 All oil piping shall be encased in a guard pipeline running parallel to turbine axis and ultimately the guard pipeline shall be connected to oil tank. Alternatively, oil pipelines can be led through a concrete canal with suitable slope to the drain pit or collecting vessel. 2.14.50 All bearing drain lines and oil lines shall be provided with visual indicators for observation from a local platform or operating floor level.		
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2.14.51 BIDDER shall provide necessary provisions along with isolation valves in the lube oil system for filling and draining lube oil from/to existing clean and dirty oil tanks. 2.14.52 <u>Steam turbine control fluid system (if applicable)</u> (a) Fire resistant fluid/mineral oil shall be employed for the control system, if separate control fluid system is offered. (b) The system shall comprise a fluid reservoir, pumps, drive motors, coolers, strainers, piping, valves and fittings, instrumentation and control hardware and purification system. Duplication of pumps, coolers, accumulators and filtration equipment shall be adopted to ensure maximum availability of the control fluid system during steady state and transient operating conditions. Provision shall also be made for initial venting of control oil system. <u>2.14.53 Central Turbine oil storage system</u> A central turbine oil storage system common to two STG units shall be provided for transferring and storage of oil to facilitate maintenance and cleaning of the unit oil tank. The system shall be complete with a dirty and a clean oil tank, each of capacity to contain the total oil requirement of one unit. One central oil purification unit shall clean the oil in the dirty oil tank and pump it to the clean oil tank or pump back to the units through polishing filter. The clean oil tank shall be arranged to receive fresh oil supplied to the power station. One dirty oil transfer pump and one clean oil transfer pump shall be provided for transferring oil respectively from the main oil tank of the individual units to dirty oil tank and from the clean oil tank to the main oil tanks of the respective units. Suitable arrangements shall be provided to dispose of the oil sludge from the oil tanks to adhere to the pollution norms. The tanks shall be sized to accommodate total quantity of oil from one unit. 2.15 <u>Turbine and integral piping drains</u> 2.15.1 The steam turbine drain system shall be designed in accordance with the recommendations outlined in ASME Standard No. TDP-1 for protection against water induction to the steam turbine. All parts of the turbine and steam pipe work where water is liable to collect shall be drained and wherever possible any clean drainage shall be recovered and returned to the condensate system. The drainage system shall be provided to the following minimum equipment / piping a. MS,CRH and HRH lines		
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b. MS stop and control valves c. Reheat stop and interceptor valves d. steam lead and turbine drains e. Steam sealing system f. HP/LP bypass valves, piping and warm up system g. Turbine extraction system The drains from turbine casings, integral drains, MS and Reheat stop & control valves etc. shall be connected to a turbine flash tanks which is brought in to service during start ups. The drains from MS,CRH, HRH , HP bypass and LP bypass , seal steam piping etc. shall be connected to HP and LP flash tanks depending on the pressure. The drains from MS, HP/LP bypass piping shall be connected to a unit flash tank which is used during start ups. The drains from HP,LP and turbine flash tanks shall recovered by connecting them to condenser both on vent and drain sides. The vent from unit flash tank shall be led to atmosphere and drain to station drainage system The flash tanks shall be adequately sized for the required drainage during various operating conditions and shall be designed as per ASME boiler and pressure vessel code. Temperature in the flash tanks shall be maintained using spray water system tapped from suitable source(condensate system). The tanks shall be vertical type with tori spherical or hemi spherical heads, shall be located on ground / mezzanine floors, provided with gauge glasses. The materials shall be ASTM 285 Gr C for shell, head, wear plate or equivalent. 2.15.2 The steam and condensate drain systems provided shall be complete from the point of drainage to the final disposal points. They shall provide for safe and efficient start-up and operation of the STG unit and be controlled remotely and automated as described in this specification. 2.15.3 Each drain shall be separately controlled and piped separately to its point of discharge to avoid preferential draining which would tend to occur under conditions of different system resistance. Drain pipes shall be continuously sloped towards the point of discharge. 2.15.4 Internal drains shall be provided on the steam turbine to ensure that water will not collect in the casings. All equipment required for the drain system shall be included under this contract.		
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2.15.5 Drains and vents to be recovered into the condenser will be discharged into flash tank / tanks with desuperheating spray arrangement for different pressure groupings. The drains through the inlet nozzles to the flash tank shall be fed inside the flash tank through distributors to avoid direct impingement on the flash tank shell. The flash tanks shall be provided with manholes having hinged and bolted manhole covers for inspection and cleaning. The contractor shall include details of all such flash tanks. The design of the flash tanks, the condenser and any drain or vent connections or vent orifice shall be such that preferential draining due to pressure effects does not occur. Flash tank shall be equipped with condensate injection. 2.15.6 The drainage from the turbine cylinders, steam chests, loop pipes shall be controlled by one motorised isolating valve and one manual isolation valve mounted in series. The main valve shall be suitable for throttling and the second valve shall provide complete isolation. The drain valves shall be installed to have easy accessibility for inspection and maintenance . 2.15.7 All drain valves required to be operated during start-up and shut-downs shall be power operated and arranged for remote operation. Drain pipes between drain valves and flash tank shall be of the same material and shall as a minimum have the same tube dimension and metal thickness as the pressure pipe before the drain valve. 2.15.8 The drain valves and traps shall be readily accessible and conveniently grouped for local operation and maintenance. The use of drain traps shall be kept to a minimum and shall be subject to the approval of the PURCHASER/ENGINEER. The steam traps shall be of an approved type and as far as possible of similar design and construction. The traps shall be of the thermostatic type. All traps shall be arranged such that wearing parts are readily replaceable. Each trap assembly shall include bypass valve(s) (double isolation is required for high pressure applications) and shall be neatly and compactly installed in the form of a self-contained unit located in a position readily accessible for valve operation and maintenance. 2.16 <u>Steam turbine governing system and accessory equipment</u> 2.16.1 The steam turbine generator unit shall be equipped with a electro-hydraulic or electronic speed governing system capable of controlling and regulating the speed of steam turbine in conformity with performance characteristics specified. . It shall include necessary speed / load/pressure/ frequency controllers, load limiter, speed / load changer.		
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2.16.2	The governor shall be configured in dual redundant hot standby system architecture to ensure continuity and safety to failure for all single defects and for a very high proportion of multiple defects. Considerable emphasis shall be placed on segregation of redundant parts of the system to minimise the effects of common mode faults. The concept of redundancy shall be carried through to the power supplies which shall be duplicated and shall be arranged so that a single supply failure will not affect operation of the equipment.	
2.16.3	The control system shall: (a) have provisions for tripping and resetting the steam turbine (b) provide the logic and signals for starting the steam turbine from turning gear speed and accelerating safely to rated speed at pre-selected selectable from man machine interface (MMI), in conjunction with turbine/rotor stress evaluator system (c) provide signals for loading and unloading the steam turbine after synchronisation in conjunction with turbine / rotor stress evaluator system and coordinated master control implemented in distributed control system loading and unloading rates shall be selectable from MMI. (d) facilitate on-load testing of all steam stop valves individually on a periodic basis sequentially, On-load testing of turbine protections individually sequentially on a periodic basis; annunciation contacts for PURCHASER's use for suspended conditions during sequential testing (e) have provision for self-monitoring of redundant circuits (f) be capable of accepting and providing necessary signal exchange with master control as required with control system / MMI (g) Facility to run down the turbine in case of troubles external to unit <u>Governor performance characteristics</u>	
2.16.4	The speed governing system shall be capable of controlling with stability the speed of the turbine at all power outputs between zero and specified maximum power output, when the unit is operating isolated or in parallel with other units.	
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2.16.5 The governing system in association with the overspeed prevention devices shall limit the speed of the unit to a value less than the trip setting in case of a full load trip out. 2.16.6 The steady state speed regulation shall be within the range of not less than 3.5% and not more than 5% when the speed changer specified herein is set to give rated speed with rated power output and shall be capable of adjustment between 2.5% and 7%, inclusive, at this setting, in steps not exceeding 0.5%. The dead band at rated speed and at any power output within the rated power output shall not exceed 0.06% of rated speed. <u>Additional features in governing system equipment</u> 2.16.7 The governing system shall include other governing system equipment viz. Load shedding relay for main steam control valve, interceptor control valves, etc. Fast responses may be required in the event of sudden load reduction to either a partial or zero load. 2.16.8 Suitable provision shall be made for testing the action of the auxiliary governing system equipment without taking the steam turbine unit out of service. HP exhaust controller shall be envisaged, if required. <u>Emergency overspeed trip device</u> 2.16.9 The steam turbine shall be equipped with independent safety devices in the form of duplicate emergency overspeed governor(s). These shall be mounted on the steam turbine shaft or the function can be realised electronically in control room and shall be arranged to actuate a tripping device at a predetermined speed which will rapidly close the emergency stop, & control valves and reheat stop & control valves and also by DCS the non return valves in the extraction lines for speeds of about 110 % of the rated speed. . Means shall be provided for adjusting the speed setting of this with the unit shut down. 2.16.10 System shall be capable of being reset by operator when the speed is reduced to approximately normal thus permitting the machine to be synchronized with other units. The emergency over speed governor shall be provided with means for testing its operation when the machine is on load without exceeding rated speed of the unit. A duplicate governing system or through a facility realised and integrated in the turbine controller shall be provided so that the emergency valve remains active during the test. In addition to the above, as a third safety element to protect the turbogenerator in the event of failure of over speed limiter or		
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turbine stop valve close, a trip shall be provided in the form of trip signal generated from the speed measuring element of the governing system to close the motorized boiler stop valves. <u>Load limiter & Speed changer</u> 2.16.11 The turbine shall be provided with electronic type speed changer to control its speed or power output within limits remotely from the turbine generator supervisory panel. This speed changer provided shall be capable of adjusting the speed of the turbo generator set to any value upto a maximum of 103% to 105% of rated speed, (manual/auto) for synchronising the generator with the bus. It shall be capable of varying the load on the machine from no load to full load. The speed droop or speed regulation shall be adjustable within 2.5% to 7% . 2.16.12 The load limiter shall be electronic type included in turbine DEHC. Remote position indicator shall be provided for indication of the setting of the load limit on the turbine generator in control room. 2.17 <u>Steam turbine protection system</u> 2.17.1 The protection system of the steam turbine generator, accessories and auxiliaries (i.e including regenerative feed water heating system) shall be designed to provide maximum degree of protection while maintaining sufficient simplicity to ensure reliability, maintainability and a minimum of nuisance shutdowns. The system circuitry shall ensure reliability of system in case failure of single components. 2.17.2 The turbine tripping system shall be designed as a triplex system operation on the basis of two out of three majority voting. All critical trip functions shall have separate triplicated initiating contacts and logic processing shall be carried out by three independent channels of electronic logic circuits. 2.17.3 Essentially the protection system shall include but not limited to the following: (a) Manual trip from control room and from local (b) Mechanical over speed trip or over speed trip realised electronically with minimum 2 out of 3 redundancy (c) Manual trip lever on turbine front pedestal or trip mechanism realised electronically with minimum 2 out of 3 redundancy, electrical over speed trip with sensors independent from speed governing sensors (with triple sensors)		
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(d) Electrical overspeed trip with sensors independent from speed governing sensors (with triple sensors) (e) Thrust bearing wear trip (with triple sensors) (f) Condenser low vacuum trip (with triple sensors) (g) Lube oil pressure low trip (with triple sensors) (h) Control oil pressure low trip (if applicable with triple sensors) (i) Relative vibration high trip (sensors as applicable) (j) Main steam temperature high trip (with triple sensors) (k) Main steam temperature low trip (with triple sensors) (l) Exhaust steam temperature high trip (with triple sensors) (m) Generator trip (n) Reverse power relay operated trip (o) Under frequency relay operated trip (p) Boiler trip operated trip (with triple signals from PURCHASER) (q) Power failure for turbine control and protection system (triple signals) (r) Turbine shaft vibration protection (vibration of HP, IP & LP turbines) (s) Top and bottom casing differential temperature protection or measurement sensors for alarm. (t) HP exhaust temperature protection. (u) Top and bottom turbine casing differential expansion protection (v) Bearing metal temperature high alarm and/or trip (w) DCS trip, rotor stress evaluator (RSE) trip or residual stress alarm		
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(x) DEHC - RSE hardware serious malfunctioning (only for alarm) y) Manual trip near Main oil tank to be operated in case of fire. (z) Any other trips recommended by manufacturer (which shall be triple sensors) 2.17.4 The steam turbine shall also be provided with following protection devices : (a) <u>Initial Pressure Regulator</u> The steam turbine shall be provided with an initial pressure regulator to decrease the steam flow to the turbine when the main steam pressure drops to a pre-determined low set-point and shall continue to decrease the steam flow in proportion to further drop in main steam pressure. The device shall be so arranged that the steam turbine is not automatically reloaded with restoration of main steam pressure. Initial pressure regulator shall be provided if the same is part of the Electro Hydraulic Governing system. (b) <u>Vacuum Unloading Device</u> If recommended by the steam turbine manufacturer, the steam turbine shall be provided with a vacuum unloading device which shall limit the steam flow to the unit when the condenser pressure reaches a preset high value and shall continue to decrease the steam flow in proportion to further increase in condenser absolute pressure. Automatic reloading of the unit with restoration of vacuum is not desirable and provision shall be made for resetting the same. Vacuum unloading device shall be provided if the same is part of the Electro Hydraulic Governing system (c) <u>Protection against Water Induction And Over speeding</u> (i) The steam turbine extraction steam lines to the regenerative feed water heating system shall be provided with pneumatically operated quick closing non-return valves. These shall close automatically when the steam turbine is tripped, to prevent any back-flow of steam from the heaters into the steam turbine. The non-return valves in the extraction steam lines to heaters shall also close on heater high level, to prevent water induction into the steam turbine.		
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(ii) Provision shall be made for on-load testing with signalling of the individual non-return valve. Group testing will not be accepted. (iii) One pneumatically operated quick closing non return valve shall be provided in each of the extraction steam lines in series with flap type non-return valve on the closed feed water heaters. The extraction steam line to the deaerator shall be provided with two pneumatically operated non-return valves in series. Differential pressure across the two pneumatically operated non-return valves shall be monitored for protection purpose. (iv) A pneumatically actuated quick closing type non-return valve on each of the cold reheat lines shall be provided to safeguard against the back flow of steam into HP turbine through its exhaust side while HP bypass is in operation. 2.17.5 <u>Exhaust temperature limiting equipment</u> The turbine exhaust shall be designed for recovery and optimization of the leaving velocity. The turbine exhausts shall be suitable for connecting to the condenser through dog bone type stainless steel expansion joint or any other proven expansion facility. The unit shall be provided with complete turbine exhaust spray water system, complete with spray nozzles, a controller, an automatic spray water control valve and all interconnecting piping between the nozzles and the spray water control valve. The spray water shall be taken from discharge of condensate extraction pump and shall limit the steam temperature at the exhaust under abnormal conditions and sustained very low load operation. 2.17.6 <u>Pressure relief diaphragms</u> The exhaust hood shall be equipped with pressure relief self closing type disc of sufficient area to pass the MCR condenser flow. These pressure relief self closing type disc shall open if the exhaust hood pressure reaches a predetermined value and closes by its self weight 2.17.7 <u>Vacuum breaker valves</u> To permit the turbine rotor to be brought to rest as quickly as possible whenever required necessary vacuum breaker permitting the rapid reduction of vacuum in condenser shall be provided. Provision shall be		
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made for remote operation of vacuum breakers. Vacuum breaker valves shall be capable of being operated remotely from the control room. 2.18 <u>Steam turbine supervisory equipment</u> 2.18.1 The steam turbine supervisory equipment shall indicate and record the behaviour of the steam turbine under varying conditions and provide adequate warning of the development of potentially dangerous steam turbine conditions. The steam turbine supervisory equipment shall include detection and recording of, but not be limited to the following : (a) Bearing & Shaft vibration (b) Shaft eccentricity (c) Differential expansion (d) axial shift (e) Overall expansion (f) Vibrations in the bearing pedestals (g) Steam turbine speed (h) Load (i) Emergency stop and governing valve positions (j) Interceptor stop and governing valve positions (k) Load limiter position (l) Speed Changer Position or suitable indicator if digital electro hydraulic governor is used. (m) Inlet steam temperatures and pressures (n) Metal temperature (o) Cylinder/flange metal temperatures, top and bottom casing temperatures including differentials (p) Bearing metal temperatures		
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(q) Body metal temperatures of main and reheat steam stop and control valves. ® Oil drain temperature. (s) Turbine stress evaluator capable of maintaining the thermal stresses within allowable limits and suitable integrated in to plant DCS. 2.18.2 The measurement of speed shall be derived from proven speed detectors. Speed recording facilities shall be included in plant DCS for start-up, normal operation and shutdown. 2.18.3 The vibration detector characteristic shall be such that the detector is adequately damped at its resonance frequency when the machine is starting up or shutting down. The vibration detector response range shall be sufficient to cover the critical speeds for the machine. 2.18.4 The shaft-vibration detector shall also be suitable to follow the shaft displacement during turning gear operation, with a view to closely monitor the eccentricity. On line condition monitoring of the systems for the turbine shall also be provided. 2.18.5 Suitable twin element thermocouples for measurement of temperature of steam in High pressure Casing (HPC) after Curtis wheel, HPC exhaust bowl, intermediate pressure casing (IPC), inlet bowl, etc., shall be provided. Twin element thermocouples shall also be provided for the measurement of metal temperature of ESV bodies, interceptor valve bodies, IPT steam admission pipes, HPC (upper and lower), , IPC (upper and lower), metal of bearings of turbine etc. Two resistance thermometers each for measurement of temperature of steam in LPC exhaust and of the temperature of drain oil from the bearings of turbine, generator etc. shall be provided. 2.19 <u>Automatic turbine run-up system (ATRS)</u> 2.19.1 The ATRS is envisaged to run-up the turbine automatically, synchronise and load the unit as required in case of a cold, warm or hot start-up. The ATRS shall also suitably co-ordinate with the steam generator and steam bypass system. The ATRS shall also be capable of automatic controlled shut-down of the STG.. 2.19.2 The system shall be based on functional group control philosophy dividing the various system/equipment associated with turbine start-up into functional groups. Each functional group shall be further sub-divided in sub groups control, sub-loop controls and control		
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interfaces. It shall be possible to intervene manually from unit control room at any level i.e control interfaces sub-loop and sub-group control. These functions shall be suitably integrated into its own STG control system. 2.19.3 The TG set shall be equipped with ATRS to enable the turbine to run automatically from zero speed to synchronising speed and thereafter loading to pre determined load without system jerks and over stressing of turbine. The system shall include all instruments and controls to ensure running of the machine, within the safe limits of rotor stress values during run up and loading/unloading and facilitate fast loading rates within permissible limits. The system shall also protect the machine from thermal stresses beyond permissible limits and other operating conditions that may jeopardize the safety and /or life of the machine. The system shall be provided with operational flexibility to enable the operator to select any mode/step of the operation at any stage. In case of any abnormality arising at any step during the run-up of the machine, the system shall bring back the machine to a safer stage. The system shall provide running the machine through critical speeds as quickly as possible. 2.19.4 The system shall be reliable, compact and self contained with self checking facility by using redundant functions and overall system monitoring. System shall be provided with adequate status indications so that the sequence status, malfunctions, unsafe and unhealthy condition can be immediately annunciated and brought to the notice of the operators. All set points shall be adjustable type to match with the operating parameters of the unit and the logic system. <u>2.20 Automatic Turbine Testing System (ATTS)</u> 2.20.1 An automatic sequence for testing safety devices shall be provided. The testing shall not cause any unintentional shutdown and shall provide full protection to turbine during testing. It shall cover the following safety devices. a) Trip solenoid valves b) Overspeed trip. c) Loss of Vacuum trip. d) Thrust bearing failure trip (from software) e) Low lube oil pressure trip.		
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For Loss of Vacuum trip and Low lube oil pressure trip, a continuous integrity check of the measuring channel is performed automatically by Turbine Tripping System. A local gauge board housing the indicating instruments shall also be provided. <u>2.21 Steam Turbine Bypass System</u> 2.21.1 The steam turbine shall be provided with electro-hydraulic operated HP and LP bypass system to condenser. The HP-LP bypass system shall be designed to safely and reliably control the flow, pressure and temperature of steam bypassing the HP and intermediate/low pressure sections of steam turbine during the steam turbine trip and during major load rejections so that the steam generator can safely be kept on-line. The HP bypass capacity at HP bypass valve inlet shall not have less than 60% SG MCR capacity. For major load rejection, the HP-LP bypass shall be capable of co-ordinating the steam turbine and steam generator such that the steam turbine will be required to carry only its own house load. The speed of initial operation of control system shall be such that the possibility of steam generator safety valves lifting is minimised. The HP and LP bypass valve shall fast open to a required level on turbine protection (other than low condenser vacuum) command or the steam inlet pressure increases beyond a preset limit. The HP bypass control valves shall have the stroking time of not more than 3-4 seconds for fast opening and 10-15 seconds for normal stroking. The spray water system for temperature control shall be compatible with these HP bypass control valve requirements. The oil system shall be of self contained unit and shall have 100% standby oil pump with necessary valves for isolation and maintenance. Hydraulic accumulators shall be provided to ensure positive supply of oil to hydraulic actuators even when main and standby oil pumps are not available. Accumulator shall be adequately sized to ensure supply for two complete stroking operations of all connected actuators. All control valves shall be of tight shut-off design and the actuators shall be designed for maximum shut-off differential pressure acting across the valve. Low noise trim shall be provided to limit the noise level to 85 dBA at a distance of 1.5 m from outline of valve at all operating conditions. 2.21.2 In addition to the above, the HP-LP bypass system shall be capable of controlling the flow, pressure and temperature of the steam bypassing the steam turbine HP and IP/LP sections prior to start-up of steam turbine unit for cold, warm and hot start condition. In this mode of operation, the system shall enable auto and manual loading of steam generator to a stable firing condition and bring steam pressures and		
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temperature to the values required for turbine metal temperature matching purposes. 2.21.3 The HP-LP bypass system shall be designed to take into account all anticipated operating conditions and regimes 2.21.4 The HP bypass valves shall operate under separate dedicated upstream pressure responsive control and the spray water desuperheating under downstream temperature/ pressure responsive control to reduce the conditions of steam leaving the bypass system to the conditions acceptable to reheater in terms of pressure and temperature. The spray water for HP bypass valves shall be from the boiler feed pump discharge. 2.21.5 The LP bypass valves shall operate under separate dedicated upstream pressure responsive control and the spray water desuperheating under downstream temperature/pressure responsive control to reduce the conditions of steam leaving the bypass system to conditions acceptable to condenser in terms of pressure and temperature. The spray water for LP bypass valves shall be from condensate extraction pump discharge. 2.21.6 The HP bypass valve shall be controlled to a set point relating to main steam pressure and temperature. 2.21.7 The LP bypass valve shall be controlled to a set point relating to reheat steam pressures. 2.21.8 The HP-LP bypass system shall rapidly shutdown upon detection of low spray water pressure, high steam temperature downstream of desuperheating stations and high reheater / condenser pressures. 2.21.9 Special attention shall be paid to provision of warming up drains as close to the bypass valves as possible in order to minimise thermal shock on bypass valves and upstream pipe work when bypass comes into operation. The warming up line of HP and LP by pass lines shall be from the bottom of the line in the upstream and connected as near as possible in the downstream of Bypass valves. 2.21.10 The systems down stream of HP-LP bypass valves shall be capable of withstanding the thermal shock due to failure of spray water. 2.21.11 The HP and LP bypass system shall preferably have a common oil supply unit or proven separate oil system with necessary accumulators. This shall not be combined with turbine oil system. The oil system shall have adequate protection by suitable annunciation against fault in the		
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power supply unit and in the oil supply unit. The oil system piping shall be of Stainless steel construction. The oil supply unit shall have inbuilt purification equipment and shall also be provided with suitable level gauge 2.22 Surface Condenser and Accessories 2.22.1 The condenser shall be designed to receive and condense the whole of the exhaust steam from the turbine including steam dump system and other drains and vents under all modes of operation. The condenser shall be designed for a temperature raise between 9 and 11⁰ C only in the cooling water circuit. The condenser design shall be of proven type and shall be designed according to HEI (USA) standards 2.22.2 The condenser shall be such that the condenser pressure, corresponding to a sustained HP-LP bypass system operation at its full open condition and turbine operation at maximum condenser cooling water inlet temperature does not exceed the turbine trip value for the condenser pressure. The design shall take of the worst conceivable air leakage in to the condenser and the minimum oxygen content in the condensate leaving condenser shall not exceed 0.02cc per litre over the entire load range. The Hotwell make up is normally from DM water system. The sizing shall be for turbine valve wide open condition (VWO) flow and three minutes storage in hotwell. 2.22.3 The location and design of steam and water dumps to the condenser shall be in accordance with ASME Standard TDP-1, Part-1. Provision shall be made to install LP heaters in the neck portion if required. 2.22.4 The VENDOR shall also take into account the following aspects in respect of condenser design: (a) Adequate priming and vent systems for initial operation and elimination of water hammer shall be provided. (b) The condenser shall be capable for part load operation of the STG unit with one half of condenser out of service. This operation, however, will be for short durations only. (c) Proper flow pattern of circulating water shall be provided at the tube inlets to prevent erosion at inlet side. (d) The condenser shall be designed to prevent the flow induced vibrations of tubes under all operating conditions which could cause mechanical failures.		
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2.22.5 The condenser design shall provide for adequate bowing or sloping of tubes to ensure complete drainage of the tubes. Adequate arrangement and space shall be provided at the rear of the condenser to facilitate the removal of condenser tubes. Also turbine foundation columns shall be suitably placed to enable easy operation of rear water box door 2.22.6 To prevent tube erosion at the points of admissions of drains and vents from equipment/piping system alloy steel plate baffles or alloy steel perforated distribution headers shall be provided. The dispersers for introducing steam/water into the condenser shall give a finely dispersed spray to obtain maximum deaeration and shall, as far as possible, be arranged to spray against the direction of flow of the condensing steam. 2.22.7 A vacuum grid shall be fitted to ensure that an average reading can be obtained and the grid shall be fitted 300 mm above the top of condenser tube bundle for measurement of condenser vacuum. 2.22.8 The condenser water boxes shall be designed for smooth entry of water into the tubes and effective uniform distribution of cooling water to all the tubes. The water boxes shall preferably be dome shaped and of hinged construction so that the water boxes can be swung open about the hinges to enable tube inspection, retubing without having to remove the water boxes. It shall also be designed such that formation of air pockets are avoided. 2.22.9 Hinged quick opening manhole covers shall be provided for easy access to the interior of water boxes for inspection or maintenance. At least one manhole shall be provided in each divided section. Suitable lifting lugs shall be provided for the water boxes. 2.21.10 The water box test pressure shall be at least 1.5 times the design pressure. 2.21.11 The circulating water inlets and outlets on water boxes shall have flat face flanges. 2.21.12 If circulating water connections enter the bottom of water box, safety guards shall be provided to protect personnel from falling in during inspection or maintenance. 2.21.13 Each water box shall be provided with a drain valve of adequate size at the bottom to enable the front and rear water box and tubes to be emptied of water in not more than 30 minutes. Also, each water box shall be provided with adequately sized vent line with two valves. One valve, immediately after the tapping and the second valve at an		
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accessible area near drain termination for frequent operation. Necessary meshes shall also be provided to the drains and vents to prevent escape of the balls of on-load tube cleaning system into the drains and vents. Cathodic protection shall be provided in the water boxes with Zinc anodes material of suitable size and shape. 2.21.14 Motorised butterfly valves, expansion joints and connecting flanges to be installed at inlet and outlet cooling water pipes shall be provided. 2.21.15 Access manholes of adequate size shall be provided, one in each of the hotwell sections. Manholes shall be provided with hinged and bolted manhole covers. All manholes shall be provided with access platforms. Hotwell connections to suction of condensate extraction pumps shall have anti-vortex baffling and the screen mesh shall be made of stainless steel type 304. 2.21.16 A suitable means of access shall be provided into the condenser to permit inspection and cleaning of confined areas. For this purpose an access manhole of 600 mm x 600 mm size minimum shall be provided on the shell above tubes. 2.21.17 Connections shall be provided to empty the hotwell and the emptying time from the normal operating level (to the station drains) in one hour or less. 2.22.18 The condenser shell shall be provided with baffles as necessary to ensure proper distribution of steam over the whole of the tube nest with minimum shock load and to eliminate all areas of excessive steam velocity. Extraction pipes coming through condenser neck shall be provided with stainless steel shroud around each pipe to prevent erosion due to steam. 2.22.19 The condenser shall be adequately supported so that no upward thrust is imposed on the turbine under all conditions of operation. Condenser, piping supports etc. including their foundations shall be designed such that with water in circulating water side also full, steam space can be filled with water upto the expansion bellow for hydraulic test/air leakage points check without giving any stiffeners etc. in any part of the condenser. 2.22.20 At all points where steam and water enters the condenser shell, baffles of SS 316 shall be provided to prevent direct impingement on the tubes. All bolts, nuts, stays, etc. inside the steam space will be of approved material and where such parts project through the tube plates, they shall be fitted with gun metal or approved cap nuts and protective sleeves.		
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Stainless steel spray piping shall be provided to distribute cold make-up water in such a manner as to provide suitable heating and deaeration. 2.22.21 The condenser shall be fitted with • two sets (one on either side) of water level gauge at the condenser hot well with illumination; • air outlet connections; • steam throw-off device to effect pressure reduction and condensate spraying of the steam from bypass station when the turbine is by-passed; • all necessary connection for instrument and controls; • one isolating valve on the top of steam space of each condenser shell or top of each turbine exhaust piece for vacuum gauge; • appropriate thermometer pockets at top of the steam space of the condenser shell and in the air suction branch; • connections for drains from the steam generator atmospheric drain tank during start-up of the steam generator. • connections for vacuum breaker system; • connection for drains from the steam generator atmospheric drain tank during start up of the steam generator. • connections for return of heater drains through flash boxes • all required instruments like level transmitters, level controllers, level gauges shall be mounted on stand pipe with individual isolation valves. Stand pipe shall be connected to condenser shell (One on each side) with isolation valves for steam and water side. Initial filling from permanent DM water source, vent and drain shall be provided to stand pipe. For initiating alarms, protective actions, level indication and level control functions, following shall be provided as a minimum on the condenser hot well a) 'LOW' level b) 'LOW-LOW' level c) 'HIGH LEVEL' d) 'HIGH-HIGH LEVEL' e) NORMAL LEVEL		
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• water boxes and reverse chambers shall be designed for the use of continuous condenser on load tube cleaning system to ensure equal distribution of cleaning balls all over the surface of the tube plate and • water boxes and reverse chambers shall be designed to carry out tube cleaning with high pressure water jet cleaning, manual brush cleaning or any other method 2.22.22 The tubes shall be welded type, manufactured and tested in accordance with the approved standard. All tubes shall be of tested quality and the Contractor shall have to submit the test certificate of the tubes. Each tube shall be eddy current tested for soundness. The tubes shall be roller expanded. The extent of tube expansion shall be established by mock-up test and all expansion shall be done to the measured extent. As the cooling water used is River water , suitable SS material of adequate thickness shall be used for making condenser tubes. The minimum cleanliness factor shall be 0.9 and the plugging margin shall be 5%. 2.22.23 The tube support plates shall be arranged suitably so that no periodic vibration of tubes may be induced by the running of the Turbine and the maximum span shall be limited such that vibration induced by steam flow may not occur. Edges of tube holes with support plates shall be chamfered and deburred to prevent tube damage. 2.22.24 The water boxes shall be hinge supported from condenser shell by a flange connection. Condenser design and construction shall assure complete support of the fully flooded water boxes from the condenser shell without requiring auxiliary supports. The outer surface of the water boxes shall be painted with suitable paint after the surface is cleaned and degreased. The inner surfaces of the water boxes and the partition plates shall be painted with fibre reinforced epoxy painting after the surface is cleaned and degreased. Adequate arrangement like monorail, hoist etc. shall be provided for removal of water box for tube replacement. Adequate space shall be allocated for complete opening of the hinged and bolted water boxes, so that after opening, they stand clear of the condenser tube removal space. 2.23 <u>Condenser Air Evacuation Equipment</u> 2.23.1 2x100% duty mechanical vacuum pumps per condenser per shell and accessories shall be used to create vacuum by removing air and non-condensable gases from steam condenser during plant start-up and daily normal operation. The condenser air evacuation system shall meet		
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requirements specified in this Section and in Data Sheet-A3 of this volume . The pumps shall be single stage liquid ring type with an air ejector or two stage liquid ring type to meet the design conditions specified. The design shall be as per latest HEI requirements and the capacity margin shall be as per HEI. 2.23.2 In case of a two stage pump both the stages shall be mounted on a common shaft. The pump unit shall require no internal lubrication and shall not be damaged by water vapour, entrained droplets or slugs or water. 2.23.3 Each condenser air evacuation unit shall be complete with liquid ring vacuum pump, drive motor, coupling and coupling guard, separator with gauge glass and automatic make-up and overflow valves, inlet system valves with differential pressure switches, system vacuum switches to automatically start the standby unit, heat exchanger for seal water cooling, seal water recirculation pump, vapour cooler (as applicable), discharge muffler (silencer), all valves, instrumentation and controls, as specified. Each pump shall be supplied as a packaged unit mounted on a common steel base and shall be complete with all the accessories, the integral piping, valves, wiring and controls as necessary. 2.23.4 Provision shall be made in the design of the equipment to prevent loss of vacuum by flow of atmospheric air back into the condenser upon shutdown of the pump. 2.23.5 The heat exchanger(s) shall be arranged to permit access to tubes without disturbing piping connections. The U-tube heat exchanger(s) shall be of removable tube bundle type. All heat exchangers shall use bolted channel covers. The tube material shall be suitable to river water, preferably SS. 2.23.6 The control system shall be such that the entire operation from hogging through holding can be carried out automatically. The system shall perform the following functions: (a) Hogging operation upto a pre determined vacuum by use of both the 100% capacity vacuum pumps. (b) Automatic changeover from hogging to holding operation at the preset vacuum. (c) Automatic starting of the standby vacuum pump unit in the event of fall in vacuum to a preset value 2.23.7 The operation of the cooling water inlet and outlet valves to the seal water heat exchangers will be manual. The seal water make-up to the		
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liquid ring pumps shall be from hotwell make-up system/condensate extraction pump discharge through an isolation valve. 2.24 <u>Condensate Extraction Pumps and Accessories</u> 2.24.1 3X50% condensate extraction pumps shall be provided to pump the condensate from the condenser hotwell through the gland steam condenser, drain cooler, deaerator level control valve, low pressure feed water heaters to the deaerator as indicated in Turbine Cycle Scheme No. TCE.-5432A –SK-0001. The condensate extraction pumps and accessories shall meet the requirements indicated in this Section and in Data Sheet-A4 of this Volume. 2.24.2 Each pump set shall: (a) be capable of supplying the starting requirements of the plant (b) satisfactorily accommodate steady and transient loadings imposed by the main pipe work (c) be capable of surviving the most likely thermal shock conditions (if any) that may occur during operation and continue to operate for long periods. 2.24.3 In order to ensure an acceptable availability between planned maintenance periods, components of pumps shall not be made of materials which are degradeable and/or which will wear and need replacing within 40,000 hours with the exception of mechanical shaft seal materials, which shall be capable of operating for not less than 15,000 hours. 2.24.4 The pump characteristic curve tolerances shall be limited to : <table> <tr> <td></td><td>Plus(%)</td><td>Minus(%)</td></tr> <tr> <td>(a) Flow at guarantee point</td><td>0</td><td>0</td></tr> <tr> <td>(b) Head at guarantee point</td><td>3</td><td>0</td></tr> <tr> <td>(c) Efficiency at guarantee point</td><td>unlimited</td><td>0</td></tr> <tr> <td>(d) Shut-off head</td><td>5</td><td>0</td></tr> </table> These tolerances shall be the permissible variations between the conditions as proposed initially by the VENDOR and the design parameters demonstrated during acceptance tests. The sizing criteria shall be with 10 to 15% margin over highest conceivable flow, 25% margin on head over De-aerator pressure, Two pumps capable of handling 100% TGMCR – HP heaters out- 1% makeup- worst condenser				Plus(%)	Minus(%)	(a) Flow at guarantee point	0	0	(b) Head at guarantee point	3	0	(c) Efficiency at guarantee point	unlimited	0	(d) Shut-off head	5	0
	Plus(%)	Minus(%)															
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pressure at 47.5Hz. NPSH (R) at 3% head break shall be well below NPSH (A). 2.24.5 When pumps operate in parallel, the load sharing deviation between them be limited to 5% at flow capacities from the design flow down to the minimum flow. 2.24.6 The suction specific speed for the pump shall be selected so as to ensure that pump is completely protected against low flow recirculation and consequential cavitation and without exceeding specified vibration level over the entire operating range. Pump with suction specific speed value higher than 11000 US units, not proven in practice, may be rejected. 2.24.7 The construction shall be such as to allow removal of pump shaft and impeller without disturbing the cannister. 2.24.8 The suction side vent of each canister shall be individually connected to the condenser. The discharge side vent of each condensate extraction pump shall have its own solenoid valve operated, together with break down orifice and be connected individually to the condenser. 2.24.9 The initial sealing water for the condensate extraction pumps shall be from the hotwell make-up system, and during normal operation from the condensate extraction pump discharge. The transfer from one sealing water source to another shall be automatic. 2.24.10 The minimum recirculation system of the condensate extraction pump shall also preferably meet the minimum flow requirements of gland steam condenser and shall not be less than 25% of design flow or set recirculation (discharge / suction) which ever is higher. 2.24.11 The design and workmanship shall be such that the pumps are readily assembled or dismantled and that they operate satisfactorily under all operating conditions without cavitation, pitting, excessive vibration, noise or undue wear. 2.24.12 Pump shaft coupling shall be of flexible type and the thrust bearing shall be provided in the pump. Pumps shall be fitted throughout with renewable wearing parts such as wearing rings, shaft sleeves, stage sealing rings, etc. 2.24.13 The suction valves shall be suitably sealed to avoid ingress of air into the condensate.		
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2.24.14 The impeller shall be cast in one piece finished all over and carefully balanced both statically and dynamically. The assembled rotor shall also be dynamically balanced. 2.24.15 Suitable automatic starting devices shall be provided to bring the stand-by pump into operation in case of failure of operating pump or when the condensate header pressure drops below a predetermined value. The following protections shall be provided for the Condensate Extraction Pump (CEP) as a minimum. a) Condenser Hot well level ‘ Low-Low’ b) Discharge pressure before Non Return Valve on the CEP pump discharge is less than pre set value c) CEP drive motor protections actuated The above listed protections are a minimum and additional protections if required shall be provided to make the system complete during detailed engineering phase. 2.24.16 The pump shall be designed to handle hot condensate at or near saturation temperature and also be capable of handling the full condensate from the condenser pressure of 68 mm Hg absolute/ or the lowest condenser pressure and also when unit is operating at full load when L.P. & H.P. heaters are out of service, with minimum permissible frequency and at rated deaerator pressure. 2.24.17 The pump motor rating shall not be less than larger of the following : (a) Sufficient to drive the pump through the entire range of runout flow to shut-off conditions. (b) 110% of pump design point rating. (c) 115% of maximum power requirement of the pump 2.25.0 <u>BRIEF DESCRIPTION OF THE CPU SYSTEM</u> 2.25.1 2x100% condensate pre filters, followed by 2x50% condensate polishing service vessels of deep mixed bed type shall be provided for each 660 MW unit. A common external regeneration facility (ERF) for deep MBs for both units shall be provided adjacent to the DM plant building. 2.25.2 The backwash and regeneration cycles are executed in separate dedicated vessels after the resins are separated. The process of resin transfer, resin separation, regeneration and re-transfer shall be of a proven and patented technology. (preferably, Conesep, ShowerSep, Seprex, Full Sep of USFilter)		
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2.25.3 The condensate pre filters shall be designed for startup conditions where the crud load is expected to be maximum. The pre filters shall be located on the discharge side of the condensate extraction pump, followed by deep MB polisher units. 2.25.4 SYSTEM DESIGN 2.25.5 Capacity Pre Filters (PF) & deep MB units shall be designed for the maximum condensate flow expected at VWO condition 100% condensate filtration & polishing is envisaged. 2.25.6 Temperature Maximum design Temperature of condensate 60°C 2.25.7 Pressure Design Pressure for Pre Filters & CPU Service Vessels = 45 kg/cm²(g) Maximum pressure drop in Clogged Pre Filters = 3.5 kg/cm² Maximum pressure drop in Clean Pre Filters = 0.5 kg/cm² Maximum pressure drop during clogged resin bed of CPU service vessels = 3.5 kg/cm² Maximum pressure drop during clear resin bed of CPU service vessels = 2.1 kg/cm² 2.25.8 Condensate Quality 2.25.9 The dosing chemicals proposed for feed water conditioning are as follows: <table border="1"> <thead> <tr> <th>CONDITIONS</th> <th>Startup</th> <th>Shutdown</th> <th>Condenser Tube Leakage</th> <th>Normal Continuous Operation</th> </tr> </thead> <tbody> <tr> <td>Dosing Chemicals</td> <td colspan="3"> AVT TREATMENT Ammonia dosage is proposed @ 0.5-1.5 mg/l </td> <td> OXYGENATED TREATMENT Gaseous oxygen treatment is proposed for feed water conditioning along with ammonia (0.07 mg/l) as a volatile alkanising agent </td> </tr> </tbody> </table> 2.25.10 The condensate quality during normal continuous operation for PF+CPU design shall be as follows :-			CONDITIONS	Startup	Shutdown	Condenser Tube Leakage	Normal Continuous Operation	Dosing Chemicals	AVT TREATMENT Ammonia dosage is proposed @ 0.5-1.5 mg/l			OXYGENATED TREATMENT Gaseous oxygen treatment is proposed for feed water conditioning along with ammonia (0.07 mg/l) as a volatile alkanising agent
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PARAMETERS	INFLUENT CONDITION	EFFLUENT CONDITION
Ammonia ppb	100 (max)	-
Crud ppb	50	<0.01
Silica ppb	30	5
Copper ppb	10	3
Iron ppb	50	5
Sodium ppb	10	2
Chloride ppb	10	2
Oxygen mg/l	0.03-0.15	< 0.1
pH		7.4
Total Dissolved Solids ppb	All Influent including ammonia	25
Conductivity		Conductivity < 0.1 micro mhos/cm at 25°C after removal of all amines.

2.25.11 In addition to the above normal contaminants, the CPU shall be designed for total removal of CO₂ ingress in the form of carbonics at the rate of minimum 50 ppm as such.

2.25.12 The condensate quality during startup / shutdown operation for PF+CPU design shall be as follows :-

PARAMETERS	INFLUENT CONDITION	EFFLUENT CONDITION
TDS	All influents + 1500 ammonia ppb	Conductivity < 0.1 micro mhos/cm at 25°C after removal of all amines. Sodium shall be < 0.005 mg/l Iron & Copper shall be < 0.01 mg/l

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Silica	150 ppb (MAX)	< 0.02 mg/l
Crud	1000 ppb (MAX)	The effluent Crud should not exceed 0.2ppb at outlet of Pre Filters
Oxygen mg/l		< 0.1 mg/l when conductivity < 0.1 μ S/cm < 0.02 mg/l when conductivity > 0.1 μ S/cm

- 2.25.13 The condensate quality during condensate tube leakage condition for CPU design shall be as follows :-
During Condenser Tube leakage condition, the plant shall be designed for 2000 ppb TDS in addition to the normal influent contaminants. The cation and anion load in 2000 ppb, shall be based on the circulating water analysis. Under such conditions, the sodium content of the effluent shall be limited to 20 ppb maximum.
During condenser tube leakage, Pre filters shall be automatically bypassed based on inlet conductivity.

2.25.14 Service Runs

During Start-up / Shut-down : 50 hours (minimum) for PF + CPU

During Normal Operation : **30 days on Hydrogen Cycle** for PF+CPU

During condenser tube leakage condition : 50 hours (minimum)

Surface Flow Rate considered for design of CPU service vessel shall be **120 m³/hr/m² for cylindrical construction and 100 m³/hr/m² for spherical construction**

2.25.15 Location

The Pre filters will be located along the feed water path between the CEP supply pump and CPU. The CPU shall be located after the PF.

External Regeneration Facility (Common to both Units) shall be located in the DM plant area.

2.25.16 Salient Features

The salient features of Pre Filters shall be as follows :

a) Filter housing of SA 516 Gr 70 material, complete with necessary instrumentation for automatic operations

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b) 6 microns Hollow polypropylene cartridges with in to out flow path. Filter media shall be designed for 99.98% absolute recovery and shall be of disposable type. c) Inlet, outlet and bypass motorised valves with necessary interlocks to CEP and CPU. d) Differential pressure indicator cum transmitters. e) Sampling points at inlet and outlet. f) Online magnetic crud / particle monitors to measure crud capture performance. Bidder to indicate the arrangement of filters in each housing and sizing criteria for achieving guaranteed performance. The pre filter designs shall be proven for similar capacities and guarantees. 2.25.17 The salient features for design and operation of the CPU are explained as follows : 2.25.18 Resin Selection (Based on Deep Mixed Bed Units) The resins used for the CPU are of the spherical form. The base is a co-polymer of styrene and di-vinyl benzene forming a macro porous or macrorecticular structure. Cation Resin : Strong Acid with sulphonic acid as functional Group Anion Resin : Strong Base with quarternary amines as functional group Inert Resin : Non Ionic, compatible with the above resin types. The ratio of cation resin to anion resin will be 2 : 1 by volume. Cation resin will be regenerated by 33 % hydrochloric acid (IS 265). Anion resin will be regenerated by 48% sodium hydroxide (IS 252) For the plant, adequate resins for polishing vessels along with one (1) spare charge of resin in the regeneration area shall be included. A separate spare charge of resin shall also be provided, which can be utilized for the commissioning of CPU. Thus, the total number of charges supplied will be as follows :- <table> <tr> <td>For 2x50% service vessels per unit</td> <td>:</td> <td>2 x 2 units = 4 charges</td> </tr> <tr> <td>Additional Charge in External Regeneration Area</td> <td></td> <td>= 1 charge</td> </tr> <tr> <td>Separate Spare Resin charge for Commissioning</td> <td></td> <td>= 1 charge</td> </tr> <tr> <td><i>Total resin charges</i></td> <td></td> <td><i>= 6 charges</i></td> </tr> </table>			For 2x50% service vessels per unit	:	2 x 2 units = 4 charges	Additional Charge in External Regeneration Area		= 1 charge	Separate Spare Resin charge for Commissioning		= 1 charge	<i>Total resin charges</i>		<i>= 6 charges</i>
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The bidder shall also provide dedicated pressure vessels for storing additional resin charges. The total wet volume Exchange Capacities will not be less than Cation in Hydrogen form : 1.7 eq/L Anion in Hydroxide form : 1.0 eq/L All resins shall be CPU grade, organic monosphere with uniformity coefficient of 1.1. 2.25.19 Vessel Requirements The pressure vessels in the common external regeneration facility will be provided with adequate freeboards over the top of the settled resins in order to minimise the loss of resin during their use. Minimum freeboards for vessels in external regeneration are as follows : Mixed Resin Storage Vessel =50% of resin Volume Resin Separator and Cation Regeneration Vessel=75% of resin volume Anion Regeneration Vessel = 75% of resin volume All pressure vessels will be rubber lined in three (3) layers, resulting in a minimum total thickness of 4.5 mm on the internal surfaces of the vessel. The lining will be extended over the full face of all flanged connections and will have a minimum thickness of 3 mm in all such external areas. The CPU service vessels shall be of cylindrical / spherical construction. The CPU regeneration vessels shall be of cylindrical construction. The effective depth of the mixed resin bed in the CPU will not be less than 1.1 m. At the design flow rate, the pressure drop across the polisher service vessels with clean resin bed will not exceed 2.1 kg/sq.cm. This pressure drop will include losses due to entrance and exit nozzles, flow elements, distributors, under drains, resins and the effluent resin traps.		
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Maximum pressure drop under clogged conditions will be restricted to about 2.5 kg/sqcm, including the pressure drop across the effluent resin traps. A typical Condensate Polishing Service Vessel will contain the following : Condensate inlet and outlet piping headers, complete with valves & instruments. All necessary sampling points, drains and vents, complete with valves. Resin transfer headers, connecting the external regeneration facilities to the condensate polisher vessels . External resin traps at the outlet of each polisher vessel, designed for in-place manual back washing. Common drain headers for the CPUs. Rinse water outlet headers from condensate polisher vessels upto the condenser hotwell. All necessary piping, fittings & valves with actuators. 2.25.20 Bypass System Automatic bypass of the polishing units are envisaged for the event of an excessive pressure difference between the condensate inlet and outlet headers. A control valve opens automatically under such conditions to bypass requisite quantities of condensate to prevent this pressure difference from exceeding a preset limit when all vessels / 1 vessel / no vessel is in operation. The control valves are designed so as to bypass 50% of rated flow when one of the service vessel is out of service and 100% of rated flow when all the service vessels are out of service. Differential pressure transmitters / controller shall be provided across the condensate inlet and outlet headers, to control the bypass valve. 2.25.21 Resin Traps Outlet of each condensate polisher vessel, ACF and waste effluent header of the common regeneration will be provided with a resin trap. All resin traps shall be provided with differential pressure indicators and transmitters.		
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Pressure drop at design flow rate through a clean resin trap will not exceed 0.35 kg/ sq. cm The resin traps on process influent header will have a screen opening not exceeding 120% of associated process vessel under drain screen opening. Other resin traps will have a screen opening of 60 mesh. All resin traps will have a provision for “in-place manual back washing”. 2.25.22 External Regeneration The requirements for external regeneration are as follows: External separation / regeneration vessels complete with vents, drains, piping, fittings and valves for air scrubbing, back-washing and regeneration. Resin injection hopper, complete with water ejector system for resin make up to the external separation vessel. Common waste effluent header with one resin trap designed for in-place manual backwashing. Two (2) nos. (1 W + 1 S) horizontal centrifugal DM water pumps which is used for water supply for chemical preparation / dosing & transfer of resin from the service vessel to the regenerating vessel & vice-versa. The process of typical external regeneration (this may be modified as per the proven regeneration process of the CPU supplier) is as follows : The main MB unit, when exhausted, is fluidized and the resins are hydraulically transported to an external separation vessel. Soon thereafter the main MB unit just emptied, is refilled hydraulically with the regenerated resin held in reserve in a resin storage vessel. The main shell thus refilled is placed in service or held on standby. The regeneration of the exhausted resins in the external separation vessel is Semi automatically controlled. The exhausted resin is first backwashed in the external separation vessel, the cation and anion beds thus getting separated. Once this is done the anion resins are hydraulically transported to the external anion regeneration vessel. The cation resin left in the separation vessel is air scrubbed, backwashed and regenerated with acid. The crud on the resin is thus removed.		
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The anion resin is similarly regenerated with alkali in the anion regeneration vessel. 2.25.23 Chemical Dosing System All equipment for dosing of acid, alkali and ammonia (if required) solutions are rated to provide a maximum dosing rate of 20 % in excess of that required from process calculations. Similarly all tanks shall be sized to store one regeneration requirement with 20% excess requirements. The acid and alkali dosing equipments for regeneration of condensate polishing resins, consists of the following : Acid measuring Tank with fume absorber Alkali measuring Tank with CO2 absorber and overflow seal Hot water Tank with 2x50% electric heating coils for heating alkali diluent water to 50°C within 2.5 hours. Acid and alkali are dosed by means of hydraulically operated ejectors / metering pumps. 2x100% ejectors / metering pumps are envisaged for each application Diluent water supply for acid and alkali shall be DM water All equipment, piping, fittings, valves etc., will be provided to make the system complete. Day tank and metering pumps for ammoniation of the Resin in regeneration area if needed. Dedicated Bulk acid and alkali tanks will be provided for CPU. These shall also cater to the requirement of acid / alkali for DM plant. 2x100% acid pumps and 2x100% alkali pumps for unloading acid/alkali from road tankers shall also be provided. <u>Alkali Solution Preparation Facility</u> The complete facility for preparing alkali solution from alkali flakes will be included in the CPU bidders scope. This facility would include One (1) no., alkali preparation tank, complete with electrically driven stirrer, and dissolving basket.		
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The tank capacity will be equal to 120% of regeneration requirement of one polisher vessel. One(1) no. Activated Carbon Filter for alkali. One (1) no., Alkali Day Tank complete with CO₂ absorber and overflow seal. The tank shall have adequate capacity to hold 120% alkali required for one regeneration. All interconnecting piping, fittings and valves as required for the system. All instrumentation and controls for alkali solution preparation as specified and as required for proper operation. <u>Activated Carbon Filter</u> The rated flow of the filter will not be less than the design capacity of the alkali transfer cum recirculation pump, and the maximum velocity through the filter for this flow will not exceed 12 meters/hour. The depth of the filter media will not be less than 1 meter. 2.25.24 Air Blowers The common external regeneration facility and CPU service vessels are provided with 2 x 100% air blowers. Each blower is complete with motor, V-belt drive with belt guard, inlet filter / silencer, flexible coupling and discharge snubber, all mounted on a single base. 2.25.25 Regeneration Water Requirement Water required for regeneration will be taken from DM Water storage tank. 2.25.26 Effluent Disposal System The wastewater from the external regeneration facility is led to the neutralising pit, which is common for DM plant and CPU, located in the External Regeneration Facility. In addition to the CPU regeneration waste, the Neutralising pit receives the regeneration wastes from DM plant.		
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The pit consists of 2 (two) compartments, each of which is sized for a maximum of 120% of the regeneration wastes from CPU and DM plant units. The required amounts of acid/alkali are dozed to neutralise the excess alkali/acid. 2x100% pumps are envisaged for recirculation and transfer of the neutralised effluent for further treatment / disposal. 2.25.27 Instrument Air Instrument Air for the CPU and regeneration facility will be tapped from convenient locations on the main instrument air header. 2.25.28 Control & Operation Philosophy The Condensate Polishing units consisting 2x50% streams with integral bypass are designed with the flexibility of full automatic operation of exchange units in any combination. <u>Operational Features</u> i) The regeneration system will be external and common to all the polishers. Under normal conditions, it will hold a complete charge of freshly regenerated and mixed resin, ready for use, in its storage tank. For regeneration, resin from the exhausted CPU service vessel will be transferred pneumatically / hydraulically to this facility. The empty CPU service vessel will then be filled up with the already regenerated resin, which was stored in the regeneration facility. This C service vessel will come into service soon after pre requisite condition is satisfied or as and when desired by the operator. In the meantime, the exhausted resin charge will be cleaned, separated, regenerated, mixed and rinsed before being stored for the next use. ii) The common influent headers of each polisher service unit will be connected to an automatic bypass line to be provided This bypass line will include a differential pressure device, which on a high signal will cause an automatic valve to open, bypassing the service vessels. iii) The condensate polisher system will consist of the two service vessels complete with the influent, effluent and rinse water headers, connections for resin transfer to and from each of the vessels and all necessary controls and instrumentation. Each of the service vessels will be provided with an external resin trap on its effluent line.		
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<u>Control & Operation of the Condensate Polishing Unit (CPU)</u> The control, monitoring and programming requirements of each of the CPUs and their common external regeneration unit shall be implemented in a single PLC based control system, located in the DM plant control room. Operator work Stations shall be provided on an LCP near each of the CPU service vesels. The LCP also houses the conductivity meters and window based alarm annunciator. The control, monitoring and programming requirements of the DM plant common shall also be implemented in the same PLC. i) The condensate-polishing unit of each unit will be controlled from the Operator Work station (OWS) provided on the CPU LCP, located near the respective polishing vessels or from the OWS in the DM plant control room. ii) It will be possible to select each of the CPU vessels for any of the following operations : a) Service b) Resin Transfer from CPU vessel to Regeneration plant. c) Resin Transfer from Regeneration Plant to CPU vessel. d) Isolation from service. e) Rinse Recycle. Further from OWS, it will be possible to initiate any of the following operating modes. i) Rinse Recycle The rinse recycle will be a manually initiated full automatic sequence. This effluent quality is acceptable for boiler feed water. The effluent quality will be determined by conductivity monitoring of the rinse water outlet, which is returned to the condenser hot well for recycle. The panel mounted Cation conductivity indicator will be interlocked to prevent advancing of the automatic sequence until the rinse down is complete. ii) Service Mode Flow indicators will monitor Service flow rate for each polishing vessel. During periods of low condensate flow the operator may select to remove one of the vessels from service by a manually initiated automatic sequence. A differential pressure switch installed between the influent and effluent headers		
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will cause an alarm on high differential pressure. By observing the individual vessel flow indicators, or conductivity at vessel outlet the operator can determine which vessel is contributing most to the pressure drop and is in need of resin cleaning. Panel mounted Cation conductivity indicators will monitor the polishing system influent and effluent streams as well as the discharge of each service vessel. A 'high influent conductivity' alarm will alert the plant operator that a problem condition such as air or condenser cooling water leakage has occurred. This conductivity analyser will also provide contacts for an alarm at the power station main control room An alarm for 'high conductivity' in effluent header or service vessel will alert the operator to the need for regeneration of a polishing vessel. iii) The sequence Resin Transfer from CPU Vessel to regeneration plant' and resin transfer from Regeneration plant to CPU Vessel' will be initiated from the condensate polishing unit OWS. External Regeneration System One common external regeneration system will be provided to serve the condensate polishing vessels of all units. This system will be designed for physical cleaning and chemical regeneration of the resin system will consist of required number of resin separation and regeneration vessels, the tank for introducing the required regeneration solutions and means for adding make-up resin, It will have acid, alkali, ammonia dosing system (if required) and alkali preparation facilities. Regeneration Control A manually initiated automatic sequence for physical cleaning and chemical regeneration of the resin shall be implemented in the PLC based control system. Control for chemical dosing system and alkali preparation facility will also be provided in it. Physical cleaning of the resin will consist of three steps, drain to level, air scrub and rinse. The air scrub and rinse steps are of short duration, approximately 1 and 2 to 3 minutes respective time. However the program will allow the operator to increase or decrease the number of times the sequence is repeated to meet the requirements existing at that time. The chemical regeneration is many step sequence. This will include hydraulic reclassification of the resins and the transfer of the resins to the respective		
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regeneration vessels. The separated resins are then back washed, regenerated with 4 percent hydrochloric acid and sodium hydroxide solutions (the latter being at 50 deg. C respectively and then rinsed. Following the rinse step the resins will be given an air scrub followed by a good backwash. The resin is then transferred back to the resin separation vessel and the resins are air mixed. The mixed resins are then given a final rinse with the discharge conductivity being monitored. The quality of this discharge will determine if the regeneration has been effective. If the quality is not satisfactory the regeneration sequence must be repeated. Demineralised water will be used through out the regeneration process for backwashing regenerant diluent, rinsing and resin transfer A conical bottom hopper having a water ejector will be used for resin make-up. Resin Transfer Manually initiated automatic sequences will be provided for transferring resin from a vessel to the remote common facility for physical cleaning and chemical regeneration and for returning fresh resin to that vessel. The transfer of resin from the service vessel will include isolation of the service vessel, hydraulic/hydro pneumatic transfer of the resin to the external regeneration system (resin separation vessel) and the complete drain down of the service vessel to the hot well. Air requirement for pneumatic transfer shall be provided by the bidder through 2X100% dedicated air compressor/blower. The complete control and operation requirements of the Regeneration Plant will be implemented in the PLC based system implementing the CPU controls. It shall be possible to operate the Regeneration Plant in Auto / Semi auto / Manual mode. Following operations will be possible for the Regeneration Control from the OWS : - Complete Regeneration - Resin Transfer from CPU vessel to Regeneration Plant. - Resin Transfer from Regeneration Plant to CPU vessel. In 'Auto' mode, once the sequence has been initiated, it will proceed from step to step automatically.		
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In 'Semi-Auto' mode a set of steps are performed after each initiation by the operator. In 'Manual' mode complete operation, step by step, will be performed by the operator from the OWS. The sequence control requirements are implemented in the PLC. It will be possible to switch mode of operation from one to the another at any moment and the operation will proceed on the newly selected mode from that step and time. For steps, which require frequent time adjustment, it will be possible to change the time setting from the OWS . For all sequences, the current step number, set time of the step, elapsed time of the step and the total elapsed time of the sequence will be indicated on the OWS. A mimic diagram of the Regeneration system will be provided on the OWS monitor to indicate the status of various drives and, valves. The system will incorporate the necessary safety features. During automatic sequential operation, if any pre-requisite criteria are not fulfilled or missing for a pre-determined time interval, the steps should not proceed further, and Alarm will be provided. The safety system for any sequence/stop will check the opening / closing of the required valves and the remaining valves of the plant to avoid mal-operation. Wherever standby equipments are provided, it shall be possible to select each of the drive on 'standby' duty. Start, progress and stop of each of the sequence shall be annunciated on the OWS monitor. <u>Interlocks :-</u> All interlocks for safe operation of the plant shall be provided. They shall include the following as a minimum : Service vessels can be back in service, only after they have been pressurised.		
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Service vessels can be taken up for resin transfer only after they have been completely isolated from the condensate system and depressurised. Resin can be transferred to and from only one service vessel at a time. Resin transfer between the service and the regeneration area shall be permitted only when the receiving vessel is empty. Wherever possible, completion of all timed steps in the regeneration and resin transfer process shall be verified by appropriate process conditions such as effluent conductivity etc, as applicable. The automatic sequence shall be prevented from advancing to the next step, till these required process conditions are achieved, and at the same time the delay if any shall be annunciated in the control panel, to draw the attention of the operator. The automatic sequence of operations will be interruptible at any time by the operator take over the control of the operation in manual from that step onwards. Further operator should be able to over ride sequence, if required. It shall be possible for the operator to extend the timing of a particular step by isolating the timer for the duration. The timer will restart once the operator puts back the system on 'auto' and the other steps will then follow as programmed. The regeneration sequence will be prevented from advancing further in the event of tripping of a running motor or other fault condition, which do not permit the various desired parameter of this step to be achieved. A manual override for this shall also be provided. Annunciation logic will be carefully designed so that the alarms are activated only under abnormal conditions. As for example, low flow of diluent water is only relevant when the chemical dosing is in progress. All other times, when no diluent water flow is required, this annunciation should be blocked. In general. Normal and trouble free operation of the plant will not activate any of these alarms. The immersion heater in the hot water tank can be put on only when there is adequate water level in the tank. CPU Service Vessel inlet and outlet isolation valves shall be closed automatically in the event of tripping of CPU supply pumps. 2.25.29 <u>Instrumentation and control system</u> The field instrumentation will be provided as per the system requirement. Instrumentation and control system shall adhere to the correct sequence		
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of operations and pre-determined time intervals as described above in 'operation & control philosophy'. The list of instruments envisaged are as follows : Conductivity indicators / recorders for each of the CPUs and for the regeneration vessels pH recorders for cation regeneration vessel Level indicators for all chemical tanks Level and temperature instrumentation & controls for hot water tank and thermostatic control for alkali heating system Concentration meters and flow indicators on chemical lines Pressure gauges and flow indication for the regeneration vessels and CPUs Differential Pressure switch across each CPU Online Silica analyser (Multi Channel) at outlet of each CPU service vessels Online Sodium analyser at outlet of each CPU service vessels All solenoid valves shall be provided with local LED status display and limit switches shall be provided for critical applications to facilitate remote indication on OWS. 2.26 <u>Closed Feed Water Heaters and Accessories</u> 2.26.1 The STG unit shall be provided with low pressure feed water heating system, one deaerating feed water heater and high pressure feed water heating system. The low pressure feed water heaters are those heaters provided upstream of deaerating feed water heater and high pressure feed water heaters are those heaters provided downstream of deaerating feed water heater. The design shall be according to the requirements of ASME boiler and pressure vessel code, HEI standards and ASME-TDP-1-1985. The TTDs and DCAs shall correspond to the heat rate guarantee conditions. The heaters shall be able to handle 110% design flow with 2x50% BFPs or CEPs with out undue vibrations and other deleterious effects. The shell side design pressure shall not be less		
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than maximum conceivable extraction pressure and tubes shall be designed for shutoff head of BFPs/CEPs at maximum speed. The heaters shall be able to handle all transient operating conditions including HP/LP bypass operation. The tube side pressure drop shall be minimum. 2.26.2 CONTRACTOR shall note that power plant capability loss due to outage/bypass of any of the heater is not acceptable. CONTRACTOR shall establish the duty range of the feed water heater from partial load to overload conditions. The feed water heater shall be rated for continuous operation for both design and off-design conditions like partial load, preceding heater bypass, start-up, shutdown and any other transients. The feed water heaters (especially high pressure heaters) shall be designed such that the heaters do not impose any other loading/unloading restrictions due to rapid rate of change of feed water temperature. The fouling resistance shall be as per HEI. 2.26.3 The design shall have provision for complete drainage of both shell and tube sides. Drains of adequate size and number at low points of heater shells and water inlet channels for proper drainage shall be provided. Vents and drains of the feed water side of HP heater shall be provided with double isolation valves. During operating condition the HP/LP heater drips shall be normally cascaded to successive lower pressure Heaters and lowest pressure heater drains shall be led to de-aerator/condenser with alternative arrangements. They shall be provided with start up vents and relief valves. 2.26.4 Wherever applicable, the temperature of steam leaving the de-superheating section shall be above the saturation temperature by a sufficient margin to ensure that no condensation will occur on the tubes under normal operating conditions and the steam leaving the de-superheating section will not cause droplet impingement in the condensing section. 2.26.5 The design shall have provision for complete drainage of both shell and tube sides, and for this purpose drains of adequate size and number at low points of heater shells and water inlet channels for proper drainage (minimum 50 mm size) shall be provided. 2.26.6 The VENDOR shall furnish calculations to demonstrate that under all conditions specified, the drain cooling zone will be free from flashing. The drain or sub-cooling section of any heater shall be designed to expose only the required internal water surface necessary to obtain proper control of the drain flow so as to avoid excessive flashback into the turbine in the event of trip out of the machine or large load reduction.		
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2.26.7 All connections to any feed water heater 65 mm NB size and larger, shall be welding-nozzle type with ends shop bevelled. The connections 50 mm NB and smaller, shall be socket welded or screwed as specified. 2.26.8 In the case of vertical feed water heaters with channel down configuration, the de-superheating and drain cooling sections shall be thermally separated and sealed off from the condensing sections around the tubes which pass through the roof plates to prevent the leakage of steam and condensate. 2.26.9 The water in the condensing zone of any horizontally mounted heater, under any operating condition shall not touch the heater tubes. This is exclusive of the water level maintained in the drain cooling zone of the heater (if this zone is provided). 2.26.10 The lowest pressure heater(s), if mounted in the condenser neck, shall confirm to the following requirements : (a) The tube bundle shall be removable and the VENDOR shall supply suitable roller type supports which can be attached to the channel to the heater for facilitating tube bundle removal. Necessary provisions shall be made by the VENDOR in the channel for attaching the supports. (b) The differential expansion between the heater shell and the condenser shall be accommodated in the design of support system. (c) The VENDOR shall provide tube bundle removal fixture and temporary intermediate tube bundle supports required to be used during heater maintenance. (d) Anti-flash baffles shall be provided to retard the backflow of steam into the steam turbine. (e) The heater shall be located in the low steam velocity area of the turbine exhaust / condenser neck. 2.26.11 The BIDDER's design shall include: (a) Suitable hydraulic entrance conditions at water side inlet of heaters which will preclude metal wastage attack of heater channel, tube sheet, tube to tube sheet inlet ends. (b) Flow diffusers, straightners and other similar devices, if utilised to accomplish this end, shall be of stainless steel		
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material. The device shall be possible to be removed or replaced through the normal channel manhole. 2.26.12 Adequate vents and internal baffles shall be provided to remove non-condensable gasses from the stagnant steam areas both during start-up and continuous operation. The continuous vent shall be provided with external flow orifice designed to pass approximately 0.5% of design extraction steam flow at normal operating condition. The start-up vent shall be separate from the continuous vent. The venting system shall be arranged in such a manner that the presence of free oxygen will not cause corrosion in the heater parts. 2.26.13 The start-up vents shall be provided at the highest points of any closed section where air may be trapped during startup. The start-up vents shall purge the shell of all air and non-condensable during initial phase of heater start-up. During plant start-up, venting to the atmosphere is satisfactory when feed water heaters are operated above atmospheric pressures at all loads. If feed water heaters are not operated above atmosphere pressure, the start-up vents should be connected to the surface condensers. It is preferred that vents are not cascaded to the lower closed feed water. A full condensing zone length vent off-take manifold is preferable. The continuous vent lines shall be provided with orifices external to the feed water heater. The high pressure feed water heater vents shall be separately connected to the deaerating feed water heater. The low pressure feed water heater vents shall be connected to the surface condenser separately. 2.26.14 All feed water heaters shall be provided with steam relief valves on the shell side and sentinel relief valves on the tube side. Shell side relief valves shall be sized for 10% of the feed water flow at 10% accumulation. Tube side relief valves shall be provided to guard against over pressure from water expansion when inlet and outlet valves are closed. 2.26.15 The heater shall be supplied with two or more bracket type supports. These shall be suitably proportioned to carry the flooded heater loading. The supports and removal features for heaters shall be submitted by the VENDOR for PURCHASER's/ENGINEER's review. The hold down lugs shall be provided for wheel supports to resist seismic induced overturning forces. Torque moments shall be considered for designing the fixed supports. 2.26.16 The shell shall be of the longitudinally welded or seamless type and of the two seamless shell is preferred.		
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2.26.17 The shell cover shall be of forged or built-up welded construction. The shell cover shall have a 2 :1 elliptical, torispherical or spherical head. The shell cover shall be welded on to the shell in case of U-tube bundles. The channel cover shall be of either rolled plate or of forged construction. The thickness of the flat channel cover shall be measured at the groove made for receiving the pass partition wall. The pass partition plates shall be tightly welded in place and shall be structurally adequate to withstand normal plant operations and transients. 2.26.18 Jack-screws of proper size and number shall be provided for separating the channel cover joint and shell cover joint. The jack screws shall have the same material specification as the bolting material. 2.26.19 Suitable forged bolts or drilled lugs shall be provided for channel cover and tube sheets for use in assembling and dismantling the unit. For the channel down constructions, suitable support devices shall also be provided for the removal and handling of the channel cover. 2.26.20 VENDOR shall permanently mark the shell cut line for the shell removal, if applicable. To protect the tube bundle a 6.25 mm (minimum) thick stainless steel band approximately 150 mm wide shall be installed around the bundle under the cut line. 2.26.21 One piece metal jacketed or solid metal gaskets shall be used and the mating surfaces shall not be exposed to fluid. 2.26.22 The stainless steel tubes shall be solution annealed prior to bending. They shall be stress relieved over the entire U-bend region plus 150 mm on either side of the point of tangency. 2.26.23 The ovality of tubes in U-bend shall be limited such that neither the major diameter nor minor diameter differ from the nominal diameter by more than 10%. 2.26.24 The materials, fabrication and testing of all tubes and U-bends shall conform to the requirements of applicable ASTM standards or approved equal. The VENDOR shall submit U-tube bendings, heat treatment and testing procedure for PURCHASER's/ENGINEER's review and acceptance. 2.26.25 The VENDOR shall submit his rolling procedure of tube after welding the tube into tube sheet for the PURCHASER's/ENGINEER's review and acceptance. 2.26.26 Impingement plates shall be continuous between adjacent tube support plates. The impingement plate shall be of stainless steel		
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10 mm thickness and shall not be less than double the area of the inlet nozzle. The impingement plate attached shall be designed for thermal expansion. 2.26.27 The tube sheets shall be designed for the full design pressure acting independently on either side. The faces of the tube sheets shall be true before and after the tubes are rolled in. Suitable threaded holes for eyebolts shall be provided on the tube sheet to facilitate pulling and removal of the tube bundle. 2.26.28 The tube sheet and welding of the tubes to tube sheet wherever applicable shall be adequately designed for sudden thermal impact due to preceding heater outage condition and also due to total unit load rejection. 2.26.29 On the groove side of a grooved tube sheet, the depth of the pass partition groove may be considered as available for corrosion allowance. The thickness of cladding material shall not be included in the minimum or effective tube sheet thickness. 2.26.30 The tube sheet may be solid or clad as specified. The nominal cladding thickness at the tube side face of a tube sheet shall not be less than 6.35 mm after all machining. After machining the overlay shall be liquid penetrant checked and ultrasonically checked to ensure proper bonding of overlay with parent metal of tube sheet. No crack or porosity is acceptable. It shall be ensured that no separation of overlay from the tube sheet has occurred after the tube holes are drilled. 2.26.31 The U-tubes when used, shall consist of one continuous bent tube. The U-tubes welded at the bends shall not be acceptable. The bends shall not have cracks, kinks or deformations. The minimum radius of U bends shall be 1.5 times the tube diameter. The hot bending to form U-tubes shall not be allowed. 2.26.32 The VENDOR shall furnish to the PURCHASER/ENGINEER for record purposes certification that all required tests as per applicable codes and standards have been performed and conditions have been met prior to shipment. 2.26.33 Each steam and drains inlet (if applicable) shall be fitted with an impingement plate or other suitable means for preventing tube wastage due to inlet erosion. A free area without tubes shall be provided between the impingement plate and the nozzle to ensure that local velocities around the impingement plate are not excessive. The impingement plates shall be continuous between adjacent tube support plates. The impingement plate shall be of stainless steel 10 mm		
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thickness and shall not be less than double the area of the inlet nozzle. 2.26.34 The tube pitch shall not be less than 1.25 times the nominal tube outside diameter. The tube sheet holes shall be reamed, debarred and cleaned prior to installing the tubes. The tube holes shall conform to TEMA specifications for 'Special Close Fit' 2.26.35 The feed water heaters shall be designed such that the super heated steam at the entry to the feed water heater will not come in contact with the tube plate and plate joint. 2.26.36 The VENDOR shall demonstrate by calculations that tubes will not be subject to damaging vibrations in desuperheating and drain cooling zones. The flow to be considered shall be higher of the following : (a) The highest shell side flow under abnormal conditions (b) Twice the design shell side flow. 2.26.37 Baffles and support plates shall be provided in each zone to properly support the tubes and prevent excessive tube vibration while allowing proper distribution of steam and segregation of non-condensable. Spacers may be welded to baffles to stiffen the baffle assembly. Alternatively, tie rods may be secured to end baffles by nuts which will be screwed on to the tie rod ends. The clearance between the tubes and the tube holes of the tube support plates and the baffles shall not exceed the limit specified. All burrs shall be removed to prevent damage to the tubes. 2.26.38 Securely fixed longitudinal baffles or shrouds of adequate thickness shall be provided between desuperheating, condensing and drain cooling sections. Preferably the desuperheater shroud and drain cooler enclosure and their attachment to tube sheet and shell wall shall be made with full penetration weld. 2.26.39 The tube support shall be arranged in such a manner as to preclude the inlet fluid from damaging the tubes. 2.26.40 The flashing drains entering a feed water heater as well as steam entry shall be directed away by a suitable baffle of stainless material not less than 6.0 mm thick. 2.26.41 The water box or channel section of all heaters shall be of fabricated or forged steel construction. The water boxes shall be sufficiently deep and specially designed for smooth entry of the water into the tubes		
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and uniform distribution of feed water to all the tubes. Wherever required, the stiffening sections shall be external to the water box in order to reduce the turbulence in the waterbox to a minimum. The water box shall be fitted with relief valves (sentinel type) and vent valves. 2.26.42 The heater channel shall be designed to allow for tools and personnel to locate and plug leaking tubes. Full access covers shall be provided for feed water heaters upto approximately 1400 mm in diameter. The channel cover thickness shall be calculated as per the HEI standard. When the feed water inlet and outlet connections are located in hemispherical head, the manholes shall be located on the same centre line as the nozzle connections. A tripod arrangement is not permitted. 2.26.43 The pass partition plate shall be thick enough so that the stresses from differential pressure do not exceed the yield strength at the design temperature. The plate shall also be flexible enough to allow a temperature rise across the heater equal to at least twice the value at the design condition. Pass partition shall be welded full length on both sides. The pass partition plates shall have hand holes bolted on the manhole side for access to the other side to plug the leaky tubes. 2.26.44 For each heater the heat transfer area shall be calculated considering 10% of the tubes plugged and for fouling factor as recommended by HEI. The shell side design flow shall be calculated for the abnormal condition of lower pressure heaters taken out of service and for a tube leakage of 20% of the condensate/boiler feed water flow. 2.26.45 Each of the L.P and H.P feed heaters shall have motorized individual and hydraulic bypass valves arrangement respectively to enable it to be taken out of service without necessitating the shutting down of the turbine generator set. If the H.P heaters provided are of single stream type (2 or 3 individual heaters) , then they shall be provided with motorised individual bypass arrangement for each HP heater to bypass feed water in case of very high level in the respective High pressure heaters. A proven group bypass system shall be provided for the same. However if two stream type (2+2 HP heaters in parallel) group HP heaters are provided, then a proven group bypass system shall be provided to isolate one train of HP heaters when necessary. L.P heaters shall be equipped with drain cooler as an integral part. 2.26.46 All level transmitters etc. shall be connected to the heater through separate standpipe which has isolation valves. The standpipe shall have provision for filling / venting and draining. All instruments like level transmitters / controller / gauges etc. around heater and turbine shall be selected so that they withstand heat transmitted from heater. High –High		
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level protection interlock shall be provided for both the HP and LP heaters as a minimum. The heaters shall have suitable lifting arrangement so that heater or shell can be removed for maintenance purpose. Stress relieving of U-Tube bends shall be carried out upto a distance of 150mm from bend area. All flanged connections shall be of the bolted type and the use of studs shall not be permitted unless with special approval. The interior surfaces of all the heaters shall be cleaned of all mill scale. The exterior surfaces shall be painted as required. Stainless steel illuminated armoured type reflex gauge glasses, level indicators with shut off valves, ball checks etc. shall be provided with each heater. Pressure gauges with needle valve and siphon (if required), for each heater shall be provided for each steam inlet, condensate/feed water inlet and outlet. Thermometers with thermometer wells for each heater shall be provided for each steam inlet, drain outlet, condensate/feed water inlet and outlet. 2.27 LP heater drain condensate pump 2.27.1 If LP heater drain condensate pump is envisaged instead of drain cooler, system shall be complete with standby pump ,automatic level controls, interlocks etc. 2.27.2 Material of construction of the LP drain condensate pump shall be same as that of the main condensate extraction pumps. The system shall be designed for complete cascading of the drain condensate to condenser in the event of non availability of both drain condensate pumps. 2.27.3 Power consumption of the drain condensate pumps shall be included in the calculation of total auxiliary power consumption. 2.28 <u>Heater Drain Systems</u> 2.28.1 Normally, the feed water heater drains shall be cascaded to the next lower pressure feed water heater. Drains from the high pressure feed water heater and low pressure feed water heater shall be led to the deaerating feed water heater and surface condenser respectively during normal operation. In addition, the high pressure heater drains		
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shall have alternate path to the surface condenser via flash tanks. The low pressure heater shall have an alternate path to the surface condenser via flash tanks. 2.28.2 The drain system shall be sized for maximum of the following conditions : (a) Ten (10) percent of maximum overload feed water/condensate flow (b) The flow based on the clean rupture of one heater tube resulting in two (2) open ends discharging as orifices. The flow shall be determined for orifices of diameter equal to normal inside diameter of tubes using an orifice co-efficient of 0.9, a pressure differential across orifice equal to the difference between tube and shell design pressures and average tube side water temperature at that condition. (c) Maximum drain flow under abnormal operating conditions. 2.29 <u>Deaerating Feed Water Heater</u> 2.29.1 The deaerators shall meet the design requirements and materials of construction as specified and shall be capable of satisfactory operation under condition of turbine trip and HP-LP steam bypass operation (full open) and lowest condenser back pressure. Outage of the low pressure feed water heater and minimum condenser back pressure shall not affect the deaerator performance in any manner. The design shall be as per IBR, ASME unfired pressure vessels-section VIII or equivalent. De-aerator shall be capable of handling all extreme operating conditions like VWO with 1% makeup operation, HP/LP bypass operation, HP heaters out of service etc. The maximum oxygen content shall not be more than 0.005cc per litre measured as per ASTM D888 or Indigo carmine method at all operating conditions. The carbon dioxide measured by APH method shall be non traceable at all loads. 2.29.2 An efficient steam distribution and deaeration of condensate shall be assured under all the operating conditions. 2.29.3 The equipment shall be capable of stable operation without water hammer, surging or vibration and noise under all the operating conditions including transients and start-up. 2.29.4 The feed water storage tank shall have a net storage capacity as specified in Data Sheet-A6 (6 minutes storage of 100% SGMCR flow) of		
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this Volume at two-thirds level (normal) in the deaerating feed water heater storage tank. The net storage capacity of tank shall be considered as the capacity between normal level and top of boiler feed pump nozzle exclusive of the volume of any internal piping, baffles and also excluding the volume of dished ends. 2.29.5 Spray-tray type Deaerator with guaranteed oxygen removal capacities to be supplied. 2.29.6 The spray type deaerator shall be Stork type or equivalent construction which combines in one vessel the functions of deaerator, pre-heater, vent condenser and feed water storage tank. The design shall incorporate suitable spray valves of disc type or equivalent, splash plates, baffles, grids, etc. which ensures fine atomisation of incoming condensate, rapid heating up by steam and higher residence time. The heating steam shall be introduced into the water stored in the feed water tank through a rake of sparger steam pipes below the minimum water level. The rake shall be suitably supported to prevent vibration during start-up, normal operation and transients. Suitable means shall be provided to prevent back flow of water into steam pipes in case there is any sudden drop in steam pressure. A separate heating steam rake to supply heating steam during start-up shall be provided. These heating steam pipes shall also be suitably supported to avoid excessive vibration during start-up, normal operation and transients. The steam pipe configuration shall be such as to prevent entrainment of any heating steam into boiler feed pump suction lines. 2.29.7 The sprayer in either type of the deaerators viz. spray-tray type and spray type shall be designed to ensure fine atomisation of condensate at all loads upto 110% of the design flow. 2.29.8 The outlet pipes from the feed water storage tank shall be provided with a vortex breaker and project a minimum of 75 mm above the bottom of the storage tank so as to prevent sludge from getting into the suction pipes of the boiler feed pumps. The feed water storage tank shall be provided with two manholes of minimum 500 mm size. In case of spray-tray type deaerator an additional manhole shall be provided at a suitable location in the deaerator section. Liberal passages shall be provided to equalise vapour pressure between the feed water storage tank and the deaerating feed water heater in case of spray-tray type deaerating feed water heater. Access shall be provided to the tray areas. The manholes shall be provided with bolted and hinged manhole covers.		
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2.29.9 The requirements indicated under Section 6.0 of Heat Exchange Institute Standards and Typical Specification for Deaerators shall be strictly adhered to. All the parts within the deaerator, coming in contact with concentrated corrosive gases, shall be of stainless steel or alternatively, clad with stainless steel to a minimum thickness of 1.5 mm. 2.29.10 The low load recirculation flow and the balancing device leak off flow systems from the boiler feed pumps (if required) shall be led to the feed water storage tank. 2.29.11 VOID 2.29.12 The deaerator shall be capable of deaerating all the incoming steam and condensate, H.P. heater drips and emergency make up water at a rate to provide boiler feed to match the boiler MCR requirements continuously. It shall be designed to avoid any stagnation pockets of non-condensable gases. Impingement plates preferably made of 400 series SS material shall be provided for flashed drains from HP heaters, BFP re-circulations, start up drains etc. 2.29.13 The operation of deaerator shall be stable and free from vibration, water hammer when subjected to pressure decay which may occur at full load trip out condition of the TG and during the interval required for change over to the alternative steam source. The tank shall be provided with safety pressure relief valves of adequate capacity. 2.29.14 The deaerator shell and storage tank may go under vacuum during certain abnormal conditions and deaerator and storage tank shall be designed accordingly. The storage tank shall have one support leg fixed and other of sliding type to take care of expansion. The Deaerator shall be provided with Drain connection on the storage tank with manual valve and drain pipe to the basement level, Initial fill line with NRV, motor operated valve, gate valve etc. Vacuum breaker valve shall be provided for deaerator. 2.29.14 The Deaerator shall also be provided with thermometer pockets and thermometers on the storage tank, deaerating section, condensate inlet, feed water outlet from the deaerator water storage tank, steam inlet etc. Pressure gauge and relief valves to conform with the code requirements, Air release valves, Water level gauge illuminated / two (2) nos., level transmitters / level controllers and other instruments mounted on separate stand pipes with isolating valves and provision for initial filling, vent and drain connection. For initiating alarms, protective actions, level indication and level control functions, the following shall be provided as a minimum on the Deaerator Feed water storage tank :		
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a) LOW level b) 'LOW –LOW ' level c) 'HIGH' level d) 'HIGH –HIGH 'level The above listed are a minimum and additional provisions if required during detailed engineering phase shall be provided to make the system complete. 2.30 <u>Boiler Feed Pumps</u> 2.30.1 The boiler feed pump group shall consists of two (2) 50 % capacity steam turbine driven main boiler feed pumps (STBFP) and one (1) 50% capacity electric motor driven standby boiler feed pump (MBFP) with its electric motor drive and variable speed hydraulic coupling . Each boiler feed pump shall have booster pump to meet the net positive suction head (NPSH) requirement of the main pump. The boiler feed pump sets shall meet the requirements specified herein and in Data sheet – A7 of this volume. The pumps shall be designed as per HEI standards. 2x50% BFPs(turbine driven) shall have 10% margin over feed flow corresponding to VWO with 1% makeup condition, design turbine pressure and corresponding load. The best efficiency point shall correspond to 100% TGMCR condition. the shut off head shall be 120% to 130% of the total developed head (TDH) under rated conditions. Frequency variations from 47.5 to 51.5 Hz shall not over load the MBFP motor during all operating conditions of driven equipment. The NPSH(R) at 3% head drop for main and booster pump shall be one third of NPSH (A) at design point with lowest de-aerator level and maximum pressure drop across suction strainer. Minimum recirculation flow shall not be less than 25% of design flow or proven manufacturing standard. 2.30.2 Each STBFP shall be complete with booster pump speed reduction gear drives, coupling between step down gear and booster pump, re-circulation control valve, hydraulic balancing device. 2.30.3 MBFP shall be complete with drive motor, booster pump, shaft couplings, variable speed hydraulic coupling and associated gear drive, lubricating oil system, automatic recirculation control valve, hydraulic balancing device. 2.30.4 The STBFPs and MBFP shall have matching characteristics to enable smooth parallel operation of STBFP'S or STBFP with MBFP over full range of capacity, and shall be of identical design to provide total interchangeability.		
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2.30.5 Each pump shall be capable of operating continuously at run-out condition at any turbine load. BIDDER shall indicate limitation if any on the pump operating at any flow, preferably by defining the operational window in the pump characteristics. 2.30.6 For modulating type the recirculation control shall be by a flow measuring primary element in the boiler feed pump suction line between each individual booster pump and boiler feed pump. The recirculation flow from each pump will be independently led to the deaerating feed water heater. 2.30.7 Leak off from the balancing device of each boiler feed pumps will be separately led to the deaerating feed water heater, with a device to monitor the balancing drum or disc (flow measuring device or pressure switch etc) in each line to monitor the extent of wear in the balancing device or can be connected back to BFP suction depending upon proven manufacturers standard. 2.30.8 In designing the system, attention shall be paid to minimization of slip losses, by adjusting the head between booster and main pump. While adjusting the same adequate attention shall be paid to the NPSH requirements of the main and the booster pumps during normal operation and transients. Location of deaerating feed water heater and offset of suction piping from pumps shall be such that the margins on net positive suction head (NPSH) required by pump during normal and transient conditions, would be as per Data Sheet-A7 and flashing/steaming in suction lines is avoided under all operating modes. The pump casing design pressure for turbine driven BFP shall be total design head(TDH) at minimum flow with pump operating at trip speed under lowest operating water density. For motor driven BFP The pump casing design pressure shall be total design head(TDH) at minimum flow with pump operating at speed corresponding to 51.5Hz under lowest operating water density. Balancing drum / disc shall be designed to balance 95% of total pump axial thrust. 2.30.9 A pump warm-up system shall be included in case BIDDER's pump required the same. In case BIDDER does not recommend provision of same, the same shall be substantiated by proven experience. However rapid start-up of pump set shall be possible from any operational condition i.e. cold or partially warmed-up. 2.30.10 The over-riding consideration in the design of the offered pump set is the reliability in operation and the design shall be on the operating experience of the supplier for identical or closely similar pumps and pump features.		
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2.30.11 The main boiler feed pump and the booster pump shall have a characteristic of rising head with reducing flow. 2.30.12 The VENDOR shall furnish calculations to justify the acceptability of the location of the deaerating feed water heater with respect to margins over the required NPSH by the pump during normal and transient conditions. The transient condition, would be during a turbine trip with HP-LP steam bypass system in operation with the preceding low pressure heaters out of service, boiler trip condition or any other condition. The calculations shall have to be approved by PURCHASER / ENGINEER. 2.30.13 During normal operation the discharge valve of standby BFP set would be kept normally open. Each BFP set as a whole shall be capable of withstanding the reverse rotational speeds which would result from non-return valve failure under the most severe condition (i.e. remaining normally working pumps operating at full speed) and provided with a suitable instrumentation to detect reverse rotation of pumps due to backflow of water after motor is tripped. CONTRACTOR shall provide reverse rotation detection system to close discharge valve on detection of same. 2.30.14 Pump characteristic curve test tolerances shall be limited to : <table> <tr> <th></th><th>Plus(%)</th><th>Minus(%)</th></tr> <tr> <td>(a) Flow at guarantee point</td><td>0</td><td>0</td></tr> <tr> <td>(b) Head at guarantee point</td><td>3</td><td>0</td></tr> <tr> <td>(c) Efficiency at guarantee point</td><td>Unlimited</td><td>0</td></tr> <tr> <td>(d) Shut-off head</td><td>5</td><td>0</td></tr> </table> These tolerances shall be the permissible variations between the conditions as proposed initially by the VENDOR and the design parameters demonstrated during acceptance tests 2.30.15 Pumps with high suction specific speed not proven in practice are not acceptable. The impeller shall be designed for a minimum 40,000 hours operation. 2.30.16 The pump shall preferably be capable of dry running and under vapour locked condition for a sufficient duration without any damage under following operating condition :				Plus(%)	Minus(%)	(a) Flow at guarantee point	0	0	(b) Head at guarantee point	3	0	(c) Efficiency at guarantee point	Unlimited	0	(d) Shut-off head	5	0
	Plus(%)	Minus(%)															
(a) Flow at guarantee point	0	0															
(b) Head at guarantee point	3	0															
(c) Efficiency at guarantee point	Unlimited	0															
(d) Shut-off head	5	0															
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(a) Complete loss of water due to incidents such as closure of suction valve. Under such conditions, the pump shall be capable of being shutdown in a controlled manner and brought to rest safely. (b) Transient reduction in suction pressure well below that required for cavitation free operation. 2.30.17 The BIDDER shall indicate the duration of the above operations for which the pump is designed and special features incorporated in the pump design to withstand the vapour lock condition. 2.30.18 All component parts including spares and spare assemblies shall be completely interchangeable. The spare rotor, if specified, shall be performance tested in any one of the pumps furnished. 2.30.19 In the event the normal sound level exceeds the allowable level specified in Data Sheet – A7 of this Volume, acoustical treatment features, subject to the PURCHASER's / ENGINEER's review and acceptance, shall be in the basic scope to achieve the specified sound level. The acoustic enclosure shall be of the pre-fabricated modular type, designed for easy assembly and dis-assembly. The performance of the acoustic device shall not be subjected to deterioration due to assembly / dis-assembly. 2.30.20 The pump motor rating shall not be less than the larger of the following : (a) Sufficient to drive the pump through the entire range of run-out flow to shut-off conditions. (b) 110% of pump design point rating. 2.20.21 Casing vent and drain connections with plugs and valves shall be provided, as required. 2.30.22 All bearings shall be provided with a forced lubrication from a common oil system. The thrust bearings shall be of tilting pad or any other proven type and suitable arrangement shall be provided to adjust the clearances. Also the design of lubricating oil system should take into account the oil requirements of the motor wherever thrust bearings are fitted. Bearings shall be easily accessible without disturbing the pump. Each bearing housing shall have a drain plug. 2.30.23 A suitable axial thrust balancing arrangement preferably balancing drum shall be provided. The balance drum leak-off shall be lead back to pump suction.		
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2.30.24 BFP set shall be provided with flexible couplings of approved type between the motor, hydraulic coupling and pumps. The coupling shall be designed to accommodate the existing expansion and movements. They shall be provided with guards. 2.30.25 The supports shall be arranged to provide equipment removability without disturbing the grouted in members. Suitable levelling, jacking and aligning devices shall also be provided for field adjustment. 2.30.26 Adequate space shall be provided between pump drain connections and base plate for installation of minimum 15 mm drain piping. Pumps shall be supplied with suitable drain pipes or drain rim type base plates with tapped drain connections. 2.30.27 Each BFP set shall have a single common lubrication system. The lubrication system shall include, but not necessarily be limited to, a shaft driven oil pump, a spare full capacity electric motor driven oil pump, all piping valves, return flow sight gauges, relief valves, oil coolers, pressure and temperature switches, duplex or two simplex filters, pressure gauges, flow control devices, oil level indicators, supply thermometers and return oil thermometers for each bearing and an oil reservoir. All oil piping, valves and fittings shall be of carbon steel and shop fabricated. One DC motor driven emergency lubricating oil pump with drive and starter shall be provided (if required). Both STBFPs and MBFP shall have adequate handling facilities for handling / maintenance of pumps / cartridges, motors, coolers , fluid couplings etc. Station building EOT crane can be used wherever possible , otherwise suitable 2.30.28 <u>Mechanical seals</u> (a) Mechanical seals shall be selected on the basis of proven long term operating experience in a BFP environment. The mechanical seals shall have a life expectancy of atleast 15,000 hours. (b) A cooling jacket shall be incorporated in the gland design. This shall consist of a water circulation ring, magnetic filter and sealing water cooler. Auxiliary cooling water shall be used for the cooling and the system shall have a suitable filling, venting and draining arrangement. 2.30.29 <u>Variable speed hydraulic coupling</u>		
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(a) This shall be of Voith design or equivalent and shall be rated for maximum duty of the main pump of the BFP set. It shall be combined gear box and fluid coupling type and shall be adequately rated to meet the requirements of pump characteristics. It shall be equipped with a complement of gears, SS casing and impellers, self supported bearings, pillow blocks, Kingsbury/Mitchell thrust bearing, removable covers, oil sump, duplex 5Micron filters, motor driven oil pumps and duplex oil coolers to provide a satisfactory operation for the working oil and lubricating oil systems for a pump set. (b) The variable speed fluid coupling shall transmit the drive from the motor to the pump in such a manner that under normal operating conditions the pump speed can be steplessly varied over a range of 20% to 100% of pump rated speed. (c) The scoop tube shall be operated by a servo positioner which is powered by the coupling lubricating oil system. A stepper motor shall interface with the servo positioner with a suitable linkage provided. A special requirement is the need for rapid starting and response to control signals. The coupling and its auxiliaries shall be designed to reduce inherent time lags to a minimum. The start-up time for the complete BFP set is to be not more than 15 seconds and if necessary, solenoid valves shall be provided in the fluid coupling control system to achieve this. 2.30.30 Suitable Gear Box shall be furnished between STBFP and its booster pump made of proper materials, instrumentation, bearings etc., designed as per code AGMA 401 or 402. <u>2.31 Steam Turbine Drive</u> 2.31.1 The boiler feed pump system shall include either 2X50 % capacity steam turbine driven and 1X50 % capacity electric motor driven boiler feed pump with variable speed hydraulic coupling, as elaborated elsewhere in this specification or 3x50% capacity electric motor driven boiler feed pump with variable speed hydraulic coupling. The steam for each boiler feed pump turbine drive (BFPTD) shall be supplied from cold reheat piping during startup and low load operation. During normal operation the steam shall be supplied from intermediate pressure (IP) low pressure (LP) cross around piping of the main steam turbine generator / or from any other point in steam path, optimized by the bidder. 2.31.2 The BFPTD shall be designed for single admission from steam sources. Alternatively, steam chest shall be designed with separate steam lines for dual admission. The dual steam admission features shall include stop valves, control valves, and nozzle ring. The control of HP and LP control		
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valves shall be integral to provide smooth, continuous automatic operation of BFPTD over the entire operating range. 2.31.2 Steam turbine drive shall have a suitable electric motor driven / hydraulic type rotor turning gear. 2.31.3 The exhaust connection of each BFPTD shall be bolted to the exhaust steam ducting through a transition piece (if required), for disposal of the exhaust steam to the main condenser. 2.31.4 Horizontal portion of the exhaust steam piping shall be provided with a slight continuous slope towards the main condenser to ensure its positive drainage. 2.31.5 The gland sealing steam supply to the BFPTD shall be provided from the main turbine sealing system supply header. 2.31.6 A common lubricating / control oil system for both BFPTD and steam turbine driven boiler feed pumps (STBFP) shall include but not be limited to the following : a) One (1) AC motor driven main oil pump with drive motor (MOP) b) One (1) AC motor driven auxiliary oil pump with drive motor (AOP) c) One (1) DC motor driven emergency oil pump with drive motor d) One (1) lubricating oil tank with integral strainer, it shall have a retention-time of at least 5 minutes . e) Two (2) AC motor driven vapour extractors with drive motor. f) Two (2) full capacity oil coolers <u>Speed Governing System</u> 2.31.7 BFP TD shall be provided with a speed governing system capable of controlling and regulating BFPTD speed in conformity with the feed water control system 2.31.8 BFP TD shall be designed with electro-hydraulic control (EHC) system as its primary control system. The control system shall be capable of adjusting the turbine speed over the entire governing range. 2.31.9 EHC system shall :		
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a) Be complete with all initiating devices for tripping and resetting BFPTD. b) Facilitate testing of all steam admission valves on a periodic basis, while in operation at rated speed. c) Have redundant power supply unit d) Have provisions for self monitoring of redundant circuits 2.31.10 The speed governing system shall limit BFPTD speed to a value less than the setting of the over speed governor in case of a full load tripout. 2.31.11 BFPTD shall be equipped with independent trip devices in the form of duplicate emergency over speed governors. These shall be mounted on the BFP TD shaft and shall be arranged to actuate a trip device at a predetermined speed which will be provided for testing the operation of the emergency overspeed governors under simulated overspeed conditions, whilst BFPTD is operating at any load. <u>BFPTD Protection System</u> 2.31.12 The protection system shall include but not limited to the following : a) Overspeed emergency governors b) Low lube oil pressure for trip c) Thrust wear trip e) Low control fluid pressure trip f) High exhaust hood temperature alarm trip. g) Low vacuum unloader <u>BFPTD drain system</u> 2.31.13 Protection against water induction shall be provided. Bidder shall state in the Bid specific requirements for protection against water induction. 2.31.14 All the bearings shall be designed to avoid oil whip under all operating conditions. The bearings shall be spherically seated, forced feed lubricated type. Lined with Babbitt material or other suitable anti-friction alloy. The thrust bearing shall be of Kingsbury or suitable pad type.		
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2.31.14 The BFP shall be driven through disconnect flexible coupling or any other proven flexible coupling. The disconnect coupling shall be automatically disconnect the driven equipment from the drive turbine so as to permit independent operation of the drive turbine on turning gear. <u>STBFP Lubrication</u> 2.31.15 The lubricating oil for each STBFP, drive turbine, booster pump and gear drives will be supplied from the steam turbine drive lubricating oil system. 2.32 <u>Hotwell Make-up and Excess Condensate Dump System</u> 2.32.1 The hotwell make-up system shall supply demineralised water from the condensate storage tank to the surface condenser. Excess condensate if any, in the condenser hotwell shall be dumped out of turbine cycle by excess condensate dump system to the condensate storage tank.. Hotwell make-up system shall also be used for initial fill of turbine cycle system. 2.32.2 Two full capacity electric motor driven centrifugal hotwell make-up pumps shall be provided for each turbine generator unit . Rated flow of each pump shall be sized considering a flow of 5% TG VWO flow. The system shall have a normal make-up control valve to be sized for 0.5% of feed water flow rate at turbine generator (TG) valve wide open (VWO) condition and an suitable emergency make-up control valve to be sized for hotwell make pump rated flow condition. In addition, to these control valves a manual quick fill line shall be provided to shorten the period for filling up of condenser. 2.32.3 Excess condensate dump system would dump the excess condensate in condenser hotwell to the condensate storage tank through an excess condensate dump line downstream of condensate extraction pump discharge. The excess condensate dump line would be provided with an excess condensate dump control valve sized for not less than 10 percent TG VWO flow. <u>Control valves for system</u> 2.32.4 The control valves and accessories shall be designed and tested in accordance with the latest applicable requirements of the code for pressure piping ANSI B 31.1, ASME boiler and pressure vessel code, IBR etc., and also in accordance with requirements of safety and health standards. The startup system control valves and HP&LP bypass control valves shall be of proven type in the same application. The design of valves shall meet the requirements of ANSI for dimensions, material specification and thickness. The sizing shall be suitable for obtaining rated flow with 80% stem travel and minimum flow		
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with 10% stem travel. The valves shall be capable of handling 110 to 120% of rated flow. The valves port outer velocity shall not exceed 8m/s for liquid services , 150m/s for steam and 50% sonic velocity for flashing services. The valves shall be designed to avoid cavitations, wire drawing and flashing on the down stream side. Anti cavitation trim or trim cages shall be provided wherever necessary(CEP recirculation and Deaerator level control services. The valves construction shall be of globe body and straight pattern design, high lift cage guided one piece plugs & quick change trims, flanged and bolted bonnets(or welded bonnets as per manufacturers design), vacuum sealing for valves in service under vacuum conditions, valve characteristics shall match with process characteristics and extended bonnet construction when the temperature of fluid handled is more than 280⁰C. the valve body rating shall be as per ANSI B16.34 The material selection shall be 316 SS with satellite facing for trims and body material suitable to pipe material for non-corrosive, non flashing and non cavitation services , Alloy steel ASTM A217 Gr WC9 valve body and 400 series SS for trim for flashing / cavitation services, 316 SS body and 316SS trim for condensate below 300 ⁰C. The valve testing requirements are NDT and hydrostatic shell test, valve closure and seat leakage tests as per ANSI B16.34, valve and actuator functional tests and CV test as per ISA 75.02 All control valves shall be sized such that the valves are controllable over entire operating regime viz. low load to VWO flow condition. The control valves which require to be operated during cold, warm and hot start conditions shall also be controllable during the respective mode of operation. To meet the above requirements if CONTRACTOR provides more than one control valve, the controllable ranges of the control valves shall overlap to ensure bumpless transfer from one control valve to other. The control valves shall not cause noise and the noise level shall be within the permissible limits of 85 dB in A scale at a distance of 1.5 metre. For other requirements of control valve refer relevant C&I sections. Leakage class for the control valves shall be class V / class VI as per ANSI/FCI-70-2- 1976(R1982), depending on metal to metal seat or soft seats. 2.33 <u>Lube Oil Centrifuge</u> An AC motor driven centrifugal type lube oil purifier shall be provided for the water and particle / sludge removal from lubricating oil, other than STG lube oil which has its own separate purifier. It shall be designed to purify the various lubricating oils used.		
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2.34 <u>H₂ , CO₂ and O₂ Cylinders</u> 2.34.1 The number of H₂, CO₂ and O₂ cylinders shall be equal to total requirement for one start up and one shut down of two units plus those required to be connected on manifolds of all units plus total requirements for seven days consumption of all units. The Contractor shall supply H₂ and CO₂ gas till completion of trial operation. 2.34.2 Getting necessary approval from chief controller of explosives is in the scope of the Contractor. The Contractor shall also furnish the necessary test certificates and filling certificates. 2.35 CHEMICAL DOSING SYSTEM The CONTRACTOR shall provide all the necessary unloading, storage, handling, measuring, dilution and metering systems for feed water chemical dosing. Oxygenated treatment (OT) along with all volatile treatment (AVT) is proposed for feed water treatment. AVT is to be adopted for emergency conditions, such as start up, shut down and condenser tube leakage conditions. OT is to be adopted for normal continuous operation. Hydrazine and phosphate is not to be used for feed water treatment. The feed water treatment program as given below is intended to achieve highest purity of feed water / steam / spray water to enhance efficiency, improve availability and reduce clean out periods. <table border="1"> <tr> <td>CONDITIONS</td> <td>Startup</td> <td>Shutdown</td> <td>Condenser Tube Leakage</td> <td>Normal Continuous Operation</td> </tr> <tr> <td rowspan="2">Dosing Chemicals</td> <td colspan="3">AVT TREATMENT</td> <td>OXYGENATED TREATMENT</td> </tr> <tr> <td colspan="3">Ammonia dosage is proposed @ 0.5-1.5 mg/l</td> <td>Gaseous oxygen treatment is proposed for feed water conditioning along with ammonia (0.07 mg/l) as a volatile alkanising agent</td> </tr> </table>					CONDITIONS	Startup	Shutdown	Condenser Tube Leakage	Normal Continuous Operation	Dosing Chemicals	AVT TREATMENT			OXYGENATED TREATMENT	Ammonia dosage is proposed @ 0.5-1.5 mg/l			Gaseous oxygen treatment is proposed for feed water conditioning along with ammonia (0.07 mg/l) as a volatile alkanising agent
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	Ammonia dosage is proposed @ 0.5-1.5 mg/l			Gaseous oxygen treatment is proposed for feed water conditioning along with ammonia (0.07 mg/l) as a volatile alkanising agent														
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2.35.1	The target levels to be guarantees are as follows : a) Specific conductivity of make up water (At hotwell) < 0.1 micromho/cm b) pH and conductivity at CPU inlet (refer CPU section for each condition, viz, startup, shutdown, tube leakage and normal continuous operation). c) Cation conductivity at CPU outlet < 0.1 micromho/cm at 25deg C after removal of all amines. d) Sodium and silica at CPU outlet (refer CPU specs) e) pH at Economiser inlet 8-8.5 (for copper free metallurgy) f) Cation conductivity at economiser inlet <0.15 micromhos/cm g) Oxygen at economiser inlet 30-150 ppb h) Iron at economiser inlet ≤2 ppb (achieve <0.5 ppb at normal full load) i) Sodium at Main & Reheat Steam ≤ 2 ppb j) Silica at main and reheat steam ≤ 10 ppb k) Cation conductivity at main and reheat steam ≤ 0.15 micromho/cm. L) Chloride and sulphate at main and reheat steam ≤ 2 ppb	
2.35.2	In addition to the above, the BTG supplier shall provide proven measurement cum monitoring technology for condenser air – in leakage and iron at economiser inlet.	
2.35.3	Ammonia and Oxygen shall be dosed on high purity condensate and feed water to achieve the above targets. Ammonia dosing points shall be upstream and downstream of CPU and BFP suction while oxygen dosing shall be at BFP suction with alternate connection to CPU outlet.	
2.35.4	Ammonia dosing system for each 660 MW unit shall consist of 2 nos ammonia preparation cum measuring tank with dilution connections from pure DM water and funnel filling connections of ammonia carboys through hand pumps. 2x100% ammonia metering pumps shall be provided to dose required ammonia at the dosing points given above.	
2.35.5	Commercial ammonia of 25% concentration is envisaged. Dosing shall be performed @ 1% concentration. Capacity of preparation cum measuring	
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tanks shall be based on one days dosage requirement based on minimum and maximum dosages (normal and startup). 2.35.6 The dosage, monitoring and control is to be performed through CCR (DCS) based on ph measurement and dosage stroke length control. Control valves shall be provided at all dosing points, linked to pH measurement and pumps. 2.35.7 Low level alarms and agitator protection interlocks shall also be provided through DCS. 2.35.8 Oxygen dosing is envisaged from pressurised oxygen cylinders of >99.5% purity. There shall be 2 banks of cylinders, each across an auto switch over valve. Each bank shall consist of 12 cylinders. Cylinder storage shall be provided in power house for one months requirement. All pipe lines shall be of SS316 grade, 2.35.9 Both oxygen and ammonia dosing skids shall be located in power house 0.0 m floor. The drains from the skids shall be collected and led to CEP pit. A Safety eye wash shower shall be provided beside each skid with potable water connection. Process P&ID and sizing calculations shall be reviewed during bidding stage. 2.36 <u>Auxiliary Coolers</u> All the auxiliary heat exchangers provided for the entire STG unit & accessories shall be designed to meet requirements of TEMA-C, unless otherwise specifically mentioned. 2.37 Specific Piping Requirements Piping shall be as detailed in Section C4 of Volume IIIA		
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SECTION: C3

SPECIFIC PIPING

DESIGN REQUIREMENTS

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3. SPECIFIC PIPING REQUIREMENTS This Section covers the basic requirements for the all the piping systems, valves and specialties and thermal insulation to be provided for the power plant (inclusive of both SG and STG Package). 3.1 LINE SIZING 3.1.1 Sizes of pipelines shall be selected such that the velocity of fluid in pipes does not exceed the following limits under conditions of maximum possible volumetric flow: Steam <table><tr><td>Superheated steam</td><td>75 m/s</td></tr><tr><td>Saturated steam</td><td>40 m/s</td></tr><tr><td>Wet steam/Exhaust steam</td><td>30 m/s</td></tr></table> Water <table><tr><td>Pump suction</td><td>1.5 m/s</td></tr><tr><td>Pump delivery</td><td>3.0 m/s</td></tr><tr><td>Boiler feed pump discharge</td><td>6.0 m/s</td></tr><tr><td>Service/Potable water</td><td>1.5 m/s</td></tr></table> Oil <table><tr><td>LDO</td><td>2 m/s</td></tr></table> Air <table><tr><td>Compressed air</td><td>15 m/s</td></tr></table> 3.1.2 Lower values of velocities than those stated above shall be used to determine line size if dictated by considerations of pressure drop, NPSH, surges, water hammer, etc. 3.1.3 The design flows considered in line sizing shall not be less than the rated capacities of equipment to which the piping is connected such as pumps, blowers, compressors, valves, flow limiting orifices, etc., or, the system heat and/or mass balance diagrams. 3.1.4 Sizes of Boiler feed pump suction piping shall be selected to meet the NPSH requirements of the pumps under transient conditions prevailing on loss of steam supply to feed water tank. Similarly for all pumps, NPSH requirements shall be satisfied in line sizing.			Superheated steam	75 m/s	Saturated steam	40 m/s	Wet steam/Exhaust steam	30 m/s	Pump suction	1.5 m/s	Pump delivery	3.0 m/s	Boiler feed pump discharge	6.0 m/s	Service/Potable water	1.5 m/s	LDO	2 m/s	Compressed air	15 m/s
Superheated steam	75 m/s																			
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3.2

MATERIALS

The material specifications of pipelines of various systems shall be as specified in Data Sheet – A16 attached to this specification.

3.3

WALL THICKNESS

3.3.1

The calculation of wall thickness required for pipelines subject to internal and/or external pressure shall be based on the formulae and recommendations as given in the applicable codes. Adequate allowances shall be made towards thinning due to bending, weakening at branch connections, threading, commercial tolerances on pipe wall thickness, corrosion and erosion, etc. and the same shall be subject to approval by ENGINEER. In any case a minimum corrosion allowance of 0.75 to 1.0 mm (satisfying IBR requirement) shall be considered while selecting the thickness.

3.3.2

In case of carbon steel materials, the nominal wall thickness of pipeline shall be not less than the minimum acceptable values given below:

NB mm	15	20	25	32	40	50	65	80	100	125
(inch)	(1/2)	(3/4)	(1)	(1 1/4)	(1.5)	(2)	(2.5)	(3)	(4)	(5)
Min. thickness, mm	3.2	3.2	3.6	3.6	3.6	3.6	3.6	4.0	4.5	5.4

NBmm	150	200	250	300	350	400	450	500	600
(inch)	(6)	(8)	(10)	(12)	(14)	(16)	(18)	(20)	(24)
Min. Thickness, mm	5.4	6.35	6.35	6.35	7.1	7.1	7.1	8.0	8.0

> NB 600 mm to NB 950 mm - 10.00 mm

> NB 950 mm to NB 1200 mm - 12.00 mm

Sizes of NB 32(1¹/₄"), NB 65(2¹/₂"), and NB 125(5") shall not be used in the piping system.

3.4

FLEXIBILITY ANALYSIS

3.4.1

Formal flexibility analysis calculations shall be carried out in case of pipelines subjected to restrained thermal expansions or contractions. The following piping systems shall be analysed:

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(a) Pipelines with a maximum operating temperature equal to or greater than 150°C (b) Regardless of their operating temperatures, all pipelines connected to sensitive rotating equipment such as turbines, feed pumps etc. for which limiting values of pipe reaction have been specified by the equipment manufacturer (c) Any other pipeline which in the opinion of the OWNER/ENGINEER requires a formal analysis. 3.4.2 If it is deemed necessary by the boiler or turbine vendor, a surge analysis shall be carried out by the Contractor to evaluate the effect of closure of valves that are hydrostatically or pneumatically actuated. The pressure rise in the pipeline, additional forces and moments at terminal points and additional stresses shall be calculated. If the stresses or the forces and moments exceed the allowable value, suitable shock absorbers shall be provided by the Contractor. 3.5 LAYOUT AND DETAILING 3.5.1 All pipelines with size greater than NB 50 mm are considered as shop fabricated piping and detailed piping layout drawings shall be prepared for all such pipelines. The drawings shall be to scale and shall be prepared as plan & sections and shall carry the following minimum details: 3.5.1.1 Fully dimensioned layout with locating dimensions referred to plant axes and coordinates 3.5.1.2 Details of all stub connections and other welded attachments as required for anchors, restraints, hangers supports, etc. 3.5.1.3 Slope, drains and vents, all vents and drain lines shall be extended to nearest drain 3.5.1.4 Edge preparation details of weld ends 3.5.1.5 Mounting and orientation of valves and specialties and maintenance space requirements 3.5.1.6 Location and tag numbers of hangers, supports, restraints, anchors, etc. 3.5.1.7 Location and magnitude of cold cuts, if any 3.5.1.8 Pipe sizes, materials, design parameters, shop and field test requirements		
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3.5.1.9 Insulation details 3.5.1.10 Tolerances, if any 3.5.1.11 Any specific requirements on shop fabrication and/or field erection 3.5.1.12 Any other detail considered necessary by the Owner / Owner's representative. 3.5.2 Pipelines with a size of NPS 50 mm or smaller are regarded as field routed. CONTRACTOR shall however indicate any specific requirements he may have in regard to the routing of these pipelines. 3.5.3 Detailed bills of material shall be prepared for all piping systems. In case of shop fabricated piping, the bill of material shall correspond to the layout drawing prepared. 3.5.4 While routing piping, the following requirements shall be taken into account: 3.5.4.1 All piping shall be routed so as to avoid interference with other pipes and their hangers and supports, electrical cable trays, ventilation ducting, structural members, equipment, etc. Adequate clearances shall be ensured with respect to the above to accommodate insulation and pipe movements. 3.5.4.2 All piping shall be grouped where practicable and shall be routed to present a neat and aesthetic appearance. 3.5.4.3 The piping shall be arranged to provide clearance for the removal of equipment requiring maintenance and for easy access to valves and other piping accessories required for operation and maintenance. Layout drawings shall indicate valve orientations and availability of access to valves and specialities. Layout of all piping shall ensure that all valves including motor operated valves are located as to be accessible conveniently for operation. Valves for operation and maintenance shall have 1.0 m clear approach space. If any of the valves are not accessible, suitable access platform shall be provided by the CONTRACTOR. 3.5.4.4 Piping shall generally be routed above ground but, where specifically indicated/approved by the ENGINEER the pipes may be arranged in trenches or buried. Pipes at working temperatures above the ambient shall however not be buried.		
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3.5.4.5 Where steel piping is required to be buried, the pipe work shall be protected from soil corrosion by suitable anti-corrosive treatment as specified. 3.5.4.6 Overhead piping shall have a minimum vertical clearance of 2.3 metres above walkways and working areas and 7.0 metres above roadways unless otherwise approved by the ENGINEER. 3.5.4.7 Drains shall be provided, at all low points and vents at all high points as per actual layout regardless of whether the same have been shown in the flow diagrams or not. Pipelines shall be sloped towards the drain points. 3.5.4.8 Besides at low points, tell tale drains shall be provided at other points as necessary to remove on-line valves and specialities from piping for repair and replacement. Wherever spray water is introduced into steam piping, at a suitable location downstream, drain pots shall be envisaged along with motor operated drain valves and high and low level switches. The drain valves shall be interlocked with the level switches for automatic operation. For operating temperatures of greater than 400°C, drip leg with drains, operated by a motor operated valve shall be provided. At all other drain locations (operating temperatures less than 400°C) traps shall be provided. All traps shall be provided with strainers, isolating, bypass and free blow valves. Traps shall be thermodynamic type. 3.5.4.9 Provision shall be made while preparing piping layout to accept control valves, flow measurement element and any other on-line speciality or equipment. Sufficient upstream and downstream lengths shall be provided for flow measuring devices, control valves, desuperheaters and other specialities as required by the respective equipment manufacturer. 3.5.4.10 In all the screwed valves and screwed connections on equipment, unions shall be provided to facilitate disassembly. Likewise, unions shall also be provided at suitable points on straight length of screwed pipelines. 3.5.4.11 At all points where pipes pass through concrete floors or brick or other walls, suitable floor collars or wall boxes shall be provided. The CONTRACTOR shall design and furnish the details of the floor collars to the ENGINEER/OWNER. 3.5.4.12 In the case of flanged pipe work, boxes shall be large enough to permit the passage of the flange. 3.5.4.13 All pipe racks shall be provided with walkways of 750 mm wide. 3.5.4.14 All pipe bends shall have a radius of five nominal pipe diameter. Lesser radius may be allowed on case to case basis only in case of layout restriction.		
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3.5.4.15 All oil piping shall be arranged such that these shall be below of away from the high temperature steam pipes or other heated surfaces. 3.5.4.16 All bearing oil drain lines and cooler outlet water flow lines shall be provided with visual indicator with rotational wheel (if possible) for observation of flow from a local platform or operating floor. 3.5.5 Hangers and Supports 3.5.5.1 All piping supports, guides, anchors, turnbuckles, rod hangers, spring hangers, rollers, with incidental structural subframing shall be designed by the CONTRACTOR. 3.5.5.2 The hangers and supports shall be spaced in accordance with standard engineering practice as outlined in applicable codes and standards. 3.5.5.3 The CONTRACTOR shall ensure that the location of the hangers and supports shall not increase the forces and moments on the equipment beyond their allowable values. 3.5.5.4 If severe vibration of piping is encountered in systems over which the CONTRACTOR has control or if the piping system is to be subjected to shock loading, hangers shall be supplemented by vibration-control equipment of an approved design. 3.5.5.5 At locations where lateral or axial movement is expected, the hangers shall be provided with suitable linkages to permit swing. All hangers shall be designed to be vertical in the hot position unless otherwise approved by the ENGINEER. 3.5.5.6 In order to minimise any horizontal force components of the dead weight or any binding of the pin or rocker joints used on the hangers, the hanger rods should be as long as possible. In critical piping systems, the length of the hanger assembly capable of swinging shall not be less than 20 times the maximum expected pipe movement in the horizontal plane at the hanger location. It is recommended in case of main steam piping to provide for a hanger rod length of atleast 5-6 metres wherever feasible. 3.5.5.7 Constant support type of hangers shall be adopted at all locations on critical piping excepting where the smallness of vertical movements of pipe justifies the use of variable spring hangers. 3.5.5.8 As far as practicable, connections of hangers to supporting structure shall be achieved without welding to structural members. If welding is inevitable, adequate factor of safety shall be considered in the design and specification of the weld.		
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3.5.5.9 The attachment of support brackets to brick walls shall be avoided as far as possible and where this is not possible, details of the attachment shall be furnished to the ENGINEER for his approval. Under unavoidable circumstances, when medium or heavy brackets are bolted to walls, back plates of adequate size and thickness shall be furnished to distribute the load against the wall. Where the use of a back plate is not practical, the brackets shall, be fastened to the wall in an approved manner. 3.5.5.10 Diameter of hangers for piping NB 50 mm and smaller shall not be less than 10 mm and for piping with size NB 65 mm and larger shall not be less than 13 mm. 3.5.5.11 All components for hangers such as turn buckles, clamps, etc. shall be of forged / fabricated steel as per the relevant standards. 3.5.6 <u>Fittings and Flanges</u> 3.5.6.1 Branch connections in piping shall be made by the use of wrought or forged seamless fittings such as tees, laterals and crosses meeting IBR requirements. Small stubs as may be required for instrument, drain and vent connection may be provided in the form of weld outlet fittings or forged couplings. Intersection welds are acceptable only in the event of non-availability of fittings. 3.5.6.2 Wherever pipe bends are employed for change of direction the same shall be to a radius of 5 times the pipe diameter. 3.5.6.3 Mitred bends may be adopted for piping systems upto a design pressure 10 bar (g) only. Mitre angle shall not exceed 22.5 degrees. 3.5.6.4 Slip-on type of flanges may be only upto a maximum pressure rating of ANSI 300 lbs. In case of higher pressure ratings, weld-neck type of flanges shall be employed. 3.5.7 <u>Dimensional Standards</u> 3.5.7.1 Uniform dimensional standards for all piping components shall be employed to ensure compatibility with each other. 3.5.7.2 Nominal pipes sizes and pipe outside diameters shall generally be as per ANSI B36.10. In case of deviation CONTRACTOR shall bring it to the specific attention of ENGINEER for prior approval stating reasons for the deviation. 3.5.8 <u>Instrument Connections</u>		
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3.5.8.1 Unless otherwise called for by OWNER all thermowell stubs shall have an internal threading to M33 x 2. 3.5.8.2 All stubs for pressure or flow measurement for pipelines with a maximum working pressure equal to or above 62 bar(g) or with a maximum working temperature equal to or above 350°C shall be NPS 25 mm and double root valves shall be used. 3.5.8.3 Stubs for pressure or flow measurement on pipelines with a maximum working pressure less than 62 bar(g) and a maximum working temperature less than 350°C shall be of NPS 15 mm size and single root valves can be used. 3.5.8.4 Measurement stubs on fuel oil lines shall be of NPS 25 mm size and provided with two root valves. 3.5.9 <u>Drain and Vent Connections</u> 3.5.9.1 Drain and vent connections on pipelines shall be atleast of NPS 25 mm size. 3.5.9.2 For pressure and temperature conditions as defined in Clause 5.8.2, double isolating valves shall be used on drain and vent lines. For pressure and temperature conditions as defined in Clause 5.8.3, single isolating valves are considered adequate. Where with single root valve, instrument and root valve are not accessible, double root valve shall be provided with one root valve near the tap off and the second root valve with instrument at accessible point. For fuel oil drain and vent lines double isolation valves shall be provided irrespective of the pressure and temperature. 3.6 WELDING AND HEAT TREATMENT All heat treatment, welding, post and pre weld temperatures shall be as per the code ASME B31.1. 3.7 INSPECTION & CLEANING 3.7.1 All pipes shall be hydrotested at shops for pressures as per standards and all erected piping shall be tested 1.5 times the design pressure. All other inspection requirements shall be as per the enclosed data sheet – A1. 3.7.2 All hot bent, forged formed, fabricated and straight pipes shall be chemically cleaned, pickled or wire brushed and purged with air blast or shot/grit blast to remove all sand and scale from the inner surface as applicable.		
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3.7.3 The Contractor shall carryout the following cleaning after hydrotest. (a) All piping shall be mass flushed, in addition to the specific cleaning operations as described below, as required. (b) Main steam, HP bypass piping shall be steam blown. (c) Extraction steam, condensate, boiler feed suction and discharge, heater drains and vents shall be alkaline flushed. (d) Auxiliary steam piping and associated steam lines, heavy fuel oil piping shall be steam blown. (e) Compressed air piping shall be blown by air. (f) Turbine lubricating oil piping shall be pickled 3.7.4 Contractor has to arrange chemicals, pumps, piping, valves, dummy devices, oil etc for acid cleaning, steam blowing, alkali boil out, oil flushing etc., 3.7.5 Weld repair in valve shall be done as per the standard welding practice. Major weld repair record of critical valve shallbe made available. 3.8.0 PAINTING AND CORROSION ON PROTECTION 3.8.1 All un-insulated piping systems, hangers and supports shall have two coats of red oxide Zinc Chromate primer (conforming to IS 2074) with minimum dry film thickness (DFT) of 25 microns per coat and two coats of finish paints using enamel paint to give a minimum total DFT of 100 microns (after two coats of primer and two coats of finish paint). Shades shall be as per IS 5 or as indicated by Owner /Engineer. Service of the pipe/line designations shall be painted on all pipes at visible locations. 3.8.2 Before application of paint, Contractor shall clean the pipes of all mill scale, dirt dust, soot, grease, rust etc. 3.8.3 All pipe lines, piping components shall be adequately protected against corrosion during manufacture, fabrication, shipment and storage by appropriate protective paint. 3.9 UNDERGROUND PROTECTION 3.9.1 Where pipelines are buried, underground protection shall be provided for the piping system as indicated any one of the methods given below: (a) Coal tar primer, coal tar enamel, inner wrap of fibre glass, final outer wrap of enamel impregnated fibre glass. Total thickness of coating shall not be less than 4.0 mm. (b) With anti-corrosive tape of 4 mm thick conforming to IS-10221 and AWWA C 203-93.		
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3.9.2 Pipe surfaces shall be cleaned by shot or sand blasting before application. 3.9.3 Tests to be carried out after application (a) Bond/Adhesion test (b) Holiday test 3.10 SPECIFIC REQUIREMENTS OF PIPING SYSTEMS These shall be as detailed out in data Sheet A 3.11 THERMAL INSULATION 3.11.1 CONTRACTOR shall provide thermal insulation for all hot piping and equipment with fluid temperatures greater than 60°C. 3.11.2 Specific requirements of thermal insulation are detailed out in Data Sheet-A. Further, the insulation thickness indicated in Data Sheet - A shall be regarded as minimum acceptable thickness. These minimum acceptable thickness are OWNER's estimate based on use of mineral wool blankets as insulating material with a surface temperature of 60°C or less over the insulation finish and Contractor is advised to ensure that the thickness envisaged by OWNER are adequate to guarantee a surface temperature measured over the finish of not greater than 60°C. In case the Contractor estimates that higher insulation thickness is required, the same shall be included and clearly indicated in the offer under the 'Schedule of Technical Deviations' of this specification. If Contractor is adopting calcium silicate insulation, the thickness shall be calculated with maximum thermal conductivity as given in IS-8154 and temperature shall be over the finish (aluminium cladding). 3.11.3 Contractor shall submit with his offer a schedule of insulation thickness proposed by him along with supporting calculations. The calculations shall be based on thermal conductivity values certified and guaranteed by the insulation supplier who shall base his guarantee on actual tests conducted by recognised test houses. Calculation of insulation shall be based on standard BS 5970/IS 3677. No credit would be claimed by the insulation manufacturer over and above those actually recognised by international standards. However, if the CONTRACTOR is offering insulation material with superior thermal conductivity this value shall be suitably substantiated by tests. 3.11.4 CONTRACTOR shall demonstrate to the OWNER/ENGINEER the surface temperature of the insulation at site. For indoor piping, the temperature shall be measured at the middle of one segment of pipe run		
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at different points. These temperatures shall be taken as representative temperatures for that length of piping. If the temperature measured is higher than that guaranteed, the whole length shall be replaced or additional thickness added to meet the surface temperature. Two measurements shall be taken at the measuring points (one at the top and another at the bottom). 3.11.5 Contractor should take care while fixing the insulation mats, no welding shall be permitted on HP/LP cylinder & steam chests for fixing nuts, bolts, and lugs, for their mats. The strip on the casing, stop valves, where provided and instructed by manufacturer shall be used to weld the insulation pins for thermal insulation. 3.12 VALVES 3.12.1 <u>Design and Construction Features</u> The following design and construction features of valves shall be complied with. 3.12.1.1 All gate and globe valves shall be of rising stem, outside screw and yoke type. The design of valves shall ensure a streamlined passage and gate valves shall have low pressure drop. The seats and discs shall be easily renewable and/or shall be suitable for easy refacing and grinding. Valve discs shall be of such design as to keep the seats tight when the valve body is subjected to pressure, temperature variations and piping stresses. Gate valves shall close in both flow directions. 3.12.1.2 All globe valves shall be capable of being closed against pressure. 3.12.1.3 All valves end details shall be as specified in Data Sheet-A3. In the case of all end-welded valves, the stub ends of the valves shall project from the valve body a sufficient amount to ensure that the welding process will not distort the valve body and internal parts. 3.12.1.4 Valves for regulating duties shall be of the globe type with tapered plug type disc. 3.12.1.5 Hardness of disc seating surface shall be minimum of 350 BHN and a minimum differential hardness of 50 BHN shall be provided between disc and seat to prevent galling. This is not applicable for stellite seats. 3.12.1.6 Check valves of sizes 400 mm NB and larger shall have dash pot arrangement.		
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PART A	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage- V, Unit # 7 & 8 at Suratgarh, Rajasthan SG, STG & their Auxiliaries SPECIFIC PIPING DESIGN REQUIREMENTS	SHEET 12 OF 15																				
3.12.1.7 All gate and globe valves shall have back-seating arrangement to facilitate easy replacement of packing with the valve in service. 3.12.1.8 All valves shall be so designed that the hand-wheel moves in a clockwise direction to close the valve. The face of the hand-wheel shall be clearly marked with the words 'OPEN' and 'CLOSE' and an arrow to indicate the direction for opening. All hand-wheels shall be fitted with name plate. 3.12.1.9 Piston lift check valves shall have accurately guided pistons so that the pistons are cushioned in their cylinders as they move up. 3.12.1.10 All gate, globe, Y-type and angle valves intended for manual operation and falling under the following categories shall be equipped with a gear operator for ease of operation and to ensure fast and tight closure: <table><tr><td>ANSI PRESSURE RATING</td><td>VALVE SIZES FOR WHICH GEAR OPERATOR IS REQUIRED</td></tr><tr><td>-----</td><td>-----</td></tr><tr><td>Class 300 and below</td><td>350 mm and larger</td></tr><tr><td>Class 600 and above</td><td>200 mm and larger</td></tr><tr><td>-----</td><td>-----</td></tr></table> 3.12.1.11 All gate valves falling in the following categories shall be provided with integral bypass valve. Bypass size shall conform to MSS-SP-45 as a minimum standard unless otherwise specified. The bypass valve shall be hand operated unless otherwise specified. Pipe for bypass shall be at least Schedule 80 seamless and of a material of the same nominal chemical composition and physical properties as that used for the main line. Orientation of bypass arrangement shall be subject to the approval of OWNER/ENGINEER. <table><tr><td>ANSI PRESSURE RATING</td><td>VALVE SIZES FOR WHICH BYPASS IS REQUIRED</td></tr><tr><td>-----</td><td>-----</td></tr><tr><td>Class 600 and over</td><td>200 mm and larger</td></tr><tr><td>Class 300 & 150</td><td>350 mm and larger</td></tr><tr><td>-----</td><td>-----</td></tr></table>			ANSI PRESSURE RATING	VALVE SIZES FOR WHICH GEAR OPERATOR IS REQUIRED	-----	-----	Class 300 and below	350 mm and larger	Class 600 and above	200 mm and larger	-----	-----	ANSI PRESSURE RATING	VALVE SIZES FOR WHICH BYPASS IS REQUIRED	-----	-----	Class 600 and over	200 mm and larger	Class 300 & 150	350 mm and larger	-----	-----
ANSI PRESSURE RATING	VALVE SIZES FOR WHICH GEAR OPERATOR IS REQUIRED																					
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Class 300 and below	350 mm and larger																					
Class 600 and above	200 mm and larger																					
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ANSI PRESSURE RATING	VALVE SIZES FOR WHICH BYPASS IS REQUIRED																					
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Class 600 and over	200 mm and larger																					
Class 300 & 150	350 mm and larger																					
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SPEC.NO. TCE.5750A-H-500-001	TATA CONSULTING ENGINEERS LIMITED	VOLUME IIIA SECTION – C3
PART A	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage- V, Unit # 7 & 8 at Suratgarh, Rajasthan SG, STG & their Auxiliaries SPECIFIC PIPING DESIGN REQUIREMENTS	SHEET 13 OF 15
3.12.1.12 All gate valves of ANSI pressure rating class 150 and 300 shall have solid or flexible wedge and ANSI pressure rating class 600 and above shall have flexible or parallel slide type of wedge. 3.12.1.13 Valves with flexible wedge shall have provision for relieving the pressure in the neck of the valve when the valve is in the closed position. 3.12.1.14 All valves of ANSI pressure rating upto class 600 shall have bolted bonnet construction and above class 600 shall have bonnet construction of the pressure seal type. Pressure seal valves shall have stainless steel inlay in the gasket area and silver-plated gaskets or other acceptable proven features. 3.12.1.15 All carbon steel valves of ANSI pressure rating upto class 150 and 300 shall have stainless steel trim (13% Cr) unless otherwise specified in Data Sheet and ANSI pressure rating class 600 and above shall have stellited trim. 3.12.1.16 All alloy steel valves shall have stellited seats. 3.12.1.17 All valves of ANSI pressure rating upto class 900 and higher shall have yoke with anti-friction bearing arrangement. 3.12.1.18 Valves that are to be kept in full 'OPEN'/'CLOSE' position shall be provided with a non-detachable locking arrangement. The locking arrangement provided shall be subject to approval by the OWNER. 3.12.1.19 Valves operating under vacuum conditions shall preferably have glands with water sealing. The inlet and outlet connections shall be NB 15mm. The CONTRACTOR shall indicate the maximum and minimum sealing water pressure and the required flow rate. Alternatively long gland stem valves with enough gland packing to avoid air ingress can be provided. 3.12.1.20 Motor actuators for motor operated valves shall meet requirements indicated elsewhere in the specification. 3.12.1.21 All HP valves of size 50- NB and blow shall be of minimum class 1500 welded bonnet type irrespective of design requirements.		
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SPEC.NO. TCE.5750A-H-500-001	TATA CONSULTING ENGINEERS LIMITED	VOLUME IIIA SECTION – C3
PART A	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage- V, Unit # 7 & 8 at Suratgarh, Rajasthan SG, STG & their Auxiliaries SPECIFIC PIPING DESIGN REQUIREMENTS	SHEET 14 OF 15
3.12.1.22 All the valves in the turbine extraction line shall be selected for one rating higher than the design requirement. 3.12.2 <u>Cleaning</u> Prior to factory inspection, all manufacturing waste, such as metal chips and filings, welding rods and stubs, rags, debris and all other foreign matter shall be removed from the interior of each valve. All mill scale, rust, oil, grease, chalk, crayon, paint marks and other deleterious material shall be removed from the interior and exterior surfaces. At the time of shipment, valves shall be clean inside and outside. 3.12.3 <u>Inspection and Tests</u> 3.12.3.1 Inspection and tests shall be as per the relevant section. 3.12.3.2 Defects in excess of acceptance standards shall be removed by suitable means. If removal of surface defects does not result in reduction in wall thickness below 5% of intended thickness of metal at that location, the area shall be blended smoothly into the surrounding surface. Where defect removal results in a wall thickness below the above, resultant cavity may be repaired by welding. The procedure and operation shall be qualified as per applicable standards. Major weld repairs shall be stress relieved or heat treated in accordance with ASME Section VIII Division I-UCS 56. 3.12.3.3 The required area shall be re-examined and the acceptance standards shall be as in the original examination. 3.12.3.4 Weld repairs made as a result of radiographic examination shall be radiographed after welding. Repairing a particular area more than 2 times is not permitted and the component shall be rejected. The acceptance standards for welds shall be as per ASME Boiler and Pressure Vessel Code, Section VIII, Division I, UW - 51.		
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SPEC.NO. TCE.5750A-H-500-001	TATA CONSULTING ENGINEERS LIMITED	VOLUME IIIA SECTION – C3
PART A	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage- V, Unit # 7 & 8 at Suratgarh, Rajasthan SG, STG & their Auxiliaries SPECIFIC PIPING DESIGN REQUIREMENTS	SHEET 15 OF 15
3.12.3.5 Prior approval shall be obtained from the OWNER/ENGINEER before taking up major weld repairs (major weld repair - when depth of repair exceeds 20% of thickness or 1 inch whichever is smaller). Mapping of major weld repairs is also required. 3.12.3.6 All valves shall be tested hydrostatically for strength, tightness of seats and tightness of back seating at the pressures indicated in Data Sheet- , in accordance with MSS-SP 61, "Hydrostatic Testing of Steel Valves". Water used for hydrostatic testing of valves with stainless steel components shall not have chloride content exceeding 20 ppm. Clean potable water may be used for testing of all other valves. 3.12.3.7 All valves except check valves shall be tested for seat tightness by air at a pressure of 6 bar (g) on both sides of seat. 3.12.3.8 All check valves shall also be hydrotested at 25% of the seat hydro test pressure. Leakage test shall be as per IS-6157. 3.12.3.9 All valves shall be checked for correctness in respect of specified end details as per applicable standards. 3.12.4 <u>Painting and Corrosion Protection</u> Two coats of primer of thickness 35 microns for each coat shall be applied to all steel and cast iron exposed surfaces as required to prevent corrosion, after release has been given for painting and before despatch. The use of grease or oil, other than light grade mineral oil, for corrosion protection is prohibited. Bores of all valves shall be covered immediately after testing, draining and drying with suitable plastic end covers to avoid ingress of foreign materials. 3.12.5 Temporary piping and accessories All temporary piping, fitting, accessories, valves, specialities etc., required for the various erection and commissioning activities such as chemical cleaning, steam blowing, hydraulic test etc shall be in the scope of the bidder.		
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DATA SHEET
FOR
SG AND ITS AUXILIARIES

DATA SHEET A
(SG AND ITS AUXILIARIES)

SPECIFICATION NO. TCE.5750A-500-H-001 PART A	TATA CONSULTING ENGINEERS LIMITED		VOLUME: IIIA
	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage- V, Unit # 7 & 8 at Suratgarh, Rajasthan DATASHEET A1 SG & their Auxiliaries STEAM GENERATOR		SHEET 1 OF 5
SL. NO.	ITEM	UNIT	

1.1	Type of Steam generator		Once through reheat, radiant, dry bottom, balanced draft, outdoor
1.2	Fuel (Ref. Project Information Volume II) - for load carrying - for flame stabilisation - for start up / warm-up		Coal Heavy fuel oil (HFO) Light Diesel Oil (LDO)
1.3	Capacity at SG MCR		102% of VWO flow
1.4	Steam pressure at main steam stop valve (Ref. Note-1)	bar(a)	Bidder to indicate
1.5	Steam temperature at SH outlet (Ref. Note-1)	°C	Bidder to indicate
1.6	Steam temperature at RH outlet (Ref. Note-1)	°C	Bidder to indicate
1.7	Exit flue gas temperature at RAPH outlet (considering leakage in RAPH)	°C	Bidder to indicate
1.8	Explosion force / Implosion		Maximum of ± 660 mm WC at 67% yield strength or maximum conceivable Shut off head of the ID/FD fan at Test Block condition and ambient temperature The boiler & ESP structures shall be designed for the same condition.
1.9	Operation		Base Load and Sliding Pressure
1.10	Code		IBR AND ASME or other reputed international codes
1.11	Heat Release Rates (Ref. Note-2)		
1.11.1	Volumetric basis (NH / FV)	kCal/m ³ /hr	≤ 100000
1.11.2	Net heat Input to plan area (NHI/ PA)	kCal/m ² /hr	$\leq 4.75 \times 106$

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PPD. BY	GS	AA					
CHD. BY	SN	SN					
DATE	26-11-2009	30-05-2012				PROJECT: 2 x 660 MW, Super-Critical TPS, Stage-V, Suratgarh, Rajasthan	ISSUE R1

SPECIFICATION NO. TCE.5750A-500-H-001 PART A	TATA CONSULTING ENGINEERS LIMITED		VOLUME: IIIA
	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage- V, Unit # 7 & 8 at Suratgarh, Rajasthan DATASHEET A1 SG & their Auxiliaries STEAM GENERATOR		SHEET 2 OF 5
SL. NO.	ITEM	UNIT	

1.11.3	Burner Zone	kCal/m ² /hr	≤ 1.55 x 10 ⁶
1.12	Gas temp. at furnace outlet at SGMCR (Ref. Note - 3)	°C	≤ 1100 or 60 °C below minimum initial deformation temperature (IDT) of ash
1.13	NOx emission limits (for coal firing)		Less than 260 grams per GJ of heat input or less than 260 nano grams per Joule of heat input.
1.14	Unburnt combustibles in flue gas	%	≤ 1.5 of fly ash at economiser outlet
1.15	Excess air at RAPH inlet	%	20% max
1.16	Ambient temp. for performance test	°C	30 °C with 66% of relative humidity.
1.17	Furnace tube arrangement		Membrane
1.18	Type of furnace tubes and header for pressure parts		Seamless spiral plus vertical, or vertical rifle tubes
1.19	Flue gas velocity in SG convection/ second pass	m/s	≤ 10
1.19.A	SG circulation pumps	Nos.	2x100%, If SG unit can be started with out SG circulation pump , then 1x100% can be envisaged.
1.20	MATERIALS OF CONSTRUCTION		
1.20.1	Furnace wall/Economiser		Medium carbon steel
1.20.2	Header Evaporator		Carbon steel / alloy steel *Evaporator: (a) T11 up to 510°C (b) T12/T23 up to 550°C
1.20.3	Super heater /Reheater		High temp. above 565 °C/ 593 °C :

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	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage- V, Unit # 7 & 8 at Suratgarh, Rajasthan DATASHEET A1 SG & their Auxiliaries STEAM GENERATOR		SHEET 3 OF 5
SL. NO.	ITEM	UNIT	

			**Super heater/Re heater: (a) T91 up to 565 deg C (b) T92 for Temperature > 565 °C up to 620 °C (c) S304H fine grain for Temperature > 600 °C up to 660 °C
			High temp. above 400°C & up to & including 550 °C : Alloy steel to ASTM A 335/ASTM A 213, P-11/T-11, P-22/T-22, P-91/T-91,P-92/T-92 OR approved equivalent.

Note –

- Bidder shall use proven materials for high temperature SH and RH tubes. Austenitic steels to be used wherever necessary based on latest feedback from performing supercritical units.
- Bidder shall follow and use the Tube material mentioned above for Evaporator and if the Bidder follows any other standards for Material selection, should see that the material is in comply with Indian standards and should indicate the equivalent ASME code for the material.
- Bidder shall follow and use the Tube material mentioned above for Super heater and Re heater and if the Bidder follows any other standards for Material selection, should see that the material is in comply with Indian standards and should indicate the equivalent ASME code for the material.

			Low temp. up to 400°C: Carbon steel to ASTM 106 Gr B/C or SA 210 C or approved equivalent.
1.20.1	Inspection /Access doors		Heat resistant without water cooling
1.20.2	Buckstay spacing and support		Spacing shall be such that the natural frequency of buckstay shall be sufficiently away from flame pulsation frequency Support shall be self support from boiler walls with out any connection with boiler structure.

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	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage- V, Unit # 7 & 8 at Suratgarh, Rajasthan DATASHEET A1 SG & their Auxiliaries STEAM GENERATOR		SHEET 4 OF 5
SL. NO.	ITEM	UNIT	

1.20.3	Pressure parts- maximum permissible temperature / metal temperature for design(as per IBR) Economiser Furnace and boiler tubes Super heaters and re-heaters Super heaters and re-heaters		Maximum working temperature plus 11 °C Saturation temperature corresponding to Maximum working pressure plus 28 °C Maximum working steam temperature plus 39 °C Maximum working steam temperature plus 50 °C
1.20.4	Economiser		Non steaming type with no steaming even at part loading and / or sliding pressure operation. The flue gas velocity to be restricted to 10m/s

NOTES :-

1.0 The bidder to decide based on throttle steam pressure at turbine inlet and pressure drops in MS piping and fittings. Similarly, the SH and RH outlet temperatures shall be based on temperature drops in MS line and RH line, respectively.

2.0 For calculating heat release rates:

2.1 The net heat (NH) is the effective heat in the furnace. This shall be calculated on the basis of the gross heating value (GHV) of the fuel corrected by subtracting radiation loss, unburnt combustible loss, latent heat of water in the fuel and adding the

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SPECIFICATION NO. TCE.5750A-500-H-001 PART A	TATA CONSULTING ENGINEERS LIMITED		VOLUME: IIIA
	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage- V, Unit # 7 & 8 at Suratgarh, Rajasthan DATASHEET A1 SG & their Auxiliaries STEAM GENERATOR		SHEET 5 OF 5
SL. NO.	ITEM	UNIT	

sensible heat in both the fuel and the combustion air above specified ambient temperature.

2.2 The volumetric heat release rate shall be calculated by dividing the NH by the net furnace volume (The net furnace volume shall be reckoned up to furnace outlet plane). Bidder shall furnish the method that bidder uses to calculate the net furnace volume, in his bid.

2.3 Plan area shall be obtained by multiplying the width with the depth of the furnace.

2.4 Burner zone heat release rate shall be obtained by dividing net heat by 2 x (furnace width + furnace depth) x burner zone height, where burner zone height is equal to (vertical distance between top and bottom row burners + 3 meters).

3.0 Furnace exit gas temperature is the temperature of flue gas at furnace outlet plane. Bidder shall furnish a sketch of the furnace indicating the furnace outlet plane, with relevant dimensions of the furnace.

4.0 In case the excess air value is less than 20%, bidder shall substantiate the same by furnishing reference of minimum of two plants of 660 MW and above and of similar design operating at least for one year

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SPECIFICATION NO. TCE.5750A-500-H-001 PART A	TATA CONSULTING ENGINEERS LIMITED		VOLUME: IIIA
	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage- V, Unit # 7 & 8 at Suratgarh, Rajasthan DATASHEET A2 SG & their Auxiliaries REGENERATIVE AIR PREHEATERS		SHEET 1 OF 1
SL. NO.	ITEM	UNIT	

1.1	Type		Trisector (2 X 50 %) / Bisector
1.2	On load cleaning medium		Steam
1.3	Off load cleaning medium		Water
1.3.1	Air preheater leakage		Shall not exceed 10 % of total air requirement.
1.4	Accessories to be provided		
1.4.1	Auxiliary air motor		Yes
1.4.2	Hand operated barring device		Yes
1.4.3	Seal plate adjustment		Automatic and external
1.4.4	Air receiver		Adequate for safe coasting down without external air supply
1.4.5	Fire fighting system provided?		yes
1.4.5	Air supply to air receiver		From station service air system
1.5	MATERIALS OF CONSTRUCTION		
1.5.1	Hot end elements		Carbon steel or equivalent
1.5.2	Cold end elements		Corten steel or equivalent
1.5.3	Rotor and intermediate elements		Corrosion resistant low alloy steel
1.5.4	Design ambient temperature		30 °C and 66% relative humidity
1.5.5	Minimum flue gas temperature at all loads		5 °C above acid dew point of flue gas.
1.5.6	Minimum flue gas temperature (corrected)at TGMCR at APH outlet		125 to 135 °C

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	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage- V, Unit # 7 & 8 at Suratgarh, Rajasthan DATASHEET A3 SG & their Auxiliaries CENTRIFUGAL FANS		SHEET 1 OF 2
SL. NO.	ITEM	UNIT	

1.0	GENERAL		
1.1	Designation		Induced draft fan (ID fan) with VFD & IGV or Bidder can also offer blade pitch controlled axial fan
1.2	Number		Two(2)
1.3	Design parameters		
a)	Capacity		With two fans operating, it shall be able to meet 120% SG MCR flow, at 50°C ambient temperature and RH-66%, 47.5 Hz power supply frequency, guaranteed APH leakage and worst coal firing.
b)	Head		30% over 100% SGMCR requirement Pressure at chimney inlet shall be +10mmwc.
c)	Temperature		15°C above maximum flue gas temperature 5°C above maximum ambient temperature
1.4	Speed	rpm	≤ 750
1.4.1	First critical speed	rpm	At least 15% above normal speed
1.5	Blade type		Backward curved, aerofoil type
1.6	Flow control		Electric motor with variable frequency drive and inlet guide vane control.
1.7	Fan / motor bearings		Self aligning
1.8	Material Of Construction		
1.8.1	Fan scroll		Lined with abrasion resistant material
1.8.2	Suction chamber		IS 1079 / 73 SH. 34
1.8.3	Casing		IS 2062
1.8.4	Shaft		SAE 1045 forged normalised and

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	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage- V, Unit # 7 & 8 at Suratgarh, Rajasthan DATASHEET A3 SG & their Auxiliaries CENTRIFUGAL FANS		SHEET 2 OF 2
SL. NO.	ITEM	UNIT	

			tempered steel
1.8.5	Sleeves		High grade Babbitt
1.8.6	Regulating vane		IS 1079 / 73
1.8.7	Diffusers and dampers		IS 2062
1.8.8	Bearing housing		Grey cast iron
1.8.9	Coupling		Flexible

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	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage- V, Unit # 7 & 8 at Suratgarh, Rajasthan DATASHEET A4 SG & their Auxiliaries AXIAL FANS		SHEET 1 OF 2
SL. NO.	ITEM	UNIT	

1.1	Designation		FD fan, PA fan , ID Fan				
1.2	Number		2x50% for each type				
1.3	Location		Outdoor				
1.4	Type		Axial blade pitch controlled				
1.5	Design parameters						
a)	Capacity		With two fans operating, it shall be able to meet 120% SG MCR flow, at 50 ⁰ C ambient temperature and RH-66%, 47.5 Hz power supply frequency, guaranteed APH leakage and worst coal firing.				
b)	Head		30 % over 100% SGMCR requirement. In case of ID fan the pressure at chimney inlet shall be +10mmwc				
c)	Temperature		5 ⁰ C above maximum ambient temperature/50 ⁰ C and relative humidity-66%				
d)	Fluid to be handled		Clean air				
1.6	Speed	RPM	≤ 1500				
1.6.1	First critical speed		At least 15% above normal speed				
1.5	Flow control		Variable blade pitch				
1.6	Blade pitch variation system		Hydraulic				
1.7	Fan / motor bearings		Self aligning				
1.8	MATERIALS OF CONSTRUCTION						
1.8.1	Impeller blade		Nodular grey cast iron or Cast aluminium alloy suitable to an inlet dust burden of 120 mg/Nm ³				
1.8.2	Impeller hub		Forged steel or fabricated steel				
1.8.3	Shaft		SAE 1045 or equivalent forged normalised and tempered steel				
REV. NO.	R0	R1			JOB NO.	CLIENT: RRVUNL	
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	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage- V, Unit # 7 & 8 at Suratgarh, Rajasthan DATASHEET A4 SG & their Auxiliaries AXIAL FANS		SHEET 2 OF 2
SL. NO.	ITEM	UNIT	

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	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage- V, Unit # 7 & 8 at Suratgarh, Rajasthan DATASHEET A5 SG & their Auxiliaries SOOT BLOWING SYSTEM		SHEET 1 OF 1
SL. NO.	ITEM	UNIT	

1.1	Type		Selective operating type control based change in heat flux on the water walls (MP based) / Regular sequential operating type for SH and RH area
1.1a	Designation		Wall blowers, Rotary blowers, long retractable blowers, short retractable blowers and air preheater blowers.
1.2	Cleaning medium		Superheated /Reheater steam
1.3	Drive		Dual electric drive for traverse and rotary motion
	<u>Location</u>		Out door
1.4	<u>Accessories Required</u>		
1.4.1	Emergency hand crank for every soot blower		Yes
1.4.2	Facility to adjust angular travel of short retractable soot blower		Yes
1.5	MATERIALS OF CONSTRUCTION		
1.5.1	Lance / swivel tube - in high temp. area		High temp. chrome steel
	- in intermediate temp area		Steel with chromium surface coating
	- in low temp. area		Carbon steel
1.5.2	Nozzle		2.5% chromium, 12% Ni stainless steel
1.5.3	Bearing (in high temp. area)		Chrome alloy steel
1.5.4	Bearing (in intermediate temp. area)		Chrome cast iron Alloy
1.5.5	Bearing (in low temp. area)		Cast Iron or Steel
1.5.6	Blowing head		Stainless steel 304
1.5.7	Feed Tube		Stainless steel 304

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PPD. BY	GS	AA					
CHD. BY	SN	SN				PROJECT: 2 x 660 MW, Super-Critical TPS, Stage- V, Suratgarh, Rajasthan	
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SPECIFICATION NO. TCE.5750A-500-H-001 PART A	TATA CONSULTING ENGINEERS LIMITED		VOLUME: IIIA
	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage- V, Unit # 7 & 8 at Suratgarh, Rajasthan DATASHEET A6 SG & their Auxiliaries COAL BURNERS		SHEET 1 OF 1
SL. NO.	ITEM	UNIT	

1.0	GENERAL		Proven make Low NOx burners. To cater to 100% SGMCR load stable operation,
1.1	Combustion air		Secondary / primary
1.2	DESIGN DATA		
1.2.1	Turn down ratio		2.5:1 / To match with coal mills
1.2.1	Coal fineness		70% through 200 mesh & 98% through 50 mesh
1.2.3	Excess air		20% at APH inlet
1.2.4	Mode of adjustment of combustion air		Air damper
1.2.5	NOx limit		Less than or equal to 260 gms/gaga joule of heat input to the steam generator or 750 mg / NM ³
1.3	MATERIALS OF CONSTRUCTION		
1.3.1	Coal burner nozzle		High chrome heat resistant
1.3.2	Guide plates		High chrome heat resistant
1.3.3	Minimum guaranteed life wear parts		8000Hrs.

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PPD. BY	GS	AA			TCE. 5750A	PROJECT: 2 x 660 MW, Super-Critical TPS, StageV, Suratgarh, Rajasthan	ISSUE R1
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SPECIFICATION NO. TCE.5750A-500-H-001 PART A	TATA CONSULTING ENGINEERS LIMITED		VOLUME: IIIA
	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage- V, Unit # 7 & 8 at Suratgarh, Rajasthan DATASHEET A7 SG & their Auxiliaries COAL MILLS		SHEET 1 OF 2
SL. NO.	ITEM	UNIT	

1.1	Coal mills Maximum permissible mill loading Mill inerting / fire fighting system		Medium speed vertical spindle; N +1 with worst coal and N + 2 with design coal [N – number of mills in operation] 85% of MCR Proven inerting / fire fighting system shall be provided along with detection system as per NFPA guidelines.
1.2	Mill inside condition		Pressurised
1.3	Output fineness		70% through 200 mesh & 98% through 50 mesh
1.4	Minimum stable load without oil support		Bidder to indicate
1.5	Coal sampling device for sampling coal from coal mill discharge with rigid accessible platform.		Required as per ISO / ASME. One working and one as standby.
1.6	Sampling connection & cock on coal pipe to each burner		Required
1.7	MATERIALS OF CONSTRUCTION		
1.7.1	Lube oil system		Integral
1.7.2	Grinding ring/race		Segmental
1.7.3	Shaft		Coupled / Mono block / Mfg. Std.
1.7.4	Coupling		Flexible gear
1.7.5	Drive transmission		Gear
1.7.6	Minimum mill wear parts life		5500 to 8000Hrs for grinding elements, 20000Hrs for seals, 15000 Hrs for mill discharge valves 25000 Hrs for classifier cone and other items lined with ceramics material and 25000 Hrs for classifier vane.

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	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage- V, Unit # 7 & 8 at Suratgarh, Rajasthan DATASHEET A7 SG & their Auxiliaries COAL MILLS		SHEET 2 OF 2
SL. NO.	ITEM	UNIT	

1.8	Raw coal feeder		Gravimetric type with 20% spare capacity, built to fire withstand capability as per NFPA standards or equivalent international standard.

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	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage- V, Unit # 7 & 8 at Suratgarh, Rajasthan DATASHEET A8 SG & their Auxiliaries FUEL OIL BURNERS AND IGNITORS		SHEET 1 OF 1
SL. NO.	ITEM	UNIT	

1.1	Designation Capacity		Start up / low load flame stabilisation with centralised automatic control with flame scanner and safety protection. LDO – 7.5% of SGMCR load HFO – 22.5% of SGMCR load
1.2	Fuel oil		Light diesel oil for start-up, heavy fuel oil for flame stabilisation
1.3	Turndown ratio of fuel oil burners		4 : 1
1.4	Igniters		HEA
1.5	Atomising medium		Air for LDO, steam for HFO
1.6	MATERIALS OF CONSTRUCTION		
1.6.1	Oil burner – spray plate mixing plate		Alloy steel
1.6.2	Diffuser		Alloy steel
1.6.3	Nozzle cap		Alloy steel

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	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage- V, Unit # 7 & 8 at Suratgarh, Rajasthan DATASHEET A9 SG & their Auxiliaries FUEL OIL PUMPS		SHEET 1 OF 1
SL. NO.	ITEM	UNIT	

1.1	Designation		Fuel oil pump
1.2	Number required		2x 100% (HFO) 2 x 100%(LDO) (For each unit) (common for two Units)
1.3	Type of bearing		Antifriction heavy duty and external
1.4	Design motor size of the pumps		Based on highest viscosity of oil plus 15% as margin
1.5	LIQUID DATA		
1.5.1	Liquid pumped		HFO LDO
1.6	MATERIALS OF CONSTRUCTION		
1.6.1	Casing		-----Fabricated steel-----
1.6.2	Rotor		-----BS 970 EN 9 or equivalent-----
1.6.3	Shaft		-----BS 970 EN 9 or equivalent-----
1.6.4	Base plate		-----Fab. Steel / CI-----

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PPD. BY	GS	AA			TCE. 5750A	PROJECT: 2 x 660 MW, Super-Critical TPS, Stage-V, Suratgarh, Rajasthan	ISSUE R1
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SPECIFICATION NO. TCE.5750A-500-H-001 PART A	TATA CONSULTING ENGINEERS LIMITED		VOLUME: IIIA
	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage- V, Unit # 7 & 8 at Suratgarh, Rajasthan DATASHEET A10 SG & their Auxiliaries ELECTROSTATIC PRECIPITATORS		SHEET 1 OF 3
SL. NO.	ITEM	UNIT	

1.1	Number required per steam generator		One unit. (One per each pass depending upon no of passes for each steam generator offered by the bidder or as per manufacturer's standard.)
1.2	Duty		Continuous, designed for 100% SGMCR, guarantee point at 30 °C ambient air temperature and 66% RH. Designed taking Inlet dust burden shall be taken as 90% ash or actual predicted which ever is higher being carried forward to ESP while firing worst coal.
1.3	Location		Between air-preheater and ID fan
1.4	Design & Construction Requirements		
1.4.1	Number of Gas Streams		two
1.4.2	Furnace condition		Balance draft, maximum flue gas velocity in ESP-1m/s
1.4.3	Number of fields in series		Bidder to indicate
1.4.4	Dust concentration at outlet of ESP with design and worst coal range. - with worst coal and one field out of service	mg/Nm ³	50 (max.)
1.4.5	Length to height ratio of collecting plate (Aspect ratio)		Not less than 1.5
1.4.6	Specific collection plate area (total collecting plate area/total gas flow)	M ² /m ³ /sec	Not less than 200
1.4.7	Bulk ash density		
	- For hopper capacity	kg/m ³	800
	- For hopper strength	kg/m ³	1600

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	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage- V, Unit # 7 & 8 at Suratgarh, Rajasthan DATASHEET A10 SG & their Auxiliaries ELECTROSTATIC PRECIPITATORS		SHEET 2 OF 3
SL. NO.	ITEM	UNIT	

1.4.8	Resistivity of ash	Ohm-cm	2x10 ¹³
1.4.9	Minimum number of transformer rectifier sets/field		By Bidder
1.4.10	Minimum number of bus sections/field		By Bidder
1.4.11	Minimum corona power density	Watts/m ²	By Bidder
1.4.12	Minimum current density	Micro amps/m ²	By Bidder
1.5	Casing and hopper		
1.5.1	Method of construction		Welded sheet metal
1.5.2	Casing design pressure		Compatible with furnace design pressure (With two fans operating, it shall be able to meet 120% SG MCR flow, at 50°C ambient temperature and RH-66%, 47.5 Hz power supply frequency , guaranteed APH leakage and worst coal firing.± 660mmwc at 67% of yield strength.)
1.5.3	Thickness of steel sheet	mm	Not less than 6 mm
1.5.4	Storage capacity of dust hopper with worst coal firing (To be measured 600 mm below electrodes)		8 hrs. (minimum)
1.5.5	Plate angle of dust hopper	degrees	around 70
1.5.6	Elevation of hopper outlet flange	M	EL (+) 2.75
1.6	Type of discharge electrode		Spring type/rigid type
1.7	Type of collection electrode		Cold rolled solid sheet construction
1.7.1	Thickness of collecting electrode plate		Not less than 18 gauge

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SL. NO.	ITEM	UNIT	

1.8	Items to be Provided		
1.8.1	Inlet and outlet gas isolation dampers/ gates		Yes
1.8.2	Fly ash hoppers with panel type / Tubular type heaters, level indicators, outlet flange poke holes, access doors etc.		Yes
1.8.3	Thermal insulation and 1 to 1.1 mm aluminium corrugated cladding		Yes
1.8.4	Weather-proof enclosure for insulator compartment with heaters, air blowers, filters, controls etc.		Yes
1.8.5	Provision of water washing system (off-load)		Yes
1.8.6	Test connections of std. size for measuring pressure, temperature, velocity, dust loading at inlet and outlet of precipitator		Yes
1.8.7	Interior access walkways minimum of 600 mm or of enough width , exterior platforms, staircase on both sides , ladder, access doors and galvanised hand rails of 40 mm pipe etc.		Yes
1.8.8	Opacity monitor		Yes

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	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage- V, Unit # 7 & 8 at Suratgarh, Rajasthan DATASHEET A11 SG & their Auxiliaries DAMPERS		SHEET 1 OF 2
SL. NO.	ITEM	UNIT	

1.1	Numbers		As per functional requirement
1.2	Application		Isolation / Control, pneumatic actuator control for control dampers and fast acting pneumatic/electric actuator control for isolation dampers
1.3	Duty		Intermittent / Continuous
1.4	Installation		Outdoor
1.5	Gas handled		Flue gas / cold air / hot air mixed with particulate matter
1.6	<u>DESIGN AND CONSTRUCTION REQUIREMENTS</u>		
1.6.1	Isolation damper		Zero leakage guillotine type / multi-louver type (with guaranteed gas tightness efficiency of 100%) - ESP inlet and outlet - ID fan inlet and outlet - GR fan inlet and outlet (if applicable) - Air pre heater inlet and outlet (flue gas side)
1.6.2	Blade shaft		Horizontal with adjustable collar
1.6.3	Pressure seal packing gland		On each shaft end
1.6.4	Bearings		Grease lubricated anti friction type
1.6.5	Drive type		Electric
1.7	<u>MATERIALS OF CONSTRUCTION</u>		
1.7.1	Dampers frame		Heavy structural steel channels or plates not less than 10 mm thick
1.7.2	Blades		Not less than 10 mm thick made up of 2 x 5 mm thick plates
1.7.3	Linkage bolts and pins		Stainless steel

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SL. NO.	ITEM	UNIT	

1.8	Ducts Flue gas side Air side		To be designed for 13m/s flue gas velocity before ESP and 16m/s flue gas velocity after ESP. Designed for 16m/s velocity
1.8.1	Design pressure		$\pm$ 660mmwc at 67% of yield strength or maximum conceivable pressure.
1.8.2	Thickness		Minimum thickness of 7mm for flue gas ducts and 6mm for air ducts

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	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage- V, Unit # 7 & 8 at Suratgarh, Rajasthan DATASHEET A12 SG & their Auxiliaries CHAIN PULLEY BLOCK (HAND OPERATED)		SHEET 1 OF 2
SL. NO.	ITEM	UNIT	

1.0	DESIGN CONDITIONS		
1.1	Type		Spur
1.2	Pulley block		As per IS: 3832
1.3	Frame made of		Steel
1.4	Hook		Forged alloy or carbon steel as per IS : 2758 / IS : 2759 / IS 3832
1.5	Load chain		As per IS 3109 / BS 1663 / BS 3114 / IS 6216
1.6	Hand chain		As per BS 590
1.7	Load chain wheel		To suit load chain
1.8	Hand chain wheel		To suit hand chain
1.9	Factor of safety		Not less than 5
1.10	Gears		Cut from cast or forged steel, Spur and helical as per BS 436 Worm as per BS 721
1.11	Brake		Friction disc type to sustain load at any working position
1.12	Bearing		Ball and / or roller
1.13	Trolley wheels		Wrought iron / cast iron / low alloy steel
1.14	Lubrication		Centralised grease lubrication with hand pump

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SL. NO.	ITEM	UNIT	

1.15	Material test certificates		To be submitted for hook, chain, pulley block, etc.
1.16	Overload test with 150% of specified load		At works – Yes At site – Yes
1.17	Visual inspection and dimensional check		Yes

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	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage- V, Unit # 7 & 8 at Suratgarh, Rajasthan DATASHEET A13 SG & their Auxiliaries ELECTRICALLY OPERATED HOISTS		SHEET 1 OF 2
SL. NO.	ITEM	UNIT	

1.0	DESIGN CONDITIONS		
1.1	Class of hoist		Class II, as per IS:807
1.2	Hoist speed		2-3 m/min
1.3	Method of operation		Pendant push button
1.4	Speed control (hoist)		Single speed
1.5	MATERIALS OF CONSTRUCTION		
1.5.1	Drums & sheave		Cast iron / cast steel / mild steel drum, grooving construction as per IS 3938
1.5.2	Hook		Forged alloy / carbon steel, as per IS 2758 / IS 2759 single hook provided with standard depress safety latch lock to prevent hook from swivelling
1.5.3	Bearing		Ball and / or roller
1.5.4	Shaft		Steel
1.5.5	Wire rope		Construction 6 x 36 minimum ultimate strength 1.6×20^6 kN/m ² as per IS 2365 factor of safety as per IS 3938
1.5.6	Gear		Cut from cast / forged steel as per IS 436
1.5.7	Brake		Electro hydraulic type to hold 125% of the load torque
1.5.8	Trolley		Gears and brakes same as for hoist
1.5.9	Lubrication		Centralised grease lubrication with hand

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SL. NO.	ITEM	UNIT	

			pump
1.5.10	Trolley wheels		Heat treated carbon steel / low alloy steel / graded CI single flanged
1.6	Material test certificates		To be submitted for critical components such as hook, wire rope, drum, trolley, etc.
1.7	Overload test with 150% of specified load		At works : Yes At site : Yes
1.8	Visual inspection and dimensional check		Yes
1.9	Hoist motor shall be suitable for inching operation		

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SL. NO.	ITEM	UNIT	

SPECIFIC REQUIREMENTS FOR PIPING

<u>SL. NO.</u>	<u>SERVICE</u>	<u>SIZE</u>	<u>PIPES</u>	<u>FITTINGS</u>	<u>FLANGES</u>	<u>GASKETS</u>	<u>LINE JOINT</u>
1.1	STEAM TEMP. 550°C AND ABOVE UPTO 600°C	NB 65 & ABOVE	ASTM A335 - P91	ASTM A234 – WP91	ASTM A182 – F91	SPIRAL WOUND SS 316	BUTT WELDED
		NB 50 & BELOW	ASTM A335 - P91	ASTM A182–F91	ASTM A182 – F91	SPIRAL WOUND SS 316	SOCKET WELDED
1.2	STEAM TEMP. ABOVE 510°C AND UPTO 549°C	NB 65MM & ABOVE	ASTM A335 - P22	ASTM A234 – WP22	ASTM A182 – F22	SPIRAL WOUND SS 316	BUTT WELDED
		NB 50 & BELOW	ASTM A335 - P22	ASTM A182 – F22	ASTM A182 – F22	SPIRAL WOUND SS 316	SOCKET WELDED
1.3	STEAM TEMP. 400°C TO 510°C	NB 65 & ABOVE	ASTM A335 - P11	ASTM A234 - WP11	ASTM A182 - F11	SPIRAL WOUND SS 316	BUTT WELDED

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SL. NO.	ITEM		UNIT	

		NB 50 & BELOW	ASTM A335 - P11	ASTM A182 - F11	ASTM A182 - F11	SPIRAL WOUND SS 316	SOCKET WELDED
1.4	STEAM BELOW 400°C	NB 65 & ABOVE	ASTM A106 Gr.B	ASTM A234 – WPB	ASTM A105	SPIRAL WOUND SS 316	BUTT WELDED
		NB 50 & BELOW	ASTM A106 Gr. B	ASTM A105	ASTM A105	SPIRAL WOUND SS 316	SOCKET WELDED
1.5	FEED WATER / CONDENSATE	NB 65 & ABOVE	ASTM A106 Gr. B	ASTM A234 WPB	ASTM A105	SPIRAL WOUND SS 316	BUTT WELDED
		NB 50 & BELOW	ASTM A106 Gr. B	ASTM A105	ASTM A105	SPIRAL WOUND SS 316	SOCKET WELDED
1.6	LUBE OIL AND CONTROL / HYDRAULIC OIL (UPSTREAM OF FILTER)	NB 65 & ABOVE	ASTM A106 Gr. B	ASTM A234 - WPB	ASTM A105	GRAFOIL	BUTT WELDED

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SL. NO.	ITEM	UNIT	

		NB 50 & BELOW	ASTM A106 Gr.B	ASTM A105	ASTM A105	GRAFOIL	SOCKET WELDED
1.7	LUBE OIL & CONTROL / HYDRAULIC OIL (BEYOND FILTER)	NB 65 & ABOVE	ASTM A 312 TP 316 (SEAM LESS)	ASTM A 403 GR. WP316	ASTM A182 F316	GRAFOIL	BUTT WELDED
		NB 50 & BELOW	ASTM A 312 TP 316 (SEAM LESS)	ASTM A 403 GR. WP316	ASTM A182 F316	GRAFOIL	SOCKET WELDED
1.8	DEMINERALISED WATER	NB 65 TO 150	ERW, BLACK, IS 1239 (PT-1) Heavy class Rubber lined (3 mm thk.)	ASTM A 234 GR. WPB RUBBER LINED (3 mm thk.)	ASTM A 105 RUBBER LINED (3 mm thk.)	GRAFOIL	FLANGED
		NB 200 TO 350	IS 3589 ERW Rubber lined (3 mm thk.)	ASTM A 234 GR. WPB RUBBER LINED (3 mm thk.)	ASTM A 105 RUBBER LINED (3 mm thk.)	GRAFOIL	FLANGED
		NB 50 & BELOW	ASTM A312 TP 304(ERW)	A 182-F304	ASTM A 182 F304	GRAFOIL	SOCKET WELDED

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PPD. BY	GS	AA					
CHD. BY	SN	SN					
DATE	26-11-2009	30-05-2012				PROJECT: 2 x 660 MW, Super-Critical TPS, Stage-V, Suratgarh, Rajasthan	

SPECIFICATION NO. TCE.5750A-500-H-001 PART A	TATA CONSULTING ENGINEERS LIMITED		VOLUME: IIIA
	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATASHEET A14 SG & their Auxiliaries PIPING AND VALVES		SHEET 4 OF 9
SL. NO.	ITEM	UNIT	

1.9	AUXILIARY COOLING WATER (PASSIVATED DM WATER), SERVICE WATER SYSTEM (FRESH WATER APPLICATION) , SERVICE AIR SYSTEM	UPTO NB 150	ERW, BLACK IS 1239 Heavy class (PT-1)	ASTM A234 Gr.WPB (NB 65 & ABOVE)	ASTM A105 (A283GR-C FOR ABOVE NB 200 MM)	GRAFOIL	SOCKET WELDED (NB 50 & BELOW)
		200 TO 450	IS 3589 FABRICATED FROM IS 2062	ASTM A105 (NB 50 & BELOW)			BUTT WELDED (NB 65 & ABOVE)
		500 & ABOVE	IS 3589 FABRICATED FROM IS 2062 PLATES				
1.10	RIVER WATER CONDENSER COOLING WATER, AUXILIARY COOLING WATER (SECONDARY CIRCUIT)	NB 65 TO 150	ERW, BLACK IS 1239 Heavy class (PT-1) Rubber Lined (5 mm thk)	ASTM A234 Gr.WPB – Rubber Lined (5 mm thk)	ASTM A105 (A283GR-C FOR ABOVE NB 200 MM) – Rubber Lined (5 mm thk)	GRAFOIL	FLANGED
		NB 200 TO 800	IS 3589 FABRICATED FROM IS 2062 – Rubber Lined (5 mm thk)				

REV. NO.	R0	R1			JOB NO. TCE. 5750A	CLIENT: RRVUNL	
PPD. BY	GS	AA					
CHD. BY	SN	SN				PROJECT: 2 x 660 MW, Super-Critical TPS, Stage-V, Suratgarh, Rajasthan	ISSUE R1
DATE	26-11-2009	30-05-2012					

SPECIFICATION NO. TCE.5750A-500-H-001 PART A	TATA CONSULTING ENGINEERS LIMITED		VOLUME: IIIA
	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATASHEET A14 SG & their Auxiliaries PIPING AND VALVES		SHEET 5 OF 9
SL. NO.	ITEM	UNIT	

		NB 900 & ABOVE	IS 3589 FABRICATE D FROM IS 2062 PLATES Gunited with cement mortar lining & Coating				
		NB 50MM & BELOW	ASTM A312 TP 304 (ERW)	A 182-F304	ASTM A 182 F304	GRAFOIL	SOCKET WELDED
1.11	POTABLE WATER SYSTEM/ INSTRUMENT AIR SERVICE	UPTO NB 150	ERW, BLACK, IS 1239 Heavy class (PT-1), GALVANISED	ASTM A234 Gr.WPB GALVANISED (NB 65 & ABOVE) ASTM A105 GALVANISED (NB 50 & BELOW)	ASTM A105 GALVANI- SED	GRAFOIL	FLANGED (NB 65 & ABOVE) SCREWED (NB 50 & BELOW)
		200 NB TO 450	IS 3589 FABRICATED FROM IS 2062 PLATES (ALL GALVANISED)				

REV. NO.	R0	R1			JOB NO.	CLIENT: RRVUNL	
PPD. BY	GS	AA			TCE. 5750A	PROJECT: 2 x 660 MW, Super-Critical TPS, Stage-V, Suratgarh, Rajasthan	ISSUE R1
CHD. BY	SN	SN					
DATE	26-11-2009	30-05-2012					

SPECIFICATION NO. TCE.5750A-500-H-001 PART A	TATA CONSULTING ENGINEERS LIMITED		VOLUME: IIIA
	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATASHEET A14 SG & their Auxiliaries PIPING AND VALVES		SHEET 6 OF 9
SL. NO.	ITEM	UNIT	

1.12	LIGHT DIESEL OIL (LDO) / HEAVY FURNACE OIL (HFO) / HIGH SPEED DIESEL (HSD)	NB 65MM & ABOVE (SEAM LESS)	ASTM A 106 Gr. 'B'	ASTM A 234 WPB	ASTM A105	TEFLON	BUTT WELDED
		NB50MM & BELOW (SEAM LESS)	ASTM A 106 Gr. 'B'	ASTM A 105	ASTM A105	TEFLON	SOCKET WELDED

1. All mandatory tests shall be carried out as per ASME Boiler & Pressure Vessel Code ASME Section-II,
2. Each length of pipe shall be hydro-tested at shop as per the Codes/Standards.
3. Blind flanges on SS Pipe lines shall be to ASTM A 240-TP 316. Stub ends shall be used at flanged connections.
4. All branch connections shall be wrought (seamless) or forged steel based on the size and availability based on ASTM Standards.
5. Piping System under Sl. No.1.1, 1.2, 1.3 & 1.4 shall have IBR Approval. Boiler feed discharge under item no.1.5 shall also be under IBR Approval.
6. All painting with primer coats (2 coats each) shall be provided for the piping and all hangers.

REV. NO.	R0	R1			JOB NO. TCE. 5750A	CLIENT: RRVUNL	
PPD. BY	GS	AA				PROJECT: 2 x 660 MW, Super-Critical TPS, Stage-V, Suratgarh, Rajasthan	
CHD. BY	SN	SN					ISSUE R1
DATE	26-11-2009	30-05-2012					

SPECIFICATION NO. TCE.5750A-500-H-001 PART A	TATA CONSULTING ENGINEERS LIMITED		VOLUME: IIIA
	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATASHEET A14 SG & their Auxiliaries PIPING AND VALVES		SHEET 7 OF 9
SL. NO.	ITEM	UNIT	

SPECIFIC REQUIREMENTS FOR VALVES

<u>SL. NO.</u>	<u>SERVICE</u>	<u>SIZE</u>	<u>BODY/ BONNET</u>	<u>DISC</u>	<u>STEM</u>	<u>HAND WHEEL</u>	<u>VALVE ENDS</u>
1.	STEAM LINES (TEMP >550°C AND <600°C)	≥65NB	ASTM A217 C- 12	ASTM A217 C- 12	ASTM A182 Gr. F6a	ASTM A 47 G Gr. 32510	BUTT WELDED
		≤ 50 NB	ASTM A182 Gr.F91	ASTM A182 Gr F91	ASTM A182 Gr.F6a	ASTM A97 Gr.32510	SOCKET WELDED
2.	STEAM LINES (TEMP >510°C AND <550 °C)	≥65NB	ASTM A217 WC-9	ASTM A217 WC- 9	ASTM A182 Gr. F6a	ASTM A47 G Gr. 32510	BUTT WELDED
		≤ 50 NB	ASTM A182 Gr.F-22	ASTM A182 Gr F22	ASTM A182 Gr.F6a	ASTM A97 Gr.32510	SOCKET WELDED
3.	STEAM LINES (TEMP>400 °C AND ≤510 °C)	≥65NB	ASTM A217 WC-6	ASTM A217 WC- 6	ASTM A182 Gr. F6a	ASTM A47 G Gr. 32510	BUTT WELDED.

REV. NO.	R0	R1			JOB NO.	CLIENT: RRVUNL	
PPD. BY	GS	AA			TCE. 5750A	PROJECT: 2 x 660 MW, Super-Critical TPS, Stage-V, Suratgarh, Rajasthan	ISSUE R1
CHD. BY	SN	SN					
DATE	26-11-2009	30-05-2012					

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	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATASHEET A14 SG & their Auxiliaries PIPING AND VALVES			SHEET 8 OF 9
SL. NO.	ITEM		UNIT	

		≤ 50 NB	ASTM A182 Gr.F-11	ASTM A182 Gr F11	ASTM A182 Gr.F6a	ASTM A97 Gr.32510	SOCKET WELDED
4.	STEAM LINES (TEMP≤400 °C), CONDENSATE BLOW DOWN, BOILER FEED SUCTION LINE	≥65 NB	ASTM A216 Gr WCB	ASTM A216 Gr WCB	ASTM A182 Gr F6a	ASTM A47 Gr 32510	BUTT WELDED
		≤ 50 NB	ASTM A105	ASTM A182 Gr F6a	ASTM A182 Gr F6a	ASTM A47Gr 32510	SOCKET WELDED
5.	BOILER FEED DISCHARGE & RECIRCULATION SYSTEMS	≥ 65 NB	ASTM A 216 Gr. WCB	ASTM A 216 Gr. WCB	ASTM A 182 Gr. F6a	ASTM A 47 Gr. 32510	BUTT WELDED
		≤ 50 NB	ASTM A 105	ASTM A 182 Gr. F6a	ASTM A 182 Gr. F6a	ASTM A 47 Gr. 32510	SOCKET WELDED
6.	LUBE OIL, SLUDGE, OILY WATER DRAINS	≥65NB	ASTM A216 Gr WCB	ASTM A216 Gr WCB	ASTM A479 Type 410-2	ASTM A47 Gr 32510	BUTT WELDED

REV. NO.	R0	R1			JOB NO. TCE. 5750A	CLIENT: RRVUNL	
PPD. BY	GS	AA				PROJECT: 2 x 660 MW, Super-Critical TPS, Stage-V, Suratgarh, Rajasthan	
CHD. BY	SN	SN					ISSUE R1
DATE	26-11-2009	30-05-2012					

SPECIFICATION NO. TCE.5750A-500-H-001 PART A	TATA CONSULTING ENGINEERS LIMITED		VOLUME: IIIA
	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATASHEET A14 SG & their Auxiliaries PIPING AND VALVES		SHEET 9 OF 9
SL. NO.	ITEM	UNIT	

	(UPTO FILTER)	≤ 50 NB	ASTM A105	ASTM A479 Type 410- 2	ASTM A479 Type 410-2	ASTM A47 Gr 32510	SOCKET WELDED

REV. NO.	R0	R1			JOB NO.	CLIENT: RRVUNL	
PPD. BY	GS	AA			TCE. 5750A	PROJECT: 2 x 660 MW, Super-Critical TPS, Stage-V, Suratgarh, Rajasthan	ISSUE R1
CHD. BY	SN	SN					
DATE	26-11-2009	30-05-2012					

SPECIFICATION NO. TCE.5750A-500-H-001 PART A	TATA CONSULTING ENGINEERS LIMITED		VOLUME: IIIA
	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATASHEET A15 SG & their Auxiliaries STRAINERS		SHEET 1 OF 3
SL. NO.	ITEM		

1.0	Tag Number	Lube Oil & Fuel oil
2.0	Quantity Required	*
3.0	Location	*
4.0	Type	Duplex
5.0	Fluid	Lube oil
6.0	Flow rate, kg/hr	*
7.0	Operating pressure – Kg/cm ² (g)	*
8.0	Operating temperature – °C	*
9.0	Design pressure – Kg/cm ² (g)	*
10.0	Design temperature – °C	*
11.0	Fluid viscosity cP at Op. temp	*
12.0	Fluid Sp. gravity at Op. temp.	*
13.0	Max. permissible Pr. Drop at 50% clogging	*
14.0	Screen / basket data	
	(i) CA of perforations	*
	(ii) Min. Thickness – mm	1.5
	(iii) Free straining area	4 times pipe cross sectional area.
15.0	Steam jacket	No

REV. NO.	R0	R1			JOB NO. TCE. 5750A	CLIENT: RRVUNL	
PPD. BY	GS	AA				PROJECT: 2 x 660 MW, Super-Critical TPS, Stage-V, Suratgarh, Rajasthan	
CHD. BY	SN	SN					ISSUE R1
DATE	26-11-2009	30-05-2012					

SPECIFICATION NO. TCE.5750A-500-H-001 PART A	TATA CONSULTING ENGINEERS LIMITED		VOLUME: IIIA
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SL. NO.	ITEM		

	(a) Inlet pr. Kg/cm ² (g) Op. / Desn.	
	(b) Inlet temp. °C Op. / Desn.	
16.0	End connections	
	(a) Size NB mm	*
	(b) Type	Welded
	(c) Details / Standards	ANSI B 16.25
17.0	Cover	Quick opng./ Bolted
18.0	(a) Body	Cast carbon steel ASTM A 216 Gr. B
	(b) Cover	- do -
	(c) Screen basket	Stainless steel
	(d) Bolts / Studs	ASTM A 193 Gr. B7
	(e) Nuts	ASTM A 194 Gr 2H
	(f) Gaskets	Red rubber – Full face wire inserted
19.0	ACCESSORIES BY VENDOR	
	(a) For Bolts	Yes
	(b) Diff. Pressure gauge	Yes
	(c) Drain / Vent cock (Forged Steel)	Yes
20.0	Hydro static test Pr. – Kg/cm ²	
	(a) Shell side	*

REV. NO.	R0	R1			JOB NO.	CLIENT: RRVUNL	
PPD. BY	GS	AA			TCE. 5750A	PROJECT: 2 x 660 MW, Super-Critical TPS, Stage-V, Suratgarh, Rajasthan	ISSUE R1
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	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATASHEET A15 SG & their Auxiliaries STRAINERS		SHEET 3 OF 3
SL. NO.	ITEM		

	(b) Jacket side	
21.0	Vacuum test required	No
22.0	Press. drop test required clean/50% clogged	Yes

- Duplex Filter shall be provided with Valves with a single handle or interlink so as to operate simultaneously.
- External valve position indicator shall be provided to indicate strainer housing in use.
- Strainer parts shall be replaceable without removing strainer housing from the line.
- Strainer housing covers shall be provided with Davit arm.
- Provision for equalising the pressure in standby housing before switching over should be provided.
- Acceptable leakage rates : NIL
- Strainers shall be skid mounted.

* VENDOR to furnish information in blank spaces

REV. NO.	R0	R1			JOB NO.	CLIENT: RRVUNL	
PPD. BY	GS	AA			TCE.	PROJECT: 2 x 660 MW, Super-Critical TPS, Stage-V, Suratgarh, Rajasthan	
CHD. BY	SN	SN			5750A		
DATE	26-11-2009	30-05-2012					ISSUE R1

SPECIFICATION NO. TCE.5750A-500-H-001 PART A	TATA CONSULTING ENGINEERS LIMITED		VOLUME: IIIA
	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATASHEET A16 SG & their Auxiliaries SHELL AND TUBE HEAT EXCHANGERS		SHEET 1 OF 3
SL. NO.	ITEM	UNIT	

1.0	Designation		By Bidder
2.0	Capacity		2 X 100% FOR EACH EQUIPMENT
3.0	MATERIALS OF CONSTRUCTION		
	COMPONENT		MATERIAL
3.1	Shell		IS-2002 GR. 2A/SA-285 GR. C/OR EQUAL
3.2	Shell Flanges		IS-2002 GR. 2A/SA-285 GR. C/OR EQUAL, SA 181 GR 1/OR EQ.
3.3	Shell Cover		IS-2002 GR. 2A/SA-285 GR. C/OR EQUAL.
3.4	Shell Cover Flange		IS-2002 GR. 2A/SA-285 GR. C/ IS 1875 CL. B/ SA 181 GR 1/OR EQ.
3.5	Shell Nozzles		IS-1978 ST 25/SA-53 GR. B/OR EQUAL.
3.6	Shell Nozzles Flanges		IS-2002 GR. 2A/IS-1875 CL. B/SA 285 GR C/SA 181 GR 1/OR EQUAL
3.7	Channels		IS-2002 GR. 2A/SA-285 GR. C/ OR EQUAL
3.8	Channel / Flanges		IS-2002 GR. 2A/IS 1875 GR B/ SA 285 GR C/SA 181 GR 1 OR EQUAL
3.9	Channel Cover Flange		IS-2002 GR. 2A/IS-1875 GR B/ SA 285 GR. C/SA 181 GR. 1/OR EQUAL
3.10	Channel Nozzles		IS-1978 ST 25/SA-53 GR B/OR EQUAL

REV. NO.	R0	R1			JOB NO. TCE. 5750A	CLIENT: RRVUNL	
PPD. BY	GS	AA				PROJECT: 2 x 660 MW, Super-Critical TPS, Stage-V, Suratgarh, Rajasthan	
CHD. BY	SN	SN					ISSUE R1
DATE	26-11-2009	30-05-2012					

SPECIFICATION NO. TCE.5750A-500-H-001 PART A	TATA CONSULTING ENGINEERS LIMITED		VOLUME: IIIA
	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATASHEET A16 SG & their Auxiliaries SHELL AND TUBE HEAT EXCHANGERS		SHEET 2 OF 3
SL. NO.	ITEM	UNIT	

3.11	Channel Nozzle Flanges		IS-2002 GR 2A/IS 1875 GR B/SA 285 GR C/SA 181 GR 1/OR EQUAL
3.12	Tubes		SA-179/BS-3059 CDS 33/OR EQUAL
3.13	Tube Sheets : i) Stationary ii) Floating	}	IS-2002 GR 2A/IS-1875 GR B/SA 285 GR C/SA 181 GR 1/OR EQUAL.
3.14	Baffles : i) Longitudinal		COMMERCIAL QUALITY STEEL
	ii) Cross		COMMERCIAL QUALITY STEEL
3.15	Support Plates		COMMERCIAL QUALITY STEEL
3.16	Pass Partition		COMMERCIAL QUALITY STEEL
SL. NO.	ITEMS	UNITS	VALUES
3.17	Impingement Plate		COMMERCIAL QUALITY STEEL
3.18	Tie Rods		COMMERCIAL QUALITY STEEL
3.19	Spacers		COMMERCIAL QUALITY STEEL
3.20	Floating Tube Sheet Joint		IS-1367-8.8, EN 24 T : SA 193-B-7-STUDS
3.21	All Other Shell Side Joints		IS-1367-B, EN 8 : SA 194-2H NUTS
3.22	<u>Gaskets</u>		

REV. NO.	R0	R1			JOB NO. TCE. 5750A	CLIENT: RRVUNL	
PPD. BY	GS	AA				PROJECT: 2 x 660 MW, Super-Critical TPS, Stage-V, Suratgarh, Rajasthan	
CHD. BY	SN	SN					ISSUE R1
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SL. NO.	ITEM	UNIT	

3.22.1	Shell Cover		ANNEALED STEEL JACKETTED COMP ASI
3.22.2	Channel Cover		ANNEALED STEEL JACKETTED COMP ASI
3.22.3	Fixed Tube Sheets Shell Side		COMP ASB
3.22.4	Fixed Tube Sheets Channel Side		ANNEALED STEEL JACKETTED COMP. ASB
3.22.5	Floating Tube Sheet Shell Side		ANNEALED STEEL JACKETTED COMP. ASB
3.22.6	Floating Tube Sheet Channel Side		ANNEALED STEEL JACKETTED COMP. ASB
3.23	Saddle Supports / Brackets		COMMERCIAL QUALITY STEEL
3.24	Jack Screws		MILD STEEL SA 193 B7 : IS-1367-B, 8.8 : EN 24 T OR EQUAL

REV. NO.	R0	R1			JOB NO. TCE. 5750A	CLIENT: RRVUNL	
PPD. BY	GS	AA				PROJECT: 2 x 660 MW, Super-Critical TPS, Stage-V, Suratgarh, Rajasthan	
CHD. BY	SN	SN					ISSUE R1
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	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATASHEET A17 SG & their Auxiliaries THERMAL INSULATION FOR HOT SURFACES		SHEET 1 OF 2
SL. NO.	ITEM	UNIT	

1.0	Insulation Material for		Lightly bonded mineral wool / pre-formed calcium silicate
1.2	Equipment		All equipment as applicable except steam turbine
2.0	Finishing Cement		No
3.0	Sheathing Material		Aluminium as per IS737 – 31000, Gr.H3
3.1	For pipes		i) Insulation outside dia above 450mm – Sheet thickness – 1 mm
			ii) Insulation outside dia 150 to 450mm – Sheet thickness –1 mm.
			iii) Insulation outside dia below 150mm – Sheet thickness – 1 mm.
3.2	For Equipment		i) Flues & ducts, ESP – Sheet thickness 1.0mm
			ii) SG casing & rear wall enclosure – Sheet thickness 1.2mm.
4.0	Design thickness is / should be based on :		
a)	Station ambient temperature	Deg.C	30

REV. NO.	R0	R1			JOB NO. TCE. 5750A	CLIENT: RRVUNL	
PPD. BY	GS	AA					
CHD. BY	SN	SN				PROJECT: 2 x 660 MW, Super-Critical TPS, Stage-V, Suratgarh, Rajasthan	ISSUE R1
DATE	26-11-2009	30-05-2012					

SPECIFICATION NO. TCE.5750A-500-H-001 PART A	TATA CONSULTING ENGINEERS LIMITED		VOLUME: IIIA
	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATASHEET A17 SG & their Auxiliaries THERMAL INSULATION FOR HOT SURFACES		SHEET 2 OF 2
SL. NO.	ITEM	UNIT	

b)	Outer surface temperature on surface of sheathing	Deg.C	60 under still air condition
5.0	Recommended thickness furnished (Applicable for calcium silicate also)		Yes / (Refer sheet 2 of 2)
7.0	Codes & Standards		IS 8183 IS 14164 BS 5970 IS-8154, BS 3958
	Notes :		
	1. For insulation thickness calculation maximum thermal conductivity indicated in relevant BIS shall be considered		

REV. NO.	R0	R1			JOB NO. TCE. 5750A	CLIENT: RRVUNL	
PPD. BY	GS	AA				PROJECT: 2 x 660 MW, Super-Critical TPS, Stage-V, Suratgarh, Rajasthan	
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	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATASHEET A18 SG & their Auxiliaries FLASH TANK		SHEET 1 OF 1
SL. NO.	ITEM	UNIT	

1.0	GENERAL		<u>FLASH TANK</u>
1.1	Number		As per requirement
1.2	Location		Atmospheric flash tanks- Outdoor, Other flash tanks – indoor.
2.0	DESIGN DATA		
2.1	Operating pressure	Kg/cm ² (a)	Bidder to indicate
2.2	Design pressure	Kg/cm ² (a)	*
2.3	Operating temperature	°C	*
2.4	Design temperature	°C	*
2.5	Corrosion allowances	mm	--- 3 (min.) ---
2.6	Spray arrangement		As per requirement.
3.0	MATERIALS OF CONSTRUCTION		
3.1	Shell and head		---Carbon steel---
3.2	Internal piping		--ASTM-A106-Gr.B--
3.3	Nozzle		----ASTM-A106-Gr.B-
	<u>Note</u> : * BIDDER to indicate		

REV. NO.	R0	R1			JOB NO. TCE. 5750A	CLIENT: RRVUNL	
PPD. BY	GS	AA				PROJECT: 2 x 660 MW, Super-Critical TPS, Stage-V, Suratgarh, Rajasthan	
CHD. BY	SN	SN					
DATE	26-11-2009	30-05-2012					ISSUE R1

SPECIFICATION NO. TCE.5750A-500-H-001 PART A	TATA CONSULTING ENGINEERS LIMITED		VOLUME: IIIA
	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATASHEET A19 SG & their Auxiliaries STEAM AIR COIL PREHEATERS		SHEET 1 OF 1
SL. NO.	ITEM	UNIT	

1.0	GENERAL		
1.1	Number of heaters		2 X 50%
1.2	Location		Outdoor, in FD fan discharge bypass duct or in both FD&PA fans discharge bypass ducts in case bisector APHs.
1.3	Mounting		Horizontal
1.4	Number for each FD/PA fan discharge duct		One
1.5	DESIGN DATA		
1.5.1	Shell side		FD Fan discharge air in trisector type or PA&FD fan discharge air in bisector type
1.5.2	Tube side fluid		Steam
1.5.3	Quality of steam		Superheated
1.5.4	Air temperature at the inlet		To keep average cold end metal temperature minimum 10 °C above the acid dew temperature of flue gas.
1.5.5	Design ambient air temperature		10 °C
1.6	MATERIALS OF CONSTRUCTION		
1.6.1	Tubes		90/10 Cu.Ni
1.6.2	Fins		Copper

REV. NO.	R0	R1			JOB NO. TCE. 5750A	CLIENT: RRVUNL	
PPD. BY	GS	AA					
CHD. BY	SN	SN				PROJECT: 2 x 660 MW, Super-Critical TPS, Stage-V, Suratgarh, Rajasthan	ISSUE R1
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DATA SHEET B
(SG AND ITS AUXILIARIES)

SPECIFICATION NO. TCE.5750A-H-500-001	TATA CONSULTING ENGINEERS LIMITED		VOLUME III
	RRVUNL RRVUNL, 2 x 660 MW, SUPER-CRITICAL TPS, STAGE-V, UNIT - 7 & 8, SURATGARH, RAJASTHAN SG and its auxiliaries DATA SHEET B 1 STEAM GENERATOR PERFORMANCE DATA		SHEET 1 OF 18
ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

1.1.0	GENERAL		60% TGMCR	80% TGMCR	100% TGMCR	100% SGMCR
1.1.1	Manufacturer					
1.1.2	No. of units					
1.1.3	Type of units					
1.1.4	Fuels					
1.1.4.1	Fuel for initial warm up					
1.1.4.2	Fuel for start up/flame stabilisation					
1.1.4.3	Fuel for performance guarantee					
1.1.4.4	Fuel for load carrying					
1.1.4.5	Fuel for igniters					
1.2.0	UNIT CAPABILITY DATA					
1.2.1	SG MCR					
1.2.1.1	Superheater flow	kg/s				
1.2.1.2	Steam conditions at super heater header Outlet a) Pressure	bar(a)				

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	b) Temperature	deg.C	
1.2.1.3	Reheater flow	kg/s	
1.2.1.4	Steam conditions at reheater inlet		
	a) Pressure	bar(a)	
	b) Temperature	deg.C	
1.2.1.5	Steam conditions at reheater outlet		
	a) Pressure	bar (a)	
	b) Temperature	deg.C	
1.2.1.6	Maximum allowable working pressure for Superheater	bar (a)	
	- Reheater	bar (a)	
1.2.1.7	Feed water inlet temperature	deg.C	
1.2.1.8	Fuel consumption	kg/s	
1.2.1.9	Efficiency based on fuel GCV	%	
1.2.1.1 0	Excess air at furnace exit	%	
1.2.1.1	Excess air at outlet of air heater	%	

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1			
			60% 80% 100% 100% TGMCR TGMCR TGMCR SGMCR
1.2.1.1 2	a) Flue gas temperature at APH outlet Considering leakage in APH - Without considering leakage in APH b) Flue gas temperature at ID fan outlet	deg.C deg.C	
1.2.1.1 3	SG Water Volume Furnace including economiser superheater - reheater	m ³ m ³ m ³	
1.3.0	ANTICIPATED PERFORMANCE FOR SLIDING PRESSURE OPERATION		
1.3.1	Steam flow :		
1.3.1.1	Steam quantity leaving final superheater outlet	kg/s	
1.3.1.2	Steam quantity leaving final reheater	kg/s	

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	outlet		
1.3.2	Steam generator efficiency based on the GCV of the fuel	%	
1.3.3	GCV of fuel as fired	Kcal/kg.	
1.3.4	NCV of fuel as fired	Kcal/Kg.	
1.3.5	Fuel, air and gas flow :		
1.3.5.1	Fuel firing rate	kg/s	
1.3.5.2	Combustion air requirement (without leakage) Burner Overfire air	kg/s	
1.3.5.3	Excess air	%	
1.3.5.4	Air handled by both FD fans	kg/s	
1.3.5.5	Air leakage in RAPH	kg/s	
1.3.5.6	Gas flow at economiser outlet	kg/s	
1.3.5.7	Gas flow at air heater outlet(including air leakage if any)	kg/s	
1.3.5.8	Feed water pressure at economiser	bar(a)	

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	inlet		
1.3.5.9	Fuel oil/gas pressure at burner inlet	bar(a)	
1.3.6	Temperatures:		
1.3.6.1	Gas –		
	a) Leaving furnace	deg.C	
	b) Entering high temperature superheater	deg.C	
	c) Leaving high temperature superheater	deg.C	
	d) Entering reheater	deg.C	
	e) Leaving reheater	deg.C	
	f) Entering low temperature superheater	deg.C	
	g) Leaving low temperature superheater	deg.C	
	h) Entering economiser	deg.C	
	i) Entering air heater	deg.C	
	j) Leaving air heater	deg.C	

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	k) At stack entrance	deg.C	
		deg.C	
			60% 80% 100% 100% TGMCR TGMCR TGMCR SGMCR
1.3.6.2	Air – a) Entering steam coil air pre heater b) Leaving steam coil air pre heater c) Entering air heater f) Entering coal mills e) Entering burner windbox d) Leaving air heater	deg.C deg.C deg.C deg.C deg.C deg.C	
1.3.6.3	Feed Water -		
	a) Entering economiser b) Leaving economiser	deg.C deg.C	

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1.3.6.4	Flue gas velocity at furnace exit	m/s	
1.3.7	Pressure drops :		
1.3.7.1	Steam path:		
	a) Superheater	bar	
	b) Superheater desuperheater	bar	
	c) Reheater	bar	
	d) Reheater desuperheater	bar	
1.3.7.2	Air pressure Losses :		
	a) Ducts	mmwc	
	b) Air preheater	mmwc	
	c) Across flow elements	mmwc	
	d) Burner registers	mmwc	
	e) Total loss through the system	mmwc	
1.3.7.3	Draft Losses		

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	a) Furnace suction	mmwc	
	b) Superheater	mmwc	
	c) Economiser	mmwc	
	d) Air preheater	mmwc	
	e) Flue gas duct upto stack	mmwc	
	f) Electrostatic precipitator including transition pieces	mmwc	
	g) Total loss through the system	mmwc	
1.3.8	Heat balance (based on GCV of fuel as fired):		
1.3.8.1	Heat to steam and water	%	
1.3.8.2	Heat loss in dry flue gases	%	
1.3.8.3	Heat loss due to moisture	%	
1.3.8.4	Heat loss due to hydrogen in fuel	%	
1.3.8.5	Heat loss due to moisture in air	%	
1.3.8.6	Unburnt fuel loss	%	

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1.3.8.7	Manufacturer's margin	%	
1.3.8.8	Radiation and unaccounted losses (radiation losses with a temperature differential of 28 deg.C between steam generator surfaces and ambient air)	%	
1.3.8.9	Gross efficiency based on GCV of fuel	%	
1.3.8.10	Total heat loss	%	
1.3.9	De-superheater		
1.3.9.1	Superheater desuperheaters		
1.3.9.1.1	Spray water pressure at inlet	bar	
1.3.9.1.2	Spray water quantity	kg/s	
1.3.9.1.3	Spray water system design capacity	kg/s	
1.3.9.2	Reheater desuperheater		

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	(If the spray is for emergency condition, indicate the maximum spray water expected under abnormal condition)		
1.3.9.2.1	Spray water pressure at inlet	bar	
1.3.9.2.2	Spray water Quantity	kg/s	
			60% TGMCR 80% TGMCR 100% TGMCR 100% SGMCR
1.3.9.2.3	Spray water system design capacity	kg/s	
1.3.10	Induced draft Fans:		
1.3.10.1	Volume of gas handled by each fan	Nm ³ /sec	
1.3.10.2	Temperature of gas at fan inlet	deg.C	
1.3.10.3	Total draft loss	mmwc	

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1.3.10.4	Speed of Fan	rpm	
1.3.10.5	Fan efficiency	%	
1.3.10.6	Variable speed hydraulic coupling efficiency (if applicable)	%	
1.3.10.7	Driving motor efficiency	%	
1.3.10.8	Electrical power input to each motor	kW	
1.3.11	Forced Draft Fans:		
1.3.11.1	Volume of air handled by each fan	Nm ³ /sec	
1.3.11.2	Temperature of air at fan inlet	deg.C	
1.3.11.3	Total air pressure loss	mmwc	
1.3.11.4	Speed of fan	rpm	

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1.3.11.5	Fan efficiency	%	
1.3.11.6	Driving motor efficiency	%	
1.3.11.7	Electrical power input to each motor	kW	
1.3.12	Primary Air Fans:		
1.3.12.1	Volume of air handled by each fan	Nm3/sec	
1.3.12.2	Temperature of air at fan inlet	deg.C	
1.3.12.3	Total air pressure loss	mmwc	
1.3.12.4	Speed of fan	rpm	
1.3.12.5	Fan efficiency	%	
1.3.12.6	Driving motor efficiency	%	
1.3.12.	Electrical power input to each motor	kW	

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7			
1.3.13	Gas Recirculation Fans(if applicable):		
1.3.13.1	Volume of gas handled by each fan	Nm3/sec.	
			60% 80% 100% 100% TGMCR TGMCR TGMCR SGMCR
1.3.13.2	Temperature of gas at fan inlet	deg.C	
1.3.13.3	Total gas pressure loss	mmwc	
1.3.13.4	Speed of fan	rpm	
3.13.5	Fan efficiency	%	
1.3.13.6	Driving motor efficiency	%	
1.3.13.7	Electrical power input to each motor	kW	
1.3.13.8	SG circulations pumps Provided or not		

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	If provided , no. of pumps used		
1.3.14	Coal Mills:		
1.3.14.1	No. of mills in operation with design coal	No.	
1.3.14.2	Load on each mill	kg/s	
1.3.14.3	Output size	%thru200 mesh	
1.3.14.4	Output size	% through 50 mesh.	
1.3.14.4	Driving motor efficiency	%	
1.3.14.5	Electrical power input to each motor	kW	
1.13.14.6	Minimum stable load of SGMCR when required no. of coal mills are in operation with design coal without oil support		

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.13.14.7	Minimum stable load of SGMCR when required no. of coal mills are in operation with worst coal without oil support			
1.4.0	MILL PERFORMANCE DATA		Load on each mill (% mill MCR)	Load on SG (%SGMCR)
1.4.1	Three coal mills in operation			
	Minimum stable load on each coal mill below which stopping of one mill is to be initiated	%		
1.4.2	Two coal mills in operation			
	Minimum load on each at which oil stabilisation is necessary before taking out a mill	%		
1.4.3	One coal mill in operation			
	Minimum load on the mill with	%		

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SL. NO.	ITEM	UNIT	

	stabilising oil burners			
1.5.0	Mode of operation		SH outlet pressure deviation	SH outlet temp deviation.
1.5.1	Steady state			
1.5.2	Load change between 40% TGMCR to 100% TGMCR			
1.5.2.1	Between 50% TGMCR to 60% TGMCR at 3% per minute of sliding pressure operation a) For sliding pressure operation			
1.5.2.2	Between 60% TGMCR to 90% TGMCR at 5% per minute for sliding pressure operation			
1.5.2.3	Between 90% TGMCR to 100% TGMCR at 3% per minute for constant pressure operation			
1.5.3	Step load change between 100% SG MCR and 60% TG MCR in case of run back due to loss of one FD/ID/PA fan or BFP or any other emergency			

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1.6.0	Time required to shut down the unit from full load condition		
1.7.0	Restart capability of the unit immediately after full load rejection		
1.8.0	Maximum permissible rate of temperature change	°C	Start up Load change Shut down
1.8.2	Superheater		
1.8.3	Reheater		
1.9.0	<u>COLD AND HOT START PROGRAMMES</u>		
1.9.1	Recommended periods to bring steam generator on load with HP-LP bypass (60% bypass)		
1.9.1.1	After cold start	hrs	
1.9.1.2	After thirty six hours shut down	hrs	
1.9.1.3	After twenty four hours shut down	hrs	
1.9.1.4	After twelve hours shut down	hrs	
1.9.1.5	After eight hours shut down	hrs	

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1.9.1.6	After four hours shut down	hrs	
1.9.1.7	Hot restart after trip out (less than 1 hr shut down)	hrs	
.10	<u>Auxiliary steam consumption</u>		
1.10.1	<u>Steam conditions</u>		
	(a) Pressure	kg/cm ² (a)	
	(b) Temperature	°C	
1.10.2	Fuel oil heating units	kg/s	
1.10.3	Fuel oil atomizing	kg/s	

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SL. NO.	ITEM	UNIT	

1.1	Maxim furnace exit gas temperature at furnace outlet	deg. C	
1.2	Clearance between pendant platen surface and furnace arch (nose) - B	m	
1.3	Clearance between centre line of top coal burners (nozzles) and work point of furnace arch (nose) – C		
1.4	Clearance between centre line of bottom coal burners (nozzles) and work point of hopper – D a) For front and / or rear wall firing b) For tangential firing	m m m	
1.5	Angle (alpha)	deg	
1.6	a)Height - H b)Width - W c)Depth - G d)Platen Height - H1	m m m m	
1.7	Volumetric heat release rate	kcal/m ³ /hr	

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SPECIFICATION NO. TCE.5750A-H-500-001	TATA CONSULTING ENGINEERS LIMITED		VOLUME III
	RRVUNL RRVUNL, 2 x 660 MW, SUPER-CRITICAL TPS, STAGE-V, UNIT - 7 & 8, SURATGARH, RAJASTHAN SG and its auxiliaries DATA SHEET B 2 HEAT RELEASE AND OTHER DATA		SHEET 2 OF 3
ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

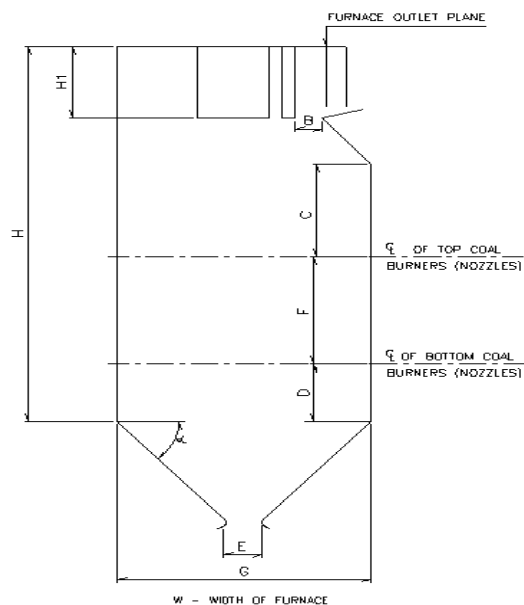
	(Net heat input at SG MCR / WxGxH)		
1.8	Furnace plan area heat release rate (Net heat input at SGMCR / furnace width x depth)	$\times 10^6$ kcal / hr/m ²	
1.9	Burner zone heat release = Net heat input at SGMCR / burner zone surface Burner zone surface = (2 x (furnace width + furnace depth) x burner zone height burner zone height = distance F + 3m	$\times 10^6$ kcal /hr/m ²	
1.10	Effective projected radiant surface release rate (Net heat input at SG MCR / effective radiant surface)	kCal/m ²	
1.11	Detail calculations for the net heat Input value, utilised in arriving at Various heat release rate mentioned above.		
1.12	Maximum flue gas velocity through tube banks at design excess air at SG MCR	m/s	

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ENQUIRY/SPECIFICATION NO.:			BIDDER:	
SL. NO.	ITEM	UNIT		

1.13	Economiser tube banks arrangement		
1.14	Clearance centreline of burner to side wall		
1.15	Maximum width of furnace hopper opening- E		

The BIDDER shall furnish the steam generator furnace dimensions and the data required on sheets with reference to the following drawing.



<u>NOTES TO BIDDER</u>	SIGNATURE OF BIDDER & DATE
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ENQUIRY/SPECIFICATION NO.:		BIDDER:	
SL. NO.	ITEM	UNIT	

1.0	GENERAL		Economiser	Evaporator	SH	RH
1.1	Design capacity	kg/s				
1.2	Design pressure	bar(a)				
1.3	Design temperature					
	Economiser	deg C				
	Furnace wall	deg C				
	Superheater	deg C				
	Reheater	deg C				
1.4	Maximum safety valve set pressure for SH	bar (a)				
1.5	Maximum safety valve set pressure for RH	bar (a)				
2.0	FURNACE WALLS					
2.1	Furnace					
2.1.1	Outside diameter	mm				
2.1.2	Pitch	mm				
2.1.3	Thickness	mm				

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

2.1.4	Design standard				
2.1.5	Material				
2.1.6	Total projected surface area of tubes	m ²			
2.2	Side Walls, Rear Walls & Roof		SideWalls	Rear Walls	Roof
2.2.1	Number				
2.2.2	Outside diameter	mm			
2.2.3	Pitch	mm			
2.2.4	Thickness	mm			
2.2.5	Design standard				
2.2.6	Material				
2.2.7	Total projected surface area of tubes	m ²			
2.3	Water Wall Headers				
2.3.1	Number of headers				
2.3.2	Outside diameter	mm			
2.3.3	Thickness	mm			

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ENQUIRY/SPECIFICATION NO.:		BIDDER:	
SL. NO.	ITEM	UNIT	

2.3.4	Length of each header	mm			
2.4	Erosion/corrosion allowance for all water wall tubes				
3.0	SUPERHEATER AND REHEATERS TUBES AND HEADERS		Radiant Section (FSH)	Convective Section(LTSH)	
3.1	Superheater Tubes				
3.1.1	Material				
3.1.2	Heating surface (effective)	m2			
3.1.3	Total circumferential heating surface	m2			
3.1.4	Gas flow path area	m2			
3.1.5	Maximum metal temperature	deg.C			
3.1.6	Outside diameter	mm			
3.1.7	Tube thickness	mm			
3.1.8	Effective length (per one tube)	mm			
3.1.9	Gross length (per one tube)	mm			
3.1.10	Number of elements/section				
3.1.11	Tube pitch (Indicate for each type of				

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

	superheater)	mm	
	a)Parallel to gas flow (Longitudinal)		
	b) Across gas flow (Transverse)	mm	
3.1.12	Erosion/corrosion allowance	mm	
3.1.13	Type of flow		
3.2	Superheater Headers		
3.2.1	Max. operating pressure	bar(a)	
3.2.2	Design pressure	bar(a)	
3.2.3	Construction		
3.2.3.1	Outside diameter	mm	
3.2.3.2	Thickness	mm	
3.2.3.3	Material		
3.2.3.4	Number of steam passes		
3.2.3.5	Erosion/corrosion allowance	mm	
3.3	Reheater Tubes		
3.3.1	Material		

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

3.3.2	Heating surface (effective)	m ²	
3.3.3	Total circumferential heating surface	m ²	
3.3.4	Gas flow path area	m ²	
3.3.5	Maximum operating pressure	bar(a)	
3.3.6	Maximum metal temperature	deg C	
3.3.7	Design pressure	bar(a)	
3.3.8	Outside diameter	mm	
3.3.9	Tube thickness	mm	
3.3.10	Effective length (per one tube)	mm	
3.3.11	Gross length (per one tube)	mm	
3.3.12	Tube pitch (Indicate for each type of reheater) a) Parallel to gas flow (Longitudinal) b) Across gas flow (Transverse)	mm mm	
3.3.13	Type of flow		

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

3.3.14	Headers		
3.3.15	Construction		
3.3.15.	Outside diameter	mm	
3.3.15.	Thickness	mm	
3.3.15. 3	Material		
3.3.15.	Number of steam passes		
3.3.16	Erosion/corrosion allowance	mm	
3.4	Economiser Tubes		
3.4.1	Effective heating surface (water side)	m ²	
3.4.2	Effective heating surface (gas side)	m ²	
3.4.3	Gas flow path area	m ²	
3.4.4	Gas velocity at SG MCR	m/s	
3.4.5	Tubes		
3.4.6	Construction		

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

3.4.6.1	Material		
3.4.6.2	Outside diameter	mm	
3.4.6.3	Thickness	mm	
3.4.6.4	Length	mm	
	Pitch		
	a) Parallel to gas flow (Longitudinal)	mm	
	b) Across gas flow (transverse)	mm	
3.4.7	Headers		
3.4.7.1	Material		
3.4.7.2	Outside diameter	mm	
3.4.7.3	Thickness	mm	
3.4.7.4	Length	mm	
3.5	Total tonnage of all the pressure parts	tonnes	
3.6	Total water fill volume	M ³	

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	RRVUNL RRVUNL, 2 x 660 MW, SUPER-CRITICAL TPS, STAGE-V, UNIT - 7 & 8, SURATGARH, RAJASTHAN SG and its auxiliaries DATA SHEET B 4 REGENERATIVE AIR PREHEATER		SHEET 1 OF 4
ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

1.1.0	GENERAL		Primary air		Secondary air	
1.1.1	No. of air preheaters (APH) per steam generator					
1.1.2	Type					
1.1.3	Make					
1.1.4	Speed	rpm				
1.2.0	HEATER ELEMENTS		No. of baskets	Height of elements (mm)	Material	
1.2.1	Cold/middle/upper hot elements					
1.2.1.1	Cold end elements					
1.2.1.2	Middle elements					
1.2.1.3	Upper hot elements					
1.2.2	Casing thickness	mm				
1.2.3	Total effective heating surface	m ²				
1.2.4	Pressure drop at SG MCR					
1.2.4.1	Air side	mmwc				

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

1.2.4.2	Gas side	mmwc			
1.3.0	SEALING				
1.3.1	Type of radial seals				
1.3.1.1	Hot end				
1.3.1.2	Cold end				
1.3.2	Type of circumferential seal				
1.3.3	Type of axial seal				
1.3.4	Air leakage across seals (expressed as % of air flow at 100% SG MCR)				
1.4.0	AIR AND GAS DATA				
1.4.1	Gas velocity at 100% SG MCR	m/s			
1.4.2	Air velocity at 100% SG MCR	m/s			
1.4.3	Net free areas for air and gas flow	m ²			
1.4.4	Air flow rate	cu.m/s			
1.4.5	Gas flow rate	cu.m/s			
1.5.0	AIR HEATER DRIVES				

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

1.5.1	Electric motor drive		
1.5.1.1	Motor speed	rpm	
1.5.1.2	Motor rating	kW	
1.5.2	Speed reducer (Three input gear box)		
1.5.2.1	Type		
1.5.2.2	Speed ratio		
1.5.2.3	Shaft power	kW	
1.5.3	Emergency drive (Air motor drive)		
1.5.3.1	Type		
1.5.3.2	Shaft power	kW	
1.5.3.3	Speed	rpm	
1.5.3.4	Air requirements		
	a) Pressure	bar(a)	
	b) Flow rate	m ³ /s	
1.6.0	ROTOR AND BEARINGS		
1.6.1	Rotor material		

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

1.6.2	Bearings		
1.6.2.1	Type		
1.6.2.2	Type of lubrication		
1.7	Total weight of RAPH	tonnes	

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

1.1.0	GENERAL		
1.1.1	No. of steam coil air pre heaters (SCAPH) per SG unit		
1.1.2	Type		
1.1.3	Manufacturer		
1.2.0	DESIGN CONDITIONS (Each SCAPH)		
1.2.1	Total air flow	m3/h	
1.2.2	Temperature of air entering heater	deg C	
1.2.3	Temperature of air leaving heater	deg C	
1.2.4	Air velocity	m/s	
1.2.5	Air pressure drop across heater	mmwc	
1.2.6	Corrosion allowance	mm	
1.2.7	Heating steam requirement:		
1.2.7.1	Quantity	kg/s	
1.2.7.2	Inlet pressure	bar(a)	
1.2.7.3	Inlet temperature	deg C	
1.2.8	Drain:		

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

1.2.8.1	Drain enthalpy	kcal/kg	
1.2.8.2	Total surface area	m ²	
1.2.8.3	Heat transfer coefficient	kcal/hr m ² /deg C	
1.3.0	CONSTRUCTION FEATURES		
1.3.1	No. of sections per heater		
1.3.2	No. of tubes in each section		
1.3.3	Materials of Construction		
1.3.3.1	Tubes		
1.3.3.2	Fins		
1.3.3.3	Nozzles		
1.3.3.4	Casing		
1.3.3.5	Supporting plate		
1.3.3.6	Gasket		
1.3.4	Surface area of each section	m ²	
1.3.5	Tube diameter	mm	

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ENQUIRY/SPECIFICATION NO.:			BIDDER:	
SL. NO.	ITEM	UNIT		

1.3.6	Tube thickness	mm	
1.4	Total weight steam coil air pre heater	tonnes	

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ENQUIRY/SPECIFICATION NO.:			BIDDER:	
SL. NO.	ITEM	UNIT		

1.1	No. of fans per steam generator		
1.2	Type		
1.3	Manufacturer		
2.0	DESIGN PERFORMANCE		
2.1	Capacity	m ³ /s	
2.2	Head	mmwc	
2.3	Design margins over BMCR- DC		
2.3.1	Capacity	%	
2.3.2	Head	%	
2.4	Design temperature	°C	
2.5	Flue gas density	kg/m ³	
2.6	Draught loss at 100% SG MCR-DC	mmwc	
2.7	Fan speed	rpm	
2.8	Fan critical speeds		
2.8.1	First critical speed	rpm	
2.8.2	Second critical speed	rpm	

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ENQUIRY/SPECIFICATION NO.:	BIDDER:

SL. NO.	ITEM	UNIT	

2.9	Fan efficiency at MCR (DC)	%	
2.10	Motor efficiency at MCR(DC)	%	
2.11	Motor rating	kW	
3.0	CONSTRUCTION FEATURES		
3.1	Casing, whether horizontally split?		
3.1.1	Material		
3.1.2	Thickness	mm	
3.2	Coupling		
3.2.1	Type, Rigid or flexible		
3.2.2	Make		
3.3	Impeller		
3.3.1	Diameter	mm	
3.3.2	Material		
3.4	Shaft		
3.4.1	Diameter	mm	
3.4.2	Material		

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SPECIFICATION NO. TCE.5750A-H-500-001	TATA CONSULTING ENGINEERS LIMITED		VOLUME III
	RRVUNL RRVUNL, 2 x 660 MW, SUPER-CRITICAL TPS, STAGE-V, UNIT - 7 & 8, SURATGARH, RAJASTHAN SG and its auxiliaries DATA SHEET B 6 CENTRIFUGAL FANS		SHEET 3 OF 3
ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

3.5	Bearings		
3.5.1	No., make and type		
3.5.2	Bearing liner material		
3.5.3	Type of cooling		
3.5.4	Bearing lubrication type		
3.6	Shaft sealing arrangement		
3.7	Total weight of the equipment	Tonnes	

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SPECIFICATION NO. TCE.5750A-H-500-001	TATA CONSULTING ENGINEERS LIMITED		VOLUME III
	RRVUNL RRVUNL, 2 x 660 MW, SUPER-CRITICAL TPS, STAGE-V, UNIT - 7 & 8, SURATGARH, RAJASTHAN SG and its auxiliaries DATA SHEET B 7 AXIAL FANS		SHEET 1 OF 3
ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

1.0	GENERAL		
1.1	Number of fans per steam generator		
1.2	Type		
1.3	Manufacturer		
2.0	DESIGN PERFORMANCE		
2.1	Capacity	m ³ /s	
2.2	Total head	mmwc	
2.3	Design margin		
2.3.1	Capacity – BMCR (DC)	%	
2.3.2	Head - BMCR (DC)	%	
2.4	Design temperature	°C	
2.5	Air density	Kg/m ³	
2.6	Draft loss at 100% SG MCR	mmwc	
2.7	Fan speed	rpm	
2.8	Fan critical speeds		
2.8.1	First critical speed	rpm	

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ENQUIRY/SPECIFICATION NO.:	BIDDER:

SL. NO.	ITEM	UNIT	

2.8.2	Second critical speed	rpm	
2.9	Fan efficiency at MCR	%	
2.10	Motor efficiency at MCR	%	
2.11	Motor rating	kW	
3.0	CONSTRUCTION FEATURES		
3.1	Casing		
3.1.1	Material		
3.1.2	Thickness	mm	
3.2	Coupling		
3.2.1	Type - rigid or flexible		
3.2.2	Make		
3.3	Impeller		
3.3.1	Diameter	mm	
3.3.2	Blade material		
3.3.3	Hub material		
3.4	Shaft		

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

3.4.1	Diameter	mm	
3.4.2	Material		
3.5	Bearings		
3.5.1	No., make and type		
3.5.2	Bearing liner material		
3.6	Shaft sealing arrangement		
3.7	Hydraulic servo drive		
3.7.1	No., make and type		
3.8	Lube oil system		
3.8.1	No. and type of pumps		
3.8.2	No. and type of oil coolers		
4.0	Total weight of Equipment	Tonnes	

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	RRVUNL RRVUNL, 2 x 660 MW, SUPER-CRITICAL TPS, STAGE-V, UNIT - 7 & 8, SURATGARH, RAJASTHAN SG and its auxiliaries DATA SHEET B 8 SOOT BLOWING SYSTEM		SHEET 1 OF 4
ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

1.1.0	GENERAL				
1.1.1	Source of steam				
1.1.2	Steam pressure	bar(a)			
1.1.3	Steam temperature	deg C			
1.2.0	SOOT-BLOWERS				
1.2.1	Furnace, Radiant, Convective Sections		Furnace	Superheater	Reheater
1.2.1.1	Type and make – selective soot blowing or sequential type				
1.2.1.2	Number of soot blowers				
	Radiant section				
	Convective section				
1.2.1.3	Material of construction				
	Lance / swivel tube				
	- Nozzle				
	- Blower head				
	- Feed tube				

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	RRVUNL RRVUNL, 2 x 660 MW, SUPER-CRITICAL TPS, STAGE-V, UNIT - 7 & 8, SURATGARH, RAJASTHAN SG and its auxiliaries DATA SHEET B 8 SOOT BLOWING SYSTEM		SHEET 2 OF 4
ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

	- Bearing (in high temp. area)				
	- Compression hangers				
1.2.1.4	Total time required for one complete cycle of soot blowing operation	hr			
1.2.1.5	Duration of operation	min.			
1.2.1.6	Operating pressure	bar(a)			
1.2.1.7	Steam consumption rate per cycle	Kg/hr			
1.2.1.8	Rate of steam consumption per blower	Kg/h			
1.2.2	Economiser & Air preheater:		Economiser	Air preheater	
1.2.2.1	Type and make				
1.2.2.2	Number of soot blowers				
1.2.2.3	Material of construction				
	/ Swivel tube				
	- Nozzle				
	- Blower head				
	- Feed tube				

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

	- Swivel joint			
1.2.2.4	Duration of operation	min.		
1.2.2.5	Operating pressure	bar(a)		
1.2.2.6	Steam consumption rate per cycle	Kg/h		
1.2.2.7	Rate of steam consumption per blower	Kg/h		
1.2.2.8	Total time required for one complete cycle of soot blowing operation	h		
1.3.0	PRESSURE REDUCING VALVES (Furnish data for all valves)			
1.3.1	Type and make			
1.3.2	Inlet pressure	bar(a)		
1.3.3	Outlet pressure	bar(a)		
1.3.4	Outlet temperature	deg C		
	Material :			
1.3.5.1	Valve seat			
1.3.5.2	Body			

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

1.3.5.3	Stem			
1.4.0	SAFETY VALVES (Furnish data for all valves)			
1.4.1	Type and make			
1.4.2	Blowing pressure	bar(a)		
1.4.3	Blowing capacity	t/h		

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	RRVUNL RRVUNL, 2 x 660 MW, SUPER-CRITICAL TPS, STAGE-V, UNIT - 7 & 8, SURATGARH, RAJASTHAN SG and its auxiliaries DATA SHEET B 9 FUEL OIL BURNERS AND IGNITORS		SHEET 1 OF 3
ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

1.1.0	GENERAL		
1.1.1	Designation		
1.1.2	Number of burners per steam generator		
1.1.3	Type		
1.1.4	Make		
1.1.5	Capacity of each burner	Kg/h	
1.1.6	Turn-down ratio of burner		
1.1.7	Heavy oil pressure :		
1.1.7.1	Maximum	bar(a)	
1.1.7.2	Normal	bar(a)	
1.1.7.3	Minimum	bar(a)	
1.1.8	Atomising medium		
1.1.8.1	Atomising steam/air requirement of each burner i) Flow rate ii) Pressure	kg/h	

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

		bar(a)	
1.1.9	Scavenging steam requirement of each burner		
1.1.9.1	Flow rate	Kg/h	
1.1.9.2	Duration of cleaning	min	
1.1.9.3	Pressure	bar(a)	
1.1.10	Viscosity of oil at burner tip for good atomisation	Cst	
1.1.11	Air requirement of auto retract mechanism		
1.1.11.1	a) Quality b) Quantity/operation c) Pressure	Nm ³ bar(a)	
1.1.12	Material of construction:		
1.1.12.1	Oil burner		
1.1.12.2	Diffuser		
1.1.12.3	Nozzle cap		

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

1.2.0	IGNITORS		
1.2.1	Type		
1.2.2	Number		
1.2.3	Fuel		
1.2.4	Capacity of each ignitors	kg/h	
1.2.5	Ignition gas pressure	bar(a)	
1.2.5.1	Maximum		
1.2.5.2	Normal		
1.2.5.3	Minimum		

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SPECIFICATION NO. TCE.5750A-H-500-001	TATA CONSULTING ENGINEERS LIMITED	VOLUME III
	RRVUNL RRVUNL, 2 x 660 MW, SUPER-CRITICAL TPS, STAGE-V, UNIT - 7 & 8, SURATGARH, RAJASTHAN SG and its auxiliaries DATA SHEET B 10 COAL BURNERS	SHEET 1 OF 2

ENQUIRY/SPECIFICATION NO.:	BIDDER:

SL. NO.	ITEM	UNIT	

1.1.0	Number of burners		
1.2.0	Type (Low Nox burner)	Yes/No	
1.3.0	Make		
1.4.0	Capacity of each burner	Kg/h	
1.5.0	Turndown ratio without oil support		
1.6.0	Coal/air mixture pressure before burner	mmwc	
1.7.0	Velocity of the mixture at entry to burner	m/s	
1.8.0	Velocity of secondary air at entry to burner	m/s	
1.9.0	Material		
1.9.1	Coal burner nozzle		
1.9.2	Guide plate		
1.9.3	Support bearing inside wind box		
1.9.4	Drive mechanism for tilting(linkages etc. if provided)		
1.9.5	Total weight of equipment	Tonnes	

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	RRVUNL RRVUNL, 2 x 660 MW, SUPER-CRITICAL TPS, STAGE-V, UNIT - 7 & 8, SURATGARH, RAJASTHAN SG and its auxiliaries DATA SHEET B 10 COAL BURNERS		SHEET 2 OF 2
ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

1.10	COAL FEEDER (GRAVIMETRIC)		
1.10.1	Type		
1.10.2	Manufacturer		
1.10.3	Capacity	T/hr	
1.10.4	Speed	rpm	
1.10.5	Distance between centre line of inlet and outlet		
1.10.6	Inlet Diameter	mm	
1.10.7	Belt width	mm	
1.10.8	Motor rating	kW	
1.10.9	Type of controls		
1.10.10	Total weight of equipment	Tonnes	

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	RRVUNL RRVUNL, 2 x 660 MW, SUPER-CRITICAL TPS, STAGE-V, UNIT - 7 & 8, SURATGARH, RAJASTHAN SG and its auxiliaries DATA SHEET B 11 COAL MILLS	SHEET 1 OF 4

ENQUIRY/SPECIFICATION NO.:	BIDDER:

SL. NO.	ITEM	UNIT	

1.1.0	Make		
1.1.1	Type		
1.1.2	No of mills		
1.1.3	Manufacturer		
1.1.4	Capacity (Indicate for worst and design coal)	t/h	
1.1.5	Method of feeding		
1.1.6	Input lump size max		
1.1.7	Speed of rotation	mm	
1.1.8	Guaranteed output at specified input size and moisture	rpm	
1.1.9	Output fineness	t/h	
1.1.10	Mode of adjustment of ball / roller		
1.1.11	Mode of adjustment of classifier vanes		
1.1.12	Material		
1.1.13	a) Grinding ring/race/cylinder b) Liner, if applicable		

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

1.1.13.1	a) Rolls/balls b) Liner, if applicable		
1.1.13.2	a) Housing grinding zone b) Liner, if applicable		
1.1.13.3	a) Reject collection zone b) Linear, if applicable		
1.1.13.4	Gear drive make		
1.1.13.5	Main drive shaft		
1.1.13.6	Worm shaft		
1.1.13.7	Classifier type		
1.1.13.8	Pressure springs		
1.1.13.9	Type of bearings and seals		
1.1.14	Method of lubrication of rotating parts		
1.1.15	Type of flexible coupling		
1.1.16	Power consumption per mill at 10%		

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

	SG MCR - For design coal - For worst coal		
1.1.17	Mill drive motor rating	kW	
1.1.18	Wear parts life	hours	
1.1.19	Grinding ring/race life		
1.1.20	Rolls / Balls life		
1.1.21	Expected no. of operating hours between major over-hauls of the coal mill		
1.2.0	Rate of coal mill rejects - When the mills are relatively new (Just started operation) - Considering worn out condition of grinding parts		
1.2.1	Total weight of mills	Tonnes	
1.3.0	Any other Data - List items		

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

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	RRVUNL RRVUNL, 2 x 660 MW, SUPER-CRITICAL TPS, STAGE-V, UNIT - 7 & 8, SURATGARH, RAJASTHAN SG and its auxiliaries DATA SHEET B 12 ROTARY GEAR SREW PUMPS		SHEET 2 OF 2
ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

1.1.12.5	Base plate		
1.1.12.6	Wearing rings (if required)		
1.1.13	Type of bearing used		Internal/external
1.1.14	Connections		
1.1.14.1	Suction size	mm	
1.1.14.2	Discharge size	mm	
1.1.15	Relief valve set pressure	bar(a)	
1.1.16	Motor		
1.1.16.1	Motor rating and speed	kW/rpm	
1.1.17	Maximum allowable suction lift	mlc	
1.1.18	Any other Data - List items		

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	RRVUNL RRVUNL, 2 x 660 MW, SUPER-CRITICAL TPS, STAGE-V, UNIT - 7 & 8, SURATGARH, RAJASTHAN SG and its auxiliaries DATA SHEET B 13 FUEL OIL HEATERS	SHEET 1 OF 2

ENQUIRY/SPECIFICATION NO.:	BIDDER:

SL. NO.	ITEM	UNIT	

1.0	Number provided		
2.0	Design Data for each heater		
2.1	Fluid circulated		
2.2	Flow rate (max)	kg/h	
2.3	Operating temperature		
	(a) Inlet	⁰ C	
	(b) Outlet	⁰ C	
2.4	Pressure drop across heater	kg/cm ²	
2.5	Hydrotest pressure	kg/cm ² (a)	
2.6	Corrosion allowance	mm	
2.7	Fouling resistance	h.m ² . ⁰ C/kcal	
2.8	No. of passes		
3.0	Total heat transfer area	m ²	
4.0	Tube details		
	(a) No.		
	(b) Outside dia	mm/BWG	

NOTES TO BIDDER 1. ITEMS WHICH DEVIATE FROM THE SPECIFICATION SHOULD BE MARKED WITHIN ASTERISK (*) AND DETAILS TO BE GIVEN IN SCHEDULE OF DEVIATIONS. 2. THIS DATA SHEET SHALL BE FILLED UP COMPLETELY AND A COPY SHALL BE ENCLOSED WITH EACH COPY OF THE BID.	SIGNATURE OF BIDDER & DATE ISSUE R1

SPECIFICATION NO. TCE.5750A-H-500-001	TATA CONSULTING ENGINEERS LIMITED		VOLUME III
	RRVUNL RRVUNL, 2 x 660 MW, SUPER-CRITICAL TPS, STAGE-V, UNIT - 7 & 8, SURATGARH, RAJASTHAN SG and its auxiliaries DATA SHEET B 13 FUEL OIL HEATERS		SHEET 2 OF 2
ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

	(c) Pitch	mm	
	(d) Length	mm	
5.0	Materials of construction		
	(a) Shell		
	(b) Tubes		
	(c) Tube sheets		
	(d) Baffles		
	(e) Gaskets		
6.0	Empty weight of heater	tonnes	
7.0	Flooded weight of heater	tonnes	
8.0	Assembled dimension of heater	m x m x m	

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SPECIFICATION NO. TCE.5750A-H-500-001	TATA CONSULTING ENGINEERS LIMITED	VOLUME III
	RRVUNL RRVUNL, 2 x 660 MW, SUPER-CRITICAL TPS, STAGE-V, UNIT - 7 & 8, SURATGARH, RAJASTHAN SG and its auxiliaries DATA SHEET B 14 AIR AND FLUE GAS DUCTS AND DAMPERS	SHEET 1 OF 3

ENQUIRY/SPECIFICATION NO.:	BIDDER:

SL. NO.	ITEM	UNIT	

1.1.0	FD fan cold air intake duct size	mm x mm	
1.1.1	FD fan cold air discharge duct size	mm x mm	
1.1.2	PA fan cold air intake duct size	mm x mm	
1.1.3	PA fan hot air duct size	mm x mm	
1.1.4	Thickness of plate :		
1.1.5	Cold air	mm	
1.1.5.1	Hot air	mm	
1.1.5.2	Material		
1.1.6	Air velocity in :		
1.1.7	Cold air duct FD fan	m/s	
1.1.7.1	Cold air duct PA fan	m/s	
1.1.7.2	Hot air duct PA fan	m/s	
	GAS DUCTS		ID Fan GR Fan (If produced)
1.2.0	Size of ID fan discharge duct	mm x	

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

		mm	
1.2.1	Size of common flue gas duct (after header ring)	mm x mm	
1.2.2	Duct plate thickness	mm	
1.2.3	Material		
1.2.4	Gas velocities:		
1.2.5	Suction side	m/s	
1.2.5.1	Discharge	m/s	
	DAMPERS		Isolation Control Guillotine
1.3.0	Type and make		
1.3.1	Location		
1.3.2	Service		
1.3.3	Type of drive		
1.3.4	Sealing efficiency	%	
1.3.5	Materials of construction		

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

1.4.0	Dampers frame		
1.4.1	Blades		
1.4.2	Linkage bolts and pins		
1.5	Total weight of Equipment	Tonnes	

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SPECIFICATION NO. TCE.5750A-H-500-001	TATA CONSULTING ENGINEERS LIMITED		VOLUME III
	RRVUNL RRVUNL, 2 x 660 MW, SUPER-CRITICAL TPS, STAGE-V, UNIT - 7 & 8, SURATGARH, RAJASTHAN SG and its auxiliaries DATA SHEET B 15 ELECTROSTATIC PRECIPITATOR		SHEET 1 OF 3
ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

1.1.0	Manufacturer		
1.1.1	Number of ESP / Steam generator		
1.1.2	Number of gas stream / ESP		
1.1.3	Number of electrical fields in series in gas path / stream		
1.1.4	Total active treatment length per stream	m	
1.1.5	Treatment time	secs.	
1.1.6	Corona power per ESP stream	watts per 1000 m ³ per min	
1.1.8	No. of hours ESP can run at specified gas flow and dust loading without emptying any hopper		
1.1.8.1	With worst coal		
1.1.8.2	With design coal		
1.1.9	Dust conc. at the ESP outlet		
1.1.9.1	Worst coal firing		

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SPECIFICATION NO. TCE.5750A-H-500-001	TATA CONSULTING ENGINEERS LIMITED	VOLUME III
	RRVUNL RRVUNL, 2 x 660 MW, SUPER-CRITICAL TPS, STAGE-V, UNIT - 7 & 8, SURATGARH, RAJASTHAN SG and its auxiliaries DATA SHEET B 15 ELECTROSTATIC PRECIPITATOR	SHEET 2 OF 3

ENQUIRY/SPECIFICATION NO.:	BIDDER:

SL. NO.	ITEM	UNIT	

	All fields in service	mg/m ³	
	One TR set out of service	mg/Nm ³	
1.1.9.2	Guarantee coal firing		
	All fields in service	mg/Nm ³	
	One TR set out of service	mg/Nm ³	
1.1.10	Total power input to the ESP per steam generator		
1.2.0	ELECTRODES & BUS SECTIONS		
1.2.1	Collecting Electrodes		
1.2.1.1	Type		
1.2.1.2	Material		
1.2.1.3	Electrode thickness	mm	
1.2.1.4	Clear distance between collecting electrode plates	mm	
1.2.1.5	Number of gas passages / stream		
1.2.1.6	Active length per electrode	m	

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SPECIFICATION NO. TCE.5750A-H-500-001	TATA CONSULTING ENGINEERS LIMITED	VOLUME III
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ENQUIRY/SPECIFICATION NO.:	BIDDER:

SL. NO.	ITEM	UNIT	

1.2.1.7	Cross sectional area of each passage	m ²	
1.2.1.8	Active height per electrode	m ²	
1.2.1.9	Specific collection plate are	m ² /m ³ /sec	
1.2.1.10	Total number of electrodes per SG		
1.2.1.11	Aspect ratio length / height		
1.2.1.12	Average gas velocity in the electrical field	m/s	

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	RRVUNL RRVUNL, 2 x 660 MW, SUPER-CRITICAL TPS, STAGE-V, UNIT - 7 & 8, SURATGARH, RAJASTHAN SG and its auxiliaries DATA SHEET B 16 THERMAL INSULATION AND REFRACTORY		SHEET 1 OF 2
ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

1.1	INSULATION		
1.1.1	AREA OF APPLICATION (SEPARATELY FURNISH FOR SG FLUE GAS DUCT, HOT AIR DUCT, ESP ETC)		
1.1.2	TYPE OF INSULATION		
1.1.3	MANUFACTURER		
1.1.4	COMPOSITION		
1.1.5	THICKNESS OF INSULATION	MM	
1.1.6	DENSITY OF INSULATION (FOR POURABLE / CASTABLE REFRACTORY INDICATE FOR DRY CONDITION)	KG/M ³	
1.1.7	THERMAL CONDUCTIVITY	MW/CM ⁰ C	
1.1.8	MAXIMUM CONTINUOUS WITHSTANDING TEMPERATURE	⁰ C	
1.1.9	CODE TO WHICH INSULATION / REFRACTORY IS OFFERED? (NAME, NUMBER AND YEAR OF CODE)		
1.1.10	FINISHING CEMENT PROVIDED?		
1.1.11	IF YES,		
	(A) THICKNESS OF FINISHING CEMENT	MM	
	(B) DENSITY OF FINISHING CEMENT	KG/M ³	
1.1.12	SHEATHING MATERIAL, TYPE		

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

	WHEREVER APPLICABLE		
1.1.13	THICKNESS OF SHEATHING MATERIAL	MM	
1.1.14	IS THE INSULATING MATERIAL CORROSIVE TO SURFACE ON WHICH IT IS APPLIED?		
1.2	REFRACTORY	VALUE	
1.2.1	AREA OF APPLICATION (FURNISH SEPARATELY FOR EACH AREA OF APPLICATION)		
1.2.2	TYPE		
1.2.3	MANUFACTURER		
1.2.4	COMPOSITION		
1.2.5	DENSITY	KG/CM ³	
1.2.6	THERMAL CONDUCTIVITY	W/ M ² °C	
1.2.7	MAXIMUM CONTINUOUS WITHSTANDING TEMPERATURE	°C	
1.2.8	CODE TO WHICH REFRACTORY MATERIAL IS OFFERED		
2.0	TOTAL WEIGHT OF EQUIPMENT	TONNES	

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	RRVUNL RRVUNL, 2 x 660 MW, SUPER-CRITICAL TPS, STAGE-V, UNIT - 7 & 8, SURATGARH, RAJASTHAN SG and its auxiliaries DATA SHEET B 17 SEPARATOR DRAIN RECIRCULATION PUMPS		SHEET 1 OF 2
ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

1.1.2	Manufacturer		
1.1.2	Type		
1.1.3	No. of pumps provided		
1.1.4	No.of pumps in operation during start up		
1.1.5	Capacity of each pump	m ³ /h	
1.1.6	Total dynamic head	mlc	
1.1.7	Suction head	mlc	
1.1.8	Efficiency	%	
1.1.9	Speed	rpm	
1.1.10	Materials of Construction		
1.1.10.1	Casing		
1.1.10.2	Impeller		
1.1.10.3	Shaft		
1.1.10.4	Bearings		
1.1.11	Motor housing	Internal / External	

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ENQUIRY/SPECIFICATION NO.:			BIDDER:	
SL. NO.	ITEM	UNIT		
1.1.17	Motor rating / speed	kW / rpm		

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	RRVUNL RRVUNL, 2 x 660 MW, SUPER-CRITICAL TPS, STAGE-V, UNIT - 7 & 8, SURATGARH, RAJASTHAN SG and its auxiliaries DATA SHEET B 18 ATMOSPHERIC DRAIN TRANSFER PUMPS		SHEET 1 OF 2
ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

1.1.1	Manufacturer		
1.1.2	Type		
1.1.3	No. of pumps provided		
1.1.4	No .of pumps in operation during startup		
1.1.5	Capacity of each pump	m ³ /h	
1.1.6	Total dynamic head	mlc	
1.1.7	Suction head	mlc	
1.1.8	Efficiency	%	
1.1.9	Speed	rpm	
1.1.10	Materials of Construction		
1.1.10.1	Casing		
1.1.10.2	Impeller		
1.1.10.3	Shaft		
1.1.10.4	Bearings		
1.1.11	Motor housing	Internal / External	

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ENQUIRY/SPECIFICATION NO.:			BIDDER:	
SL. NO.	ITEM	UNIT		
1.1.17	Motor rating / speed	kW/rpm		

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

19.1	Service		
19.2	Number Offered		
19.3	Pump Make And Model Number		
19.4	Design Capacity	m ³ /hr	
19.5	TDH	mlc	
19.6	Shut-Off Head	mlc	
19.7	Number Of Stages		
19.8	Pump Efficiency At Duty Point	%	
19.9	Pump Speed	rpm	
19.10	Drive Motor Rating	kW	
19.11	Method Of Lubrication		
19.12	NPSH Required	mlc	
19.13	Type And Make Of Mechanical Seal		
19.14	Type Of Coupling		
19.15	Minimum Capacity For Continuous	m ³ /hr	

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ENQUIRY/SPECIFICATION NO.:			BIDDER:	
SL. NO.	ITEM	UNIT		

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	RRVUNL RRVUNL, 2 x 660 MW, SUPER-CRITICAL TPS, STAGE-V, UNIT - 7 & 8, SURATGARH, RAJASTHAN SG and its auxiliaries DATA SHEET B 20 DRAWINGS AND DETAILS		SHEET 1 OF 4
ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

1.0	The dimensioned drawings / details and data listed below shall be submitted with the bid. The BIDDER shall note that these drawings are minimum requirement only and he must include sufficient drawings to give a clear and comprehensive indication of the plant offered.		
1.1	General Arrangement		
1.1.1	Steam generator area plan up to stack for both 1st and 2nd unit.		
1.1.2	Front elevation, side elevation, and cross-section of the steam generating unit showing location of headers and drums/separators.		
1.1.3	Layout of interconnecting platforms and platforms meant for connecting the steam generator floors to the turbine operating floor.		
1.2	Flow Diagrams, Control Schemes And Performance Curves		
1.2.1	Scheme of steam and water showing instrument tap-off points		

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ENQUIRY/SPECIFICATION NO.:			BIDDER:	
SL. NO.	ITEM	UNIT		

1.2.2	Scheme of air and gas path with instrument tap off points		
1.2.3	Scheme of pulveriser system with instrumentation		
1.2.4	Scheme of fuel oil supply and burning system with instrumentation		
1.2.5	Cold start up, warm start up (Overnight shutdown) and hot start-up curves.		
1.2.6	Correction curves		
1.3	Draft Plant		
1.3.1	FD / SA and PA fans blade angle lines, stall line, equal efficiency line, system resistance line with all fans in service and with one SA and one PA fan out both at 50 Hz and 47.5 Hz respectively showing SGMCR & test block points, for both one fan and two fan operation as applicable.		
1.3.2	ID fan inlet vane angle / speed lines, stall line, equal efficiency line, system resistance line for normally fouled condition with both ID fans and electrostatic precipitator sections in		

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

	service and also with one ID fan and one electrostatic precipitator section out both at 50 Hz and 47.5 Hz respectively showing SG MCR and test block points, for both one fan and two fans operations as applicable.		
1.4	Coal Burning System		
1.4.1	General arrangement of feeders, etc.		
1.4.2	General arrangement of mill, etc.		
1.4.3	Description of coal feeders		
1.4.4	Description of coal mills		
1.5	Fuel Oil Burning System		
1.5.1	Description of supply and firing system with associated equipment drawings		
1.6	Ignition System		
1.6.1	Description of supply and firing system including associated equipment and drawings		
1.7	Soot Blowing System		

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

1.7.1	Scheme of soot blowing system		
1.7.2	Write-up on operation of soot blowing system		
1.8	Description of flame scanners used on igniters and fuel oil guns and installation list covering the latest three year period of in-service experience		

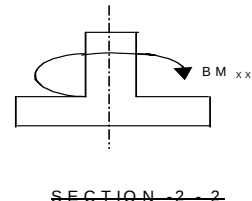
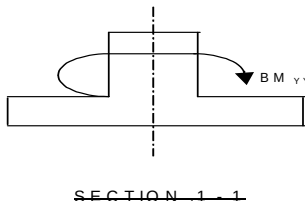
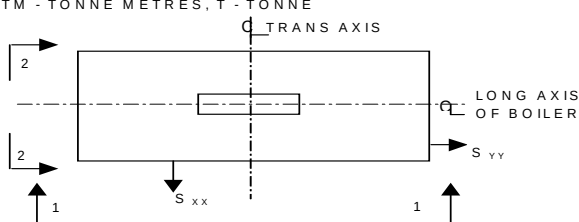
NOTES TO BIDDER 1. ITEMS WHICH DEVIATE FROM THE SPECIFICATION SHOULD BE MARKED WITHIN ASTERISK (*) AND DETAILS TO BE GIVEN IN SCHEDULE OF DEVIATIONS. 2. THIS DATA SHEET SHALL BE FILLED UP COMPLETELY AND A COPY SHALL BE ENCLOSED WITH EACH COPY OF THE BID.	SIGNATURE OF BIDDER & DATE	
	ISSUE R1	

	SPEC.NO. TCE.5750A-H-500-001		TATA CONSULTING ENGINEERS LIMITED		VOLUME III SG SHEET 3 OF 3	
			RRVUNL, 2X 660 MW, SUPER CRITICAL TPS, STAGE-V, UNIT-7 & 8, SURATGARH, RAJASTHAN SG AND ITS AUXILIARIES B21 : ELECTRICALLY OPERATED HOISTS			
MISCELLANEOUS	SL. NO.	ITEM	UNIT	BIDDER		
	30.	WIRE ROPE DIAMETER	mm			
	31.	WIRE ROPE BREAKING LOAD	KN			
	32.	WEIGHT OF COMPLETE HOIST AND TROLLEY ASSEMBLY	Kg			
	33.	WEIGHT OF HOIST	Kg			
	34.	WHEEL LOAD WITH IMPACT AND WITHOUT IMPACT	Kg	/		
	35.	PRELIMINARY DIMENSIONED GENERAL ARRANGEMENT DRAWING OF ELECTRICALLY OPERATED HOIST ALONG WITH WHEEL STOP DETAILS TO BE FURNISHED		WHETHER FURNISHED YES/ NO		
	36.					
	37.					
<u>NOTES TO BIDDER</u> 1. DATA SPECIFIED IN DATA SHEET-A HAS NOT BEEN REPRODUCED IN DATA SHEET-B. IN CASE OF DEPARTURE FROM DATA SHEET-A, BIDDER SHALL BRING OUT THE SAME IN SCHEDULE OF DEVIATIONS, FAILING WHICH IT SHALL BE CONSTRUED THAT BIDDER COMPLIES WITH THE REQUIREMENTS STIPULATED IN DATA SHEET-A. 2. THIS DATA SHEET SHALL BE FILLED UP COMPLETELY AND A COPY SHALL BE ENCLOSED WITH EACH COPY OF THE BID.			SIGNATURE OF BIDDER			
			DATE			

SPECIFICATION NO. TCE.5750A-H-500-001	TATA CONSULTING ENGINEERS LIMITED RRVUNL RRVUNL, 2 x 660 MW, SUPER-CRITICAL TPS, STAGE-V, UNIT - 7 & 8, SURATGARH, RAJASTHAN SG and its auxiliaries DATA SHEET B 22 FOUNDATION LOADINGS AT COLUMNS BASE	VOLUME III SHEET 1 OF 1
ENQUIRY/SPECIFICATION NO.:		BIDDER:
SL. NO.	ITEM	UNIT

SL. NO	KIND OF LOAD	UNIT	COLUMN DESIGNATION															
1	LOADS DUE TO BOILER PARTS AND SELF WEIGHT OF STRUCTURE ETC.	UNDER MAXIMUM LOADING CONDITIONS	W	T														
			BM _{xx}	TM														
			BM _{yy}	TM														
			SF _{xx}	T														
			SF _{yy}	T														
		UNDER MINIMUM LOADING CONDITIONS	W	T														
			BM _{xx}	TM														
			BM _{yy}	TM														
			SF _{xx}	T														
			SF _{yy}	T														
2	ADDITIONAL LOADING DUE TO WIND	WIND ACTING ALONG LONG AXIS	W	T														
			BM _{yy}	TM														
			SF _{yy}	T														
		WIND ACTING ALONG TRANS AXIS	W	T														
			BM _{xx}	TM														
			SF _{xx}	T														
3	ADDITIONAL LOADING DUE TO SEISMIC	SEISMIC FORCES ACTING ALONG LONG AXIS	W	T														
			BM _{yy}	TM														
			SF _{yy}	T														
		SEISMIC FORCES ACTING ALONG TRANS AXIS	W	T														
			BM _{xx}	TM														
			SF _{xx}	T														

BM_{xx} - B M ABOUT LONG AXIS, BM_{yy} - B M ABOUT TRANS AXIS, W - VERTICAL AXIAL LOAD
 SF_{xy} - HORIZONTAL SHER ALONG AXIS, SF_{xx} - HORIZONTAL SHEAR ALONG TRANS AXIS
 TM - TONNE METRES, T - TONNE



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SPECIFICATION NO. TCE.5750A-H-500-001	TATA CONSULTING ENGINEERS LIMITED		VOLUME III
	RRVUNL RRVUNL, 2 x 660 MW, SUPER-CRITICAL TPS, STAGE-V, UNIT - 7 & 8, SURATGARH, RAJASTHAN SG and its auxiliaries DATA SHEET B 23 FLASH TANK		SHEET 1 OF 1
ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

1.0	GENERAL		<u>FLASH TANK</u>
1.1	Number		
1.2	Location		
2.0	DESIGN DATA		
2.1	Operating pressure	Kg/cm ² (a)	
2.2	Design pressure	Kg/cm ² (a)	
2.3	Operating temperature	°C	
2.4	Design temperature	°C	
2.5	Corrosion allowances	mm	
2.6	Spray arrangement		
3.0	MATERIALS OF CONSTRUCTION		
3.1	Shell and head		
3.2	Internal piping		
3.3	Nozzle		

NOTES TO BIDDER 1. ITEMS WHICH DEVIATE FROM THE SPECIFICATION SHOULD BE MARKED WITHIN ASTERISK (*) AND DETAILS TO BE GIVEN IN SCHEDULE OF DEVIATIONS. 2. THIS DATA SHEET SHALL BE FILLED UP COMPLETELY AND A COPY SHALL BE ENCLOSED WITH EACH COPY OF THE BID.	SIGNATURE OF BIDDER & DATE	
	ISSUE R1	

SPECIFICATION NO. TCE.5750A-H-500-001	TATA CONSULTING ENGINEERS LIMITED		VOLUME III
	RRVUNL RRVUNL, 2 x 660 MW, SUPER-CRITICAL TPS, STAGE-V, UNIT - 7 & 8, SURATGARH, RAJASTHAN SG and its auxiliaries DATA SHEET B 24 STRAINERS		SHEET 1 OF 3
ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

1.0	Tag Number	
2.0	Quantity Required	
3.0	Location	
4.0	Type	
5.0	Fluid	
6.0	Flow rate, kg/hr	
7.0	Operating pressure – Kg/cm ² (g)	
8.0	Operating temperature – °C	
9.0	Design pressure – Kg/cm ² (g)	
10.0	Design temperature – °C	
11.0	Fluid viscosity cP at Op. temp	
12.0	Fluid Sp. gravity at Op. temp.	
13.0	Max. permissible Pr. Drop at 50% clogging	
14.0	Screen / basket data	

NOTES TO BIDDER 1. ITEMS WHICH DEVIATE FROM THE SPECIFICATION SHOULD BE MARKED WITHIN ASTERISK (*) AND DETAILS TO BE GIVEN IN SCHEDULE OF DEVIATIONS. 2. THIS DATA SHEET SHALL BE FILLED UP COMPLETELY AND A COPY SHALL BE ENCLOSED WITH EACH COPY OF THE BID.	SIGNATURE OF BIDDER & DATE	
	ISSUE R1	

SPECIFICATION NO. TCE.5750A-H-500-001	TATA CONSULTING ENGINEERS LIMITED		VOLUME III
	RRVUNL RRVUNL, 2 x 660 MW, SUPER-CRITICAL TPS, STAGE-V, UNIT - 7 & 8, SURATGARH, RAJASTHAN SG and its auxiliaries DATA SHEET B 24 STRAINERS		SHEET 2 OF 3
ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

	(i) CA of perforations	
	(ii) Min. Thickness – mm	
	(iii) Free straining area	
15.0	Steam jacket	
	(a) Inlet pr. Kg/cm ² (g) Op. / Desn.	
	(b) Inlet temp. °C Op. / Desn.	
16.0	End connections	
	(a) Size NB mm	
	(b) Type	
	(c) Details / Standards	
17.0	Cover	
18.0	(a) Body	
	(b) Cover	
	(c) Screen basket	

NOTES TO BIDDER 1. ITEMS WHICH DEVIATE FROM THE SPECIFICATION SHOULD BE MARKED WITHIN ASTERISK (*) AND DETAILS TO BE GIVEN IN SCHEDULE OF DEVIATIONS. 2. THIS DATA SHEET SHALL BE FILLED UP COMPLETELY AND A COPY SHALL BE ENCLOSED WITH EACH COPY OF THE BID.	SIGNATURE OF BIDDER & DATE	
	ISSUE R1	

SPECIFICATION NO. TCE.5750A-H-500-001	TATA CONSULTING ENGINEERS LIMITED		VOLUME III
	RRVUNL RRVUNL, 2 x 660 MW, SUPER-CRITICAL TPS, STAGE-V, UNIT - 7 & 8, SURATGARH, RAJASTHAN SG and its auxiliaries DATA SHEET B 24 STRAINERS		SHEET 3 OF 3
ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

	(d) Bolts / Studs	
	(e) Nuts	
	(f) Gaskets	
19.0	ACCESSORIES BY VENDOR	
	(a) For Bolts	
	(b) Diff. Pressure gauge	
	(c) Drain / Vent cock (Forged Steel)	
20.0	Hydro static test Pr. – Kg/cm ²	
	(a) Shell side	
	(b) Jacket side	
21.0	Vacuum test required	
22.0	Press. drop test required clean/50% clogged	

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	ISSUE R1	

DATA SHEET
FOR
STG AND ITS AUXILIARIES

DATA SHEET A
(STG AND ITS AUXILIARIES)

SPECIFICATION NO. TCE.5750A-500-H-001 PART A	TATA CONSULTING ENGINEERS LIMITED		VOLUME: IIIA
	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATA SHEET A1B STG and its Auxiliaries UTILITY REQUIREMENTS		SHEET 1 OF 2
SL. NO.	ITEM	UNIT	

1.0	<u>AUXILIARY STEAM</u>		
1.1	Pressure	bar (a)	19
1.2	Temperature	°C	305
1.3	Capacity of Aux PRDS (To be decided by bidder) - Requirement for others	t/hr	Max : 68 Min : 2
2.0	<u>COMPRESSED AIR</u>		
2.1	Pressure	bar (a)	7 - 8
3.0	<u>CONDENSER COOLING WATER</u>		
3.1	Quality	River water	As per Section B
3.2	Temperature at condenser inlet for performance guarantee (average temperature)	°C	33
3.3	Minimum temperature at condenser inlet	°C	25
3.4	Maximum temperature at condenser inlet	°C	36
3.5	Temperature rise across condenser limited to	°C	10
4.0	<u>AUX COOLING WATER</u>		

REV. NO.	R0	R1			JOB NO. TCE. 5750A	CLIENT: RRVUNL	
PPD. BY	GS	AA				PROJECT: 2 x 660 MW, Super-Critical TPS, Stage-V, Suratgarh, Rajasthan	
CHD. BY	SN	SN					
DATE	26-11-2009	30-05-2012					ISSUE R1

SPECIFICATION NO. TCE.5750A-500-H-001 PART A	TATA CONSULTING ENGINEERS LIMITED		VOLUME: IIIA
	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATA SHEET A1B STG and its Auxiliaries UTILITY REQUIREMENTS		SHEET 2 OF 2
SL. NO.	ITEM	UNIT	

4.1	Quality		Passivated DM water
4.2	Pressure (Design)	Kg/cm ² (a)	10
4.3	Inlet Temperature (Max.)	°C	37

NOTE : Vendor to arrange booster pumps (2 x 100%) to augment the inlet pressure in case pressure drop is more than 1.5 bar

REV. NO.	R0	R1			JOB NO. TCE. 5750A	CLIENT: RRVUNL	
PPD. BY	GS	AA					
CHD. BY	SN	SN				PROJECT: 2 x 660 MW, Super-Critical TPS, Stage-V, Suratgarh, Rajasthan	ISSUE R1
DATE	26-11-2009	30-05-2012					

SPECIFICATION NO. TCE.5750A-500-H-001 PART A	TATA CONSULTING ENGINEERS LIMITED		VOLUME: IIIA
	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATA SHEET A1 STG and its Auxiliaries STEAM TURBINE		SHEET 1 OF 7
SL. NO.	ITEM	UNIT	

1.0	<u>STEAM TURBINE & ACCESSORIES</u>		
1.1	<u>General</u>		
1.1.1	Number of steam turbine units		Two (2)
1.1.2	Type of steam turbine		Reheat condensing with regenerative feed water heating, Tandem compound coupled to a direct AC generator
1.1.3	Operating mode		a) Constant pressure between 90% TGMCR to 100% SGMCR b) Sliding pressure between 35% TGMCR to 90%TGMCR
1.1.4	Duty Variations in rated steam temperature and pressure Turbine protection against water induction		As per IEC 45 As per IEC 45 As per ASME-TDP-1-2006
1.1.5	<u>Installation</u> <u>Operation capability</u>		Indoor Continuous 100% output With HP heaters out of service , Continuous 100% output at VWO condition i.e. TGMCR + 5%, two shift operation and cyclic load variation, Part load, start up and House load operations, No. of start ups, rate of loading etc as indicated in Volume-II
1.1.6	<u>Application</u>		Utility: Will be connected to RRVPNL/Will also operate in island mode.

REV. NO.	R0	R1			JOB NO.	CLIENT: RRVUNL	
PPD. BY	GS	AA			TCE. 5750A	PROJECT: 2 x 660 MW, Super-Critical TPS, Stage-V, Suratgarh, Rajasthan	ISSUE R1
CHD. BY	SN	SN					
DATE	26-11-2009	20-05-2012					

SPECIFICATION NO. TCE.5750A-500-H-001 PART A	TATA CONSULTING ENGINEERS LIMITED		VOLUME: IIIA
	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATA SHEET A1 STG and its Auxiliaries STEAM TURBINE		SHEET 2 OF 7
SL. NO.	ITEM	UNIT	

1.2	<u>Design Data and Construction Requirements</u>		
1.2.1	100% TG MCR gross output at the generator terminals at:		
a)	0% make-up and maximum circulating water temperature.		Bidder to indicate
b)	1 % make up (i.e. 1% auxiliary steam from CRH) and maximum cooling water temperature.		Bidder to indicate
c)	1 % make up (i.e. 1% auxiliary steam from CRH) and minimum cooling water temperature.		Bidder to indicate
d)	Any single closed feed water heater out of service ,1% make up and maximum cooling water temperature		Bidder to indicate
1.2.2	Turbine valve wide open condition (Maximum continuous flow passing capability at HP turbine throttle)		Bidder to indicate
1.2.3	Number of LP and HP heaters for cycle		Bidder to optimise and indicate
1.2.4	Overall pressure drop between HP turbine exhaust and IP turbine strainer inlet	% of HP turbine exhaust	8- 10 % (suggested) : however Bidder to optimise and indicate
1.2.5	Turbine generator steam parameters at HP turbine stop valve		
a)	Pressure	Bar (a)	242 at 100% load
b)	Temperature	° C	565
c)	Steam temperature at IP turbine inlet	° C	593
1.2.6	Turbine speed		3000 rpm

REV. NO.	R0	R1			JOB NO. TCE. 5750A	CLIENT: RRVUNL	
PPD. BY	GS	AA				PROJECT: 2 x 660 MW, Super-Critical TPS, Stage-V, Suratgarh, Rajasthan	
CHD. BY	SN	SN					ISSUE R1
DATE	26-11-2009	20-05-2012					

SPECIFICATION NO. TCE.5750A-500-H-001 PART A	TATA CONSULTING ENGINEERS LIMITED		VOLUME: IIIA
	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATA SHEET A1 STG and its Auxiliaries STEAM TURBINE		SHEET 3 OF 7
SL. NO.	ITEM	UNIT	

1.2.7	Operating frequency range		47.5 Hz to 51.5 Hz
1.2.7.1	Critical speeds		Bidder to indicate
1.2.8	Quantity of demineralised water make-up to cycle		A maximum of one(1) percent of throttle flow, introduced at surface condenser hotwell
a)	Quality of demineralised water make-up		Passivated DM water
1.2.9	Type of governing system		Throttle or Nozzle
1.2.10	Type of governor		Electronic / Electro-hydraulic
1.2.11	Type of foundation for turbine generator		Conventional
1.2.11a	Type of steam admission		Bidder to indicate
1.2.11b	Mode of deaerating feed water heater operation		Variable pressure
1.2.12	<u>Main oil tank</u>		
a)	Number		One for each unit
b)	Capacity of tank		The capacity shall be adequate to contain total volume in circuit plus sufficient space available above "High Oil Level" to accommodate oil in circuit which will flow back to the tank during unit trips and also sufficient space for oil vapour separation. .
	Material of construction of tank		Structural steel
1.2.13	<u>Turbine Oil coolers</u>		
a)	Number		2 x 100% oil coolers for each unit
b)	Type		Shell and tube type with removable tube bundle/Plate heat exchanger
c)	Quality of water		filtered water
d)	Tube material		Stainless steel

REV. NO.	R0	R1			JOB NO. TCE. 5750A	CLIENT: RRVUNL	
PPD. BY	GS	AA					
CHD. BY	SN	SN				PROJECT: 2 x 660 MW, Super-Critical TPS, Stage-V, Suratgarh, Rajasthan	ISSUE R1
DATE	26-11-2009	20-05-2012					

SPECIFICATION NO. TCE.5750A-500-H-001 PART A	TATA CONSULTING ENGINEERS LIMITED		VOLUME: IIIA
	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATA SHEET A1 STG and its Auxiliaries STEAM TURBINE		SHEET 4 OF 7
SL. NO.	ITEM	UNIT	

1.2.14	<u>Turbine Oil Pumps</u>		MOP	AOP	EOP	JOP
a)	Number of pumps per unit		1x100%	2x100%	1x100%	2x100%
b)	Drive		Turbine shaft driven (if applicable)	AC motor	DC motor	One on AC motor and other on DC motor
c)	Control oil pumps (if required)					
c)	Material of Construction for oil pumps					
	Casing					
	Rotor/impeller					
	Shaft					
1.2.15	<u>Oil vapour extractor</u>					
a)	Numbers					
b)	Drive					
1.2.16	<u>Oil purification equipment :</u>					
a)	Mode of operation of turbine oil conditioning equipment					
b)	Type of conditioning equipment.					
c)	Hourly capacity of oil conditioning					
d)	Maximum particle size and water content in purified oil					
e)	<u>Material of Construction</u>					
	Casing					
	Disc and other rotating parts					
	Parts in contact with oil					

REV. NO.	R0	R1			JOB NO.	CLIENT: RRVUNL	
PPD. BY	GS	AA					
CHD. BY	SN	SN			TCE.	PROJECT: 2 x 660 MW, Super-Critical TPS, Stage-V, Suratgarh, Rajasthan	ISSUE R1
DATE	26-11-2009	20-05-2012			5750A		

SPECIFICATION NO. TCE.5750A-500-H-001 PART A	TATA CONSULTING ENGINEERS LIMITED		VOLUME: IIIA
	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATA SHEET A1 STG and its Auxiliaries STEAM TURBINE		SHEET 5 OF 7
SL. NO.	ITEM	UNIT	

1.2.17	Type of turning gear		
1.2.18	Bearing cap vibration at all operating conditions		
1.2. 19	Shaft vibration		
1.2. 20	Thermal insulation for turbine		
1.2.21	<u>HP Bypass System</u>		
a)	Capacity of HP bypass system		
b)	Spray water for HP Bypass system		
1.2.22	LP Bypass System		
a)	Capacity of LP bypass system		
b)	Spray water for LP bypass system		
1.2.23	Noise level at all operating conditions		
1.3	<u>MAINTENANCE TOOLS</u>		
1.3.1	Lifting tackles, including lifting beams, slings and eye bolts for turbine casing and rotor		
1.3.2	Turbine flange bolt heating and tightening equipment (if applicable)		
1.3.3	Lifting gear for ESV and governing valves (if necessary)		
1.3.4	Assembly rig for HP barrel casing (If necessary), shaft lifting devices, dummy shafts, coupling spanners,		

REV. NO.	R0	R1			JOB NO. TCE. 5750A	CLIENT: RRVUNL	
PPD. BY	GS	AA				PROJECT: 2 x 660 MW, Super-Critical TPS, Stage-V, Suratgarh, Rajasthan	
CHD. BY	SN	SN					
DATE	26-11-2009	20-05-2012					ISSUE R1

SPECIFICATION NO. TCE.5750A-500-H-001 PART A	TATA CONSULTING ENGINEERS LIMITED		VOLUME: IIIA
	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATA SHEET A1 STG and its Auxiliaries STEAM TURBINE		SHEET 6 OF 7
SL. NO.	ITEM	UNIT	

	special insert spanner set		
1.3.5	Any special tools required for maintenance		
1.3.5	Two complete sets of spanners of appropriate sizes to fit all nuts and bolts of entire STG unit		
1.3.6	Two complete sets of special dies and taps for all bolts and nuts of entire STG unit		
	Total weight of STG Equipment		
	Total weight of Lube oil piping / Equipment		
	Total weight of HP/LP bypass Equipment, piping etc.		
1.4	<u>CODES AND STANDARDS</u>		
1.4.1	American Society of Mechanical Engineers		
1.4.2	American National Standards Institute		
1.4.3	American Society for Testing and Materials		
1.4.4	Hydraulic Institute Standards		
1.4.5	Heat Exchange Institute		
1.4.6	Institute of Electrical and Electronics Engineers		
1.4.7	International Electro-Technical Commission Publications		
1.4.8	National Fire Protection Association		

REV. NO.	R0	R1			JOB NO. TCE. 5750A	CLIENT: RRVUNL	
PPD. BY	GS	AA				PROJECT: 2 x 660 MW, Super-Critical TPS, Stage-V, Suratgarh, Rajasthan	
CHD. BY	SN	SN					ISSUE R1
DATE	26-11-2009	20-05-2012					

SPECIFICATION NO. TCE.5750A-500-H-001 PART A	TATA CONSULTING ENGINEERS LIMITED		VOLUME: IIIA
	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATA SHEET A1 STG and its Auxiliaries STEAM TURBINE		SHEET 7 OF 7
SL. NO.	ITEM	UNIT	

1.4.9	National Electrical Manufacturer's Association		
1.4.10	Power Test Codes for Steam Turbines – PTC 6		
1.4.11	Tubular Exchanger Manufacturer's Association		
	NOTE:		
	1. All steam turbine auxiliary pumps/ exhausters shall be designed to deliver its rated capacity when in under frequency operation of 47.5Hz occurs		

REV. NO.	R0	R1			JOB NO. TCE. 5750A	CLIENT: RRVUNL	
PPD. BY	GS	AA				PROJECT: 2 x 660 MW, Super-Critical TPS, Stage-V, Suratgarh, Rajasthan	
CHD. BY	SN	SN					
DATE	26-11-2009	20-05-2012					ISSUE R1

SPECIFICATION NO. TCE.5750A-500-H-001 PART A	TATA CONSULTING ENGINEERS LIMITED		VOLUME: IIIA
	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATA SHEET A2 STG and its Auxiliaries SURFACE CONDENSER AND ACCESSORIES		SHEET 1 OF 3
SL. NO.	ITEM	UNIT	

1.0	<u>GENERAL</u>			
1.1	Number of surface condensers per steam turbine generator unit	No.	Bidder to indicate	
1.2	Type of condenser		Bottom mounted single/ Multiple shell with divided water box to facilitate unit operation with one half under maintenance	
1.3	Orientation of condenser tube axis		Perpendicular to turbine rotor axis	
1.4	Quality of circulating water		River water (analysis as per datasheet A4 of volume-II)	
	Installation		Indoor inside turbine building	
	Number of passes		Bidder to indicate	
1.5	Design circulating water inlet parameters			
1.5.1	Pressure at the specified terminal point.	MWC	By Bidder	
1.5.2	<u>Temperature</u>	° C	By Bidder	
1.6	Design margin on heat load at TG VWO, 0% MU and design CWT of 32 ° C.	%	5	
1.7	Howell storage capacity normal level to low level		3 minutes of turbine VWO flow(Heat balance at TGVWO, 1 % makeup and design cooling water temperature)	
1.8	Tube cleanliness factor	%	90	
1.9	Oxygen in condensate at hot well outlet from 30% TG MCR to TGVWO (HBs at 1 % MU and design CW inlet temp)	cc/litre	Not to exceed 0.02	
1.10	Tube side/water box design pressure		Shall be equal to the circulating water pump shut-off head, rounded off to next higher 0.5 kg/sq.cm plus an allowance for water hammer surge,etc..	

REV. NO.	R0	R1			JOB NO. TCE. 5750A	CLIENT: RRVUNL	ISSUE R1
PPD. BY	GS	AA				PROJECT: 2 x 660 MW, Super-Critical TPS, Stage-V, Suratgarh, Rajasthan	
CHD. BY	SN	SN					
DATE	26-11-2009	30-05-2012					

SPECIFICATION NO. TCE.5750A-500-H-001 PART A	TATA CONSULTING ENGINEERS LIMITED		VOLUME: IIIA
	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATA SHEET A2 STG and its Auxiliaries SURFACE CONDENSER AND ACCESSORIES		SHEET 2 OF 3
SL. NO.	ITEM	UNIT	

1.11	Shell design pressure		Turbine pressure relief self closing type disc release pressure & full vacuum
1.12	Shell design temperature		Turbine exhaust hood temperature high trip setting
1.13	Tube gauge in air cooling zone	BWG	18
1.14	Tube gauge in condensing zone	BWG	22
1.15	Minimum tube sheet thickness	mm	40
1.16	Minimum tube support plate thickness	mm	12
1.17	Minimum steam impingement baffle thickness	mm	10
1.18	Water box lining		Fibre reinforced epoxy
1.19	Tube sheet painting on CW side		Epoxy
1.20	Type of protection for tubes against impingement of steam from		
	(a) Main turbine exhaust		Higher thickness tubes / dummy tubes
	(b) HP / LP bypass exhaust		Steam throw-off device / baffles(as required)
	(c) Drains		Baffles
1.21	Type of tube sheet to shell joint		Welded
1.21	Vertical movement of condenser compensated by		Spring support / expansion bellow
1.23	Corrosion allowance on ferrous parts	mm	3.2
1.24	<u>Materials of Construction</u>		
1.14.1	Condenser shell, hotwell and condenser neck		Carbon steel to SA 516 Gr. 70 or equivalent
1.14.2	Water box		Carbon steel to SA 516 Gr. 70 or equivalent

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1.14.3	Structural parts		Carbon steel
1.14.4	Tube sheets		Carbon steel to SA 516 Gr. 70 with titanium cladding
1.14.5	Tubes in condensing section		SS of suitable quality
1.14.6	Tubes in air cooling section		SS of suitable quality
1.14.7	Tube support plates		Carbon steel to SA 516 Gr. 70 or equivalent
1.14.8	Gaskets on water side		Neoprene
1.14.9	Bolts		ASTM A. 193-B7 or equivalent
1.14.10	Nuts		ASTM A. 193-2H or equivalent
1.14.11	Dummy tubes / rods		SS 304
1.14.2	Cathodic protection for water boxes		To be provided with Zinc material
1.14.3	Total weight of condenser and other equipment	tonnes	
1.15	Codes and Standards		
1.15.1	Heat Exchange Institute, latest edition		
1.15.2	American Society of Mechanical Engineers		
1.15.3	ASME Performance Test Code for Condensers- PTC 12.2		
1.15.4	American Society for Testing Materials		

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1.0	GENERAL		
1.1	Number required per STG unit		Two x 100% capacity per condenser per shell; During normal operation one pump will be in operation
1.2	Duty		Continuous
1.3	Vapour to be handled		Mixture of air, steam and non-condensable gases
1.4	HEI standard pressure and temperature conditions for air suction		0.034 kg/sq.cm (a) and 21.1 degC
1.5	<u>Capacity</u>		
1.5.1	Capacity of pump		Shall be not less than the capacity obtained from HEI standards
1.5.2	Capacity of pump during hogging		Shall be able to maintain vacuum up to 0.35 kg/sq.cm(a) within 20 minutes with both the vacuum pumps in operation
1.6	Source of sealing water		Condensate
1.7	Type of coupling		Flexible coupling
1.8	Acceptable noise level at all operating conditions	dBA	Not to exceed 85 at a distance of 1.5m from the outline of equipment
1.9	Allowable vibration level at all operating conditions	mm/sec	As per ISO10816-1 CL II zone A/B
1.10	<u>Material of Construction</u>		
1.10.1	Vacuum Pumps:		
a)	Casing		Cast iron
b)	Shaft		Carbon steel EN-8
c)	Impeller		Nodular iron / SS
d)	Shaft sleeves		Nodular iron / SS
1.10.2	Seal Water Recirculation Pumps : (if		

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	required)		
a)	Casing		Cast iron
b)	Shaft		Carbon Steel EN-8
c)	Impeller		Nodular iron
1.10.3	Heat Exchangers :		
a)	Shell		Carbon steel
b)	Tubes		SS
c)	Tube sheet		Carbon steel with epoxy coating as required
1.11	ACCESSORIES		
1.11.1	Air flow meter (Rotameter)		Yes
1.11.2	Instrumentation & Cables required for		Yes
1.11.3	Base plate & foundation bolts		Yes
1.11.4	Others as to make the system complete		Yes
1.11.5	Maintenance tools & tackles		All special maintenance tools and tackles as required.
1.11.6	Start-up spares		To be included as required.
1.11.10	Total weight of equipment	tonnes	
1.12	<u>Codes and Standards</u>		
1.12.1	HEI Standards for Steam Surface Condenser		
1.12.2	HEI Standards – Performance Standard for Liquid ring vacuum pumps		
1.12.3	ASME Performance Test Code		
1.12.4.	TEMA Standards		
1.12..5	Hydraulic Institute Standards		

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1.0	GENERAL		
1.1	Number of pumps for each STG unit		Three (3) x 50% capacity; During normal unit operation two pumps will be in operation
1.2	Operation		Continuous at any point between min. flow to run out flow
1.3	Pump type		Vertical canister type
1.4	Design capacity per pump		Shall be as per the following rounded off to nearest higher 5 m ³ /hr: [1.1 x (Flow at turbine VWO + sprays + sealing water)] x 0.5
1.5	Minimum flow per pump		Not less than twenty five (25) percent
1.6	Best efficiency point of pump		Shall be at 100% TG MCR
1.7	Total dynamic head (TDH) at design capacity		While establishing the design TDH the following shall be considered :
			(a) One twenty five percent (125%) of deaerating feedwater heater operating pressure at TG VWO(1% MU and design CWT)
			(b) A ten percent (10%) margin on equipment and piping pressure drops at TG VWO(HB as in (a))
			(c) Shall be selected such that pump would be capable of meeting the 100% TG MCR requirement during an under frequency operation of 47.5Hz.
1.8	Shut-off pressure		Between 115% and 130% of pump design total dynamic head,

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1.9	NPSH available (min.)		Shall be based on condenser hot well lowest level
1.10	NPSH required at 3% percent head break		Shall not be greater than 80% of NPSH available over the entire range of operation from minimum flow to pump run out
1.11	Acceptable noise level at all operating conditions		Not greater than 85 dBA at a distance of 1.5 m from the outline of equipment
1.12	Maximum speed	rpm	1500
1.13	Maximum allowable vibration level at all operating conditions	mm/sec	As per ISO 10816-1 Cl II Zone A/B
1.14	Suction specific speed	US units	Preferably not greater than 11,000
1.15	Condensate pH		8.6 to 9.2 during normal operation and 11 to 12 during flushing
1.16	Internal element		Removable
1.17	Type of lubrication		Self
1.18	Type of coupling		Flexible type
1.19	Suction nozzle location		Preferable to have CEP suction piping and strainer (horizontal) above ground level to avoid any trench in the ground floor of steam turbine building.
1.20	Type of seals		Mechanical seals
1.21	Thrust bearing type		Kingsbury or equivalent
1.22	Thrust bearing location		In the pump
1.23	Reverse rotation protection		Capable of withstanding reverse rotation due to discharge NRV failure while system is at maximum discharge

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			pressure
1.24	<u>Materials of Construction</u>		
1.21.1	Mounting flange		Carbon Steel
1.21.2	Discharge elbow, Column pipe		Carbon Steel
1.21.3	Suction bell, Bowl or casing, Discharge casing		Cast Iron / Carbon steel
1.21.4	Diffuser & guide vanes, canister		Carbon steel
1.21.5	Impeller		Stainless steel
1.21.6	Shaft sleeves		11 - 13% chrome steel
1.21.7	Pump shaft		11 - 13% Forged chrome steel
1.21.8	Suction strainer		Stainless steel
1.21.9	Wearing rings		13 - 17% Chrome steel
1.21.10	Bolts		SA 193 B7 or equivalent
1.21.11	Nuts		SA 194 2H or equivalent
1.21.12	Canister		Fabricated mild steel
1.22	Shop Tests		
1.22.1	NPSH test		Witnessed
1.22.2	Performance test		Witnessed
1.22.3	Field tests		Witnessed
1.22.4	Start-up spares		To be included as required
1.22.5	Maintenance tools and tackles		All special maintenance tools and tackles as required
1.23	CODES AND STANDARDS		
1.23.1	American Society for Testing & Materials		
1.23.2	Hydraulic Institute Standards		

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1.23.3	ASME Performance Test Code for Centrifugal Pumps – PTC 8.2		
1.23.4	American Welding Society		

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	GENERAL		
1.1	Designation		Low pressure (LP) / High pressure (HP) feed water heaters
1.2	Type of feedwater heaters		i. U-Tube two pass type ii. Removable tube bundle / Shell iii. Desuperheating, condensing and drain cooling sections (as applicable)
1.3	Orientation		Horizontal / Vertical channel down as per turbine building layout requirements furnished
1.4	Type of extraction		Uncontrolled
	Location		Indoor inside turbine building
1.5	<u>Design data</u>		
1.1.1	Normal		For TG VWO condition of design circulating water temperature and 1% make-up.
1.1.2	Abnormal		As per Technical details of this Section
1.6	<u>Tube side design pressure</u>		
1.6.1	LP Heaters		105% of CEP's shut-off head
1.6.2	HP Heaters		105% of combined BFP's maximum discharge pressure corresponding to BFP cold shut-off head
1.7	<u>Shell side design pressure</u>		
1.7.1	LP Heater		110% of maximum extraction steam pressure or 4.5 kg/sq.cm(a) whichever is higher rounded off to next higher 0.5kg/sq.cm and full vacuum
1.7.2	HP Heater		110% of maximum extraction steam pressure rounded off to next higher 0.5

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			kg/sq.cm(a).
1.8	Design temperature (shell and tube side)		As per HEI Standards rounded-off to next higher 10 deg. C
1.9	Maximum tube side velocity	m/sec	Not to exceed 3.0
1.10	Minimum fouling resistance		As per HEI Standards
1.11	Fixing of tubes to tube sheet		Welded and rolled for HP heater Grooved and rolled for LP heater
1.12	Corrosion allowance on ferrous parts	mm	3.2
1.13.0	<u>Materials of Construction</u>		
1.13.1	Shell		Carbon steel to SA 516 grade 70 or equivalent
1.13.2	Channel / Channel cover		
	(a) LP Heaters		Carbon steel to SA 516 grade 70 or equivalent
	(b) HP heaters		Carbon steel to SA 266 grade II or equivalent
1.13.3	Tubes		LP Heaters : Stainless steel to SA 249 grade TP 304 welded or equivalent HP heaters : Stainless steel seamless
1.13.4	Tube sheet		
	(a) LP heaters		Carbon steel to SA 516 grade 70 or equivalent
	(b) HP heaters		Carbon steel to SA 350 grade LF2 or equivalent with stainless steel cladding
1.13.5	Tube support plate		Carbon steel to SA 516 grade 70 or equivalent

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1.13.6	Nozzles except HP heaters channel side		Carbon steel to SA 106 Gr.B or equivalent for temperature less than 400 deg.C Suitable material for above 400 deg. C
1.13.7	Nozzles on HP heaters channel side		Carbon steel to SA 350 LF2 or equivalent
1.13.8	Steam and drain impingement baffles		Stainless steel to SA 240 Gr TP 304 or equivalent
1.13.9	Tie rods		Carbon steel to SA 36 or equivalent
1.13.10	Spacers		Stainless steel to TP 304
1.13.11	Bolts		SA 193 B7 or equivalent
1.13.12	Nuts		SA 194 2H or equivalent
1.13.13	Vent orifice plate		Stainless steel
1.14	Thermal insulation		Lightly bonded mineral wool with cladding. Design thickness shall be based on outer surface temperature of 60°C under still air condition with station maximum ambient temperature.
1.15	Maintenance tools		a) All special tools as required
			b) One set of roller expanders for each tube dia. And gauge.
1.16	Codes and Standards		
1.16.1	Heat Exchange Institute (HEI)		
1.16.2	Tubular Exchanger Manufacturers Association		
1.16.3	Standards of feedwater heater manufacturers association		
1.16.4	American society of mechanical Engineers (ASME)		

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1.16.5	American Society of Testing Materials (ASTM)		
1.16.6	Performance Test Code for Feed water Heater (ASME0-PTC 12.1)		

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	GENERAL		
1.1	Type of deaerating feed water heater		Spray – tray type or spray type
1.2	Type of spraying arrangement		Spray valves (variable flow area)
1.3	Operation		To match steam turbine generator requirements with backup steam supply from cold reheat line and auxiliary steam line
1.4	Design pressure of deaerator and feed water storage tank		One hundred and twenty five (125) percent of maximum extraction steam pressure rounded off to next higher 0.5 kg/cm ² and full vacuum
1.5	Minimum Design temperature of deaerator		Compatible with heating sources temperature of maximum extraction steam, cold reheat steam & auxiliary steam or 297 ⁰ C whichever is higher, rounded off to next higher 5 ⁰ C
1.6	Minimum Design temperature of feed water storage tank		5 ⁰ C higher than saturation temperature corresponding to the design pressure or 205 ⁰ C whichever is higher, rounded off to next higher 5 ⁰ C
1.7	Net feed water storage tank capacity at 2/3rd level (Normal) between normal level and top of boiler feed pump suction in deaerator exclusive of volume of any internal piping, baffles & excluding volume of dished ends		6 minutes of feed water outflow based on HBD at TG VWO,1% MU condition with design CWT
1.8	Corrosion allowance over & above design code requirements	mm	3.2

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1.9	Pressure drop across spray valve assembly at maximum condensate flow	kg/sq.cm	Bidder to indicate
1.10	Terminal Temperature difference		Less than 0.3 Deg C.
	<u>PERFORMANCE GUARANTEE OVER COMPLETE LOAD RANGE</u>		
	Maximum oxygen content in deaerated feed water from 30% TGMCR to TGVWO with 3% makeup	Cc/lit	0.005
	Maximum carbon dioxide content in deaerated feed water from 30% TGMCR to TGVWO with 3% makeup.		Nil
1.11	<u>Materials of Construction</u>		
1.11.1	Deaerating shell & heads		Carbon steel to SA 516 Gr. 70 or equivalent
1.11.2	Feed water storage tank shell & heads		Carbon steel to SA 516 Gr. 70 or equivalent
1.11.3	Trays		Stainless steel to SS 304
1.11.4	Tray enclosure		Stainless steel to SS 304
1.11.5	Spray valves / sprayer assembly		Stainless steel to SS 304
1.11.6	Steam distribution pipe (Internal) / Nozzles / Condensate pipes		Carbon steel to SA 106 Gr. B or equivalent
1.11.7	Splash plates & Baffle plates		Stainless steel to SS 304
1.11.8	Bolts		SA - 193 B7 or equivalent
1.11.9	Nuts		SA - 194 2H or equivalent
1.11.10	Gaskets		CAF 40

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1.11.11	Internal bolting		Stainless steel to SS 304
1.11.12	Vent orifice		Stainless steel to SS 304
1.12	<u>Thermal insulation</u>		Lightly bonded mineral wool with cladding. Design thickness shall be based on outer surface temperature of 60°C under still air condition with station ambient temperature of 30°C
1.13	All accessories as required to make system complete		Yes
1.14	Performance test at site		Yes
1.15	Start-up spares		To be included as required
1.16	Maintenance tools and tackles		All special maintenance tools and tackles

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1.0	GENERAL		
1.1	Number of boiler feed pump sets		2X50% steam turbine driven pumps, and 1x50% motor driven standby pump, with matching Booster pumps.
1.2	Type of pump		Centrifugal multistage barrel type main pump with variable speed hydraulic coupling and horizontal / Radially split type booster pump connected to a common electric motor
1.3	Mode		Continuous, either singly or in parallel, from minimum flow to run-out flow
1.4	Liquid handled		Feedwater
1.5	Minimum temperature		Ambient
1.6	Rated capacity of each pump		Total combined flow of normally working pump(s) shall be 110% of the total feedwater flow at TG VWO, 1% MU and design CWT together with any other feedwater requirements, rounded off to nearest higher 10 cubic metre per hour.
1.7	Flow at best efficiency point of each pump		Total combined flow of normally working pump(s) shall be 100% of the total feedwater requirement at 100% TG MCR and 0% MU and design CWT
1.8	Total head at rated capacity		Shall include 10% margin on equipment and piping pressure drops for TGVWO, 1% MU and design CWT
			Shall be selected such that :
			- Normally working pump(s) would be capable of meeting the 100% TG MCR requirement during an under

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			frequency operation of 47.5 Hz.
			- Normally working pump(s) would be capable of meeting SG MCR flow
1.9	NPSH available at booster pump centre line (min), Normal operation		Shall not be less than three hundred percent NPSH required at 3% head break by booster pump
1.10	NPSH available at booster pump centre line (min), Transient operation		Shall not be less than one hundred and twenty five percent the NPSH required at 3% head break by booster pump
1.11	Design speed		Preferably around 5000 rpm for main pump and 1500 rpm for booster pump
1.12	Maximum suction specific speed	US units	Preferably not greater than 9500
1.13	Shut-off head		Shall be continuously rising for both main and booster pump from run out to shut off. And Combined shut-off head of BFP set shall be not less than 120% and not greater than 130 %
1.14	Load sharing between pumps		Not exceeding 5% over entire operating range when operating with one or both pumps
1.15	Minimum capacity of low flow recirculation		Not less than 25% of pump rated capacity
1.16	Type of recirculation control		Separate modulating type/automatic modulating type recirculation valve(ARC)
1.17	Maximum noise level at all operating conditions for the pump set comprising main pumps, hydraulic coupling, booster pump, drive motor	dBA	Not to exceed 85 at a distance of 1.5 m from outline of equipment with / without acoustic enclosure. Acoustic enclosure if provided, shall be of pre-fabricated modular type with ease for assembly /

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			disassembly
1.18	Maximum vibration level at all operating conditions		VDI 2056 group G degree 'Good'
1.19	Type of impeller		Enclosed
1.20	Seals		Mechanical seal
1.21	Coupling		Flexible type
1.22	Type of thrust bearing strainer		Kingsbury type or equivalent type
			a) Fine mesh size shall be less than minimum internal clearance of the pumps during commissioning.
1.23			b) Normal operation coarse strainer mesh size as recommended by manufacturer
1.24	<u>Materials of Construction</u>		
1.24.1	Outer casing		Forged Carbon steel with austenitic steel inlay at high velocity zones and sealing surface.
1.24.2	Inner casing		ASTM A743 CA 6 NM
1.24.3	Impellers		ASTM A743 CA 6 NM
1.24.4	Wearing rings		13 – 17% Chrome steel (Material shall be non-galling type with differential hardness not less than 100 BHN)
1.24.5	Stuffing box bushing & Stuffing box		13% chrome steel
1.24.6	Pump shaft		13% Forged chrome steel
1.24.7	Shaft sleeves Balancing drum/disc		Stellite on 13% chrome steel Stainless steel

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1.24.8	Base plate		Structural steel
1.24.9	Diffuser / Volute		13% chrome steel
1.24.10	Strainer		Stainless steel mesh
1.24.11	<u>Hydraulic Coupling</u> a) Coupling wheels & casing b) Scoop tube		Alloy steel Stainless steel
1.25	<u>Thermal insulation</u>		Lightly bonded mineral wool with cladding. Design thickness shall be based on outer surface temperature of 60°C under still air condition with station ambient temperature of 30°C
1.25.1	Vibration isolation system		Bidder can offer solid block foundation
1.25.2	<u>Maintenance Tools</u>		
1.25.3	One set of impeller withdrawal gear		Yes
1.25.4	Lifting tackles, screwing tackles, eye bolts, shackles etc.		Yes
1.25.4	<u>Codes and Standards</u>		
1.25.5	American Society for Testing and Materials (ASTM)		
1.25.6	American Society of Mechanical Engineers (ASME)		
1.25.7	Hydraulic Institute Standards		
1.26	ASME Power Test Code for Centrifugal Pumps (PTC 8.2)		
1.26.1	<u>STEAM TURBINE DRIVE</u>		
1.26.1.1	No. of turbine drives		Two
1.26.1.2	Driven equipment		Boiler feed pumps
1.26.1.3	Installation		Indoor

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1.26.1.4	Type of operation		Continuous
1.26.1.5	Design pressure and temperature		As per IEC45
1.26.1.6	Turbine Valve Wide Open condition (Maximum continuous flow passing capability at BFPTD inlet)		Minimum 105% of 100% BFPTD flow corresponding to STBFB rated capacity and head
1.26.2	Type of coupling between turbine drive driven equipment		Disconnect type flexible coupling
1.26.2.1	<u>Accessories</u>		
1.26.2.2	Protection against fire hazard for oil piping`		Required
1.26.2.3	All instruments required for the complete system		Required
1.26.3	All turbine supervisory equipments		Required
1.26.4	Bearing vibration sensors		Required
1.26.5	Bursting diaphragm		Required
1.26.6	Jacking oil system		Required
1.26.7	Hand barring device		Required
1.27.1	<u>Maintenance tools</u>		
1.27.2	Lifting tackles, including lifting beams and eye bolts for turbine casing and rotor		Required
1.27.3	Turbine flange bolt tightening equipment		Required
1.27.4	Lifting gear for ESV governing valves etc		Required
1.27.5	Any special tool required for maintenance		Required
1.27.6	One set of spanners of approximate size for each unit to fit all nuts and bolts		Required

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1.28	<u>Codes and standards</u>		
1.28.1	American Society of Mechanical Engineers		
1.28.2	American National Standards Institute		
1.28.3	American Society for Testing and Materials		
1.28.4	Hydraulic Institute Standards		
1.28.5	Heat Exchange Institute		
1.28.6	Institute of Electrical and Electronics Engineers		
1.28.7	International Electro-technical Commission Publications		
1.28.8	National Fire Protection Association		
1.28.9	National Electrical Manufacturer's Association		
1.28.10	Performance Test Codes for Steam Turbines		
1.28.11	Tubular Exchanger Manufacturer's Association		
1.28.12	Other established national or international standards equal or superior to the above listed standards		

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1.0	<u>Central Turbine Oil System</u>		
	Number	No.	One (1) clean oil tank and one (1) dirty oil tank common for Two STG units. To facilitate maintenance and cleaning of unit main oil tank.
1.1.2	Capacity of each tank		120% of the total oil quantity in the oil system inclusive of main oil tank of one STG unit.
1.1.3	Material of construction of tank		Structural Steel
1.1.4	The following connections on the tank to be provided :		
a)	Vent connection		Required
b)	Drain connection		Required
c)	Sampling connection		Required
d)	Connection for filling / emptying tank (other than drain connection)		Required
e)	Man hole		Required
1.2	<u>Clean Oil Transfer Pump & Dirty Oil Transfer Pump</u>		
1.2.1	Number of pumps		One (1) dirty oil transfer pump and one (1) clean oil transfer pump.
1.2.2	Type of pump		Rotary screw / gear / centrifugal pump
1.2.3	Liquid pumped		Turbine oil
1.2.4	Capacity		Clean oil transfer pump shall be selected such that the entire oil of one steam turbine generator unit shall be transferred to main oil tank in two hours. Dirty oil transfer pump shall have

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			capacity equal to the oil purifier capacity
1.2.6	<u>Material of Construction</u>		
a)	Casing		Fabricated steel
b)	Rotor / impeller		BS 970 ENB hardened or equivalent
c)	Shaft		BS 970 ENB hardened and ground or equivalent
d)	Base plate		Fabricated steel
1.2.7	<u>Accessories</u>		
	Drain rim / drip tray to collect oil drips		Yes
1.2.8	<u>Purifier for Central Turbine oil system</u>		
a)	Mode of operation		Shall receive oil either from the Dirty oil tank or from the unit MOTs.
b)	Type of conditioning equipment		Centrifuge
c)	Hourly capacity of oil conditioning		10 % of the total oil charge quantity in Central Turbine oil system
	<u>Design Data</u>		
	Particle size in purified oil (Max.)	Microns	As required by the turbine manufacturer.
	Water content in purified oil (Max.)	% by Vol.	As required by the turbine manufacturer
	Booster and discharge pumps capacity		Shall be not less than 110% of the centrifuge capacity
	<u>Construction Features</u>		
	Type of centrifuge drive		Direct driven
	Centrifuge bowl cleaning		Manual
	Type of centrifuge booster and discharge pump		Rotary gear pump

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	<u>Materials of Construction</u>		
	<u>Centrifuge</u>		
	Separator discs		Stainless steel
	Bowl body		Carbon steel
	Bowl cover		Carbon steel
	<u>Feed and Discharge Pumps</u>		
	Casing		Cast iron
	Rotor		
	Base Plate		BS 970 hardened or equivalent
	Necessary elec. Automatic		Fabricated steel
	preheating system		To be included

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1	Designation		CW system / any other system as required by the Bidder
2	Expansion joint ID/Pipe ID	mm	By bidder
3	Numbers required	no.	Each pump discharge – 1 no.
			Condenser inlet/.Outlet- 1no. for each nozzle./ any other location as required by the Bidder
4	Fluid handled		River water
5		m ³ /hr	By bidder (Refer Note – 2).
6	Flow Normal	m ³ /hr	By bidder
7	Maximum	MWC	By bidder
8	Pressure – operating / design / test	MWC	By bidder
9	Vacuum (Test) in mm of Hg		700 /
10	Operating temperature in	°C	By bidder
11	Movements (Min) Axial Compression elongation Lateral movement	mm } mm } mm }	12 (Refer Note – 1) 12 12
12	No. of arches		By bidder
13	Controls unit to be provided		Yes
14	Companion flanges can be made in one piece or in segments. If segmentally welded 100% radiography shall be		

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	carried out		
15	Companion flanges shall be supplied with bolts, nuts and washers		
16	Material of construction		
16.1	Main body		High grade abrasion resistant natural or synthetic rubber compound
16.2	Reinforcement		Steel rings
16.3	Retaining ring		Galvanised steel retaining rings
16.4	Outer cover		Exposed surface shall be given 3 mm thick coating of neoprene
16.5	Bolts & nuts		IS 1367 Gr. 4.6
16.6	Stretch bolt plates		IS 2062
Note :-			
1. Bidder to check the value with the movement of condenser and design the expansion joint.			
2. Flow values to be based on single pump operation.			

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SL. NO.	ITEM	UNIT	

1.0	DESIGN CONDITIONS		
1.1	Type		Spur
1.2	Pulley block		As per IS 3832
1.3	Frame made of		Steel
1.4	Hook		Forged alloy or carbon steel as per IS : 2758 / IS : 2759 / IS 3832
1.5	Load chain		As per IS 3109 / BS 1663 / BS 3114 / IS 6216
1.6	Hand chain		As per BS 590
1.7	Load chain wheel		To suit load chain
1.8	Hand chain wheel		To suit hand chain
1.9	Factor of safety		Not less than 5
1.10	Gears		Cut from cast or forged steel, Spur and helical as per BS 436 Worm as per BS 721
1.11	Brake		Friction disc type to sustain load at any working position
1.12	Bearing		Ball and / or roller
1.13	Trolley wheels		Wrought iron / cast iron / low alloy steel
1.14	Lubrication		Centralised grease lubrication with hand pump
1.15	Material test certificates		To be submitted for hook, chain, pulley

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			block, etc.
1.16	Overload test with 150% of specified load		At works – Yes At site – Yes
1.17	Visual inspection and dimensional check		Yes
2.0	DESIGN CONDITIONS		
2.1	Type		Spur
2.2	Pulley block		As per IS 3832

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SL. NO.	ITEM	UNIT	

1.0	DESIGN CONDITIONS		
1.1	Class of hoist		Class II, as per IS:807
1.2	Hoist speed		2-3 m/min
1.3	Method of operation		Pendant push button
1.4	Speed control (hoist)		Single speed
1.5	MATERIALS OF CONSTRUCTION		
1.5.1	Drums & sheave		Cast iron / cast steel / mild steel drum, grooving construction as per IS 3938
1.5.2	Hook		Forged alloy / carbon steel, as per IS 2758 / IS 2759 single hook provided with standard depress safety latch lock to prevent hook from swivelling
1.5.3	Bearing		Ball and / or roller
1.5.4	Shaft		Steel
1.5.5	Wire rope		Construction 6 x 36 minimum ultimate strength 1.6×10^6 kN/m ² as per IS 2365 factor of safety as per IS 3938
1.5.6	Gear		Cut from cast / forged steel as per IS 436
1.5.7	Brake		Electro hydraulic type to hold 125% of the load torque
1.5.8	Trolley		Gears and brakes same as for hoist
1.5.9	Lubrication		Centralised grease lubrication with hand pump

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1.5.10	Trolley wheels		Heat treated carbon steel / low alloy steel / graded CI single flanged
1.6	Material test certificates		To be submitted for critical components such as hook, wire rope, drum, trolley, etc.
1.7	Overload test with 150% of specified load		At works : Yes At site : Yes
1.8	Visual inspection and dimensional check		Yes

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	DESIGN DATA			
1.0	Tag Number	Lube Oil	Condensate	Boiler Feed Pump Suction
2.0	Quantity Required	*	*	Six (6)
3.0	Location	*	*	*
4.0	Type	Duplex	Simplex basket	Simplex basket
5.0	Fluid	Lube oil	Condensate	Deaerated condensate
6.0	Flow rate, kg/hr	*	*	*
7.0	Operating pressure – Kg/cm ² (g)	*	*	*
8.0	Operating temperature – 0C	*	*	*
9.0	Design pressure – Kg/cm ² (g)	*	*	*
10.0	Design temperature – 0C	*	*	*
11.0	Fluid viscosity cP at Op. temp	*	*	*
12.0	Fluid Sp. gravity at Op. temp.	*	*	*
13.0	Max. permissible Pr. Drop at 50% clogging	*	*	*
14.0	Screen / basket data			
	(i) CA of perforations	*	*	*
	(ii) Min. Thickness – mm	1.5	1.5	1.5
	(iii) Free straining area	Minimum – 4 times pipe cross sectional area.		

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15.0	Steam jacket	No		No
	(a) Inlet pr. Kg/cm2(g) Op. / Desn.			
	(b) Inlet temp. 0C Op. / Desn.			
16.0	End connections			
	(a) Size NB mm	*	*	*
	(b) Type	Welded	Flanged	Welded
	(c) Details / Standards	ANSI B 16.25	ANSI B 16.5	ANSI B 16.25
17.0	Cover	Quick opng./ Bolted	Quick opng. / Bolted	Quick opng./Bolted
	MATERIAL OF CONSTRUCTION			
18.0	(a) Body	Cast carbon steel ASTM A 216 Gr. B	Cast carbon steel ASTM A 216 Gr. B	ASTM 216 Gr. WCB or Eqvt
	(b) Cover	- do -	- do -	- do -
	(c) Screen basket	Stainless steel	Stainless steel	Stainless steel (304)
	(d) Bolts / Studs	ASTM A 193 Gr. B7	ASTM A 193 Gr B7	ASTM A 193 GrB7
	(e) Nuts	ASTM A 194 Gr 2H	ASTM A 194 Gr. 2H	ASTM A 194 Gr. 2H
	(f) Gaskets	Red rubber – Full face wire inserted	CAF	CAF
19.0	ACCESSORIES BY VENDOR			

REV. NO.	R0	R1			JOB NO. TCE. 5750A	CLIENT: RRVUNL	
PPD. BY	GS	AA				PROJECT: 2 x 660 MW, Super-Critical TPS, Stage- V, Suratgarh, Rajasthan	
CHD. BY	SN	SN					ISSUE R1
DATE	26-11-2009	30-05-2012					

SPECIFICATION NO. TCE.5750A-500-H-001 PART A	TATA CONSULTING ENGINEERS LIMITED		VOLUME: IIIA
	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATA SHEET A13 STG and its Auxiliaries STRAINERS		SHEET 3 OF 3
SL. NO.	ITEM		

	(a) For Bolts	Yes	Yes	Yes
	(b) Diff. Pressure gauge	Yes	Yes	Yes
	(c) Drain / Vent cock (Forged Steel)	Yes	Yes	Yes
20.0	Hydro static test Pr. – Kg/cm2			
	(a) Shell side	*	*	*
	(b) Jacket side			
21.0	Vacuum test required	No	Yes / No	Yes
22.0	Press. drop test required clean/50% clogged	Yes	Yes	Yes

1. Duplex Filter shall be provided with Valves with a single handle or interlink so as to operate simultaneously.
2. External valve position indicator shall be provided to indicate strainer housing in use.
3. Strainer parts shall be replaceable without removing strainer housing from the line.
4. Strainer housing covers shall be provided with Davit arm.
5. Provision for equalising the pressure in standby housing before switching over should be provided.
6. Acceptable leakage rates: NIL
7. Strainers shall be skid mounted.

* VENDOR to furnish information in blank spaces

REV. NO.	R0	R1			JOB NO. TCE. 5750A	CLIENT: RRVUNL	
PPD. BY	GS	AA				PROJECT: 2 x 660 MW, Super-Critical TPS, Stage- V, Suratgarh, Rajasthan	
CHD. BY	SN	SN					ISSUE R1
DATE	26-11-2009	30-05-2012					

SPECIFICATION NO. TCE.5750A-500-H-001 PART A	TATA CONSULTING ENGINEERS LIMITED		VOLUME: IIIA
	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATA SHEET A14 STG and its Auxiliaries SHELL AND TUBE HEAT EXCHANGERS		SHEET 1 OF 3
SL. NO.	ITEM	UNIT	

1.0	Designation		By Bidder
2.0	Capacity		2 X 100% FOR EACH EQUIPMENT
3.0	<u>MATERIALS OF CONSTRUCTION</u>		
	COMPONENT		MATERIAL
3.1	Shell		IS-2002 GR. 2A/SA-285 GR. C/OR EQUAL
3.2	Shell Flanges		IS-2002 GR. 2A/SA-285 GR. C/OR EQUAL, SA 181 GR 1/OR EQ.
3.3	Shell Cover		IS-2002 GR. 2A/SA-285 GR. C/OR EQUAL.
3.4	Shell Cover Flange		IS-2002 GR. 2A/SA-285 GR. C/ IS 1875 CL. B/ SA 181 GR 1/OR EQ.
3.5	Shell Nozzles		IS-1978 ST 25/SA-53 GR. B/OR EQUAL.
3.6	Shell Nozzles Flanges		IS-2002 GR. 2A/IS-1875 CL. B/SA 285 GR C/SA 181 GR 1/OR EQUAL
3.7	Channels		IS-2002 GR. 2A/SA-285 GR. C/ OR EQUAL
3.8	Channel / Flanges		IS-2002 GR. 2A/IS 1875 GR B/ SA 285 GR C/SA 181 GR 1 OR EQUAL
3.9	Channel Cover Flange		IS-2002 GR. 2A/IS-1875 GR B/ SA 285 GR. C/SA 181 GR. 1/OR EQUAL
3.10	Channel Nozzles		IS-1978 ST 25/SA-53 GR B/OR EQUAL
3.11	Channel Nozzle Flanges		IS-2002 GR 2A/IS 1875 GR B/SA 285 GR C/SA 181 GR 1/OR EQUAL
3.12	Tubes		SA-179/BS-3059 CDS 33/OR EQUAL

REV. NO.	R0	R1			JOB NO. TCE. 5750A	CLIENT: RRVUNL	
PPD. BY	GS	AA					
CHD. BY	SN	SN				PROJECT: 2 x 660 MW, Super-Critical TPS, Stage-V, Suratgarh, Rajasthan	ISSUE R1
DATE	26-11-2009	30-05-2012					

SPECIFICATION NO. TCE.5750A-500-H-001 PART A	TATA CONSULTING ENGINEERS LIMITED		VOLUME: IIIA
	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATA SHEET A14 STG and its Auxiliaries SHELL AND TUBE HEAT EXCHANGERS		SHEET 2 OF 3
SL. NO.	ITEM	UNIT	

3.13	Tube Sheets : i) Stationary ii) Floating		IS-2002 GR 2A/IS-1875 GR B/SA 285 GR C/SA 181 GR 1/OR EQUAL.
3.14	Baffles : i) Longitudinal		COMMERCIAL QUALITY STEEL
	ii) Cross		COMMERCIAL QUALITY STEEL
3.15	Support Plates		COMMERCIAL QUALITY STEEL
3.16	Pass Partition		COMMERCIAL QUALITY STEEL
3.17	Impingement Plate		COMMERCIAL QUALITY STEEL
3.18	Tie Rods		COMMERCIAL QUALITY STEEL
3.19	Spacers		COMMERCIAL QUALITY STEEL
3.20	Floating Tube Sheet Joint		IS-1367-8.8, EN 24 T : SA 193-B-7- STUDS
3.21	All Other Shell Side Joints		IS-1367-B, EN 8 : SA 194-2H NUTS
3.22	<u>Gaskets</u>		
3.22.1	Shell Cover		ANNEALED STEEL JACKETTED COMP ASI
3.22.2	Channel Cover		ANNEALED STEEL JACKETTED COMP ASI
3.22.3	Fixed Tube Sheets Shell Side		COMP ASB
3.22.4	Fixed Tube Sheets Channel Side		ANNEALED STEEL JACKETTED COMP. ASB
3.22.5	Floating Tube Sheet Shell Side		ANNEALED STEEL JACKETTED COMP. ASB
3.22.6	Floating Tube Sheet Channel Side		ANNEALED STEEL JACKETTED COMP. ASB
3.23	Saddle Supports / Brackets		COMMERCIAL QUALITY STEEL

REV. NO.	R0	R1			JOB NO. TCE. 5750A	CLIENT: RRVUNL	
PPD. BY	GS	AA					
CHD. BY	SN	SN				PROJECT: 2 x 660 MW, Super-Critical TPS, Stage-V, Suratgarh, Rajasthan	ISSUE R1
DATE	26-11-2009	30-05-2012					

SPECIFICATION NO. TCE.5750A-500-H-001 PART A	TATA CONSULTING ENGINEERS LIMITED		VOLUME: IIIA
	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATA SHEET A14 STG and its Auxiliaries SHELL AND TUBE HEAT EXCHANGERS		SHEET 3 OF 3
SL. NO.	ITEM	UNIT	

3.24	Jack Screws		MILD STEEL SA 193 B7 : IS-1367-B, 8.8 : EN 24 T OR EQUAL

REV. NO.	R0	R1			JOB NO. TCE. 5750A	CLIENT: RRVUNL	
PPD. BY	GS	AA					
CHD. BY	SN	SN				PROJECT: 2 x 660 MW, Super-Critical TPS, Stage-V, Suratgarh, Rajasthan	ISSUE R1
DATE	26-11-2009	30-05-2012					

SPECIFICATION NO. TCE.5750A-500-H-001 PART A	TATA CONSULTING ENGINEERS LIMITED		VOLUME: IIIA
	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATA SHEET A15 STG and its Auxiliaries THERMAL INSULATION		SHEET 1 OF 3
SL. NO.	ITEM	UNIT	

1.0	Insulation Material for		Lightly bonded mineral wool / pre-formed calcium silicate
1.2	Equipment		All equipment as applicable except steam turbine
2.0	Finishing Cement		No
3.0	Sheathing Material		Aluminium as per IS737 – 31000, Gr.H3
3.1	For pipes		i) Insulation outside dia. above 450mm – Sheet thickness – 20 SWG.
			ii) Insulation outside dia. 150 to 450mm – Sheet thickness – 22 SWG.
			iii) Insulation outside dia. below 150mm – Sheet thickness – 24 SWG.
3.2	For Equipment		i) Flues & ducts – Sheet thickness 1.0mm
			ii) SG casing & rear wall enclosure – Sheet thickness 1.6mm.
4.0	Design thickness is / should be based on :		
	A. Station ambient temperature	⁰ C	30
	B. Outer surface temperature on surface of sheathing	⁰ C	60 under still air condition

REV. NO.	R0	R1			JOB NO.	CLIENT: RRVUNL	
PPD. BY	GS	AA			TCE. 5750A	PROJECT: 2 x 660 MW, Super-Critical TPS, Stage-V, Suratgarh, Rajasthan	ISSUE R1
CHD. BY	SN	SN					
DATE	26-11-2009	30-05-2012					

SPECIFICATION NO. TCE.5750A-500-H-001 PART A	TATA CONSULTING ENGINEERS LIMITED		VOLUME: IIIA
	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATA SHEET A15 STG and its Auxiliaries THERMAL INSULATION		SHEET 2 OF 3
SL. NO.	ITEM	UNIT	

5.0	Recommended thickness furnished (Applicable for calcium silicate also)		Yes / (Refer sheet 2 of 2)
6.0	Codes & Standards		IS 8183 IS 14164 BS 5970 IS-8154, BS 3958

NOTES:

- For insulation thickness calculation maximum thermal conductivity indicated in relevant BIS shall be considered

Temp (°C)	51 – 100	101- 150	151- 200	201- 250	251- 300	301- 350	351- 400	401- 450	451- 500	501- 550	551- 575
Pipe Dia	INSULATION THICKNESS IN mm.										
15 mm (1/2")	25	25	40	40	50	65	80	90	100	115	125
20 mm (3/4")	25	25	40	50	50	65	80	90	100	125	125
25 mm (1")	25	40	40	50	65	80	90	100	115	125	140
32 mm (1-1/4")	25	40	40	50	65	80	90	100	115	140	140
40mm (1-1/2")	25	40	40	50	65	80	90	115	125	140	150
50mm (2")	25	40	40	50	65	80	100	115	125	150	165
80mm (3")	25	40	50	50	80	90	100	125	140	165	170
100mm (4")	40	50	50	65	80	90	115	125	150	165	190
150mm	40	50	50	65	80	100	115	140	165	190	200

REV. NO.	R0	R1			JOB NO.	CLIENT: RRVUNL	
PPD. BY	GS	AA			TCE. 5750A	PROJECT: 2 x 660 MW, Super-Critical TPS, Stage-V, Suratgarh, Rajasthan	ISSUE R1
CHD. BY	SN	SN					
DATE	26-11-2009	30-05-2012					

SPECIFICATION NO. TCE.5750A-500-H-001 PART A	TATA CONSULTING ENGINEERS LIMITED			VOLUME: IIIA		
	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATA SHEET A15 STG and its Auxiliaries THERMAL INSULATION			SHEET 3 OF 3		
SL. NO.	ITEM			UNIT		

(6")											
200mm (8")	40	50	50	65	80	100	125	140	165	190	215
250mm (10")	40	50	50	65	90	115	125	150	175	200	215
300mm (12")	40	50	65	75	90	115	140	150	190	215	225
350mm (14")	50	65	75	75	90	115	140	165	190	215	225
400mm (16")	50	65	75	75	90	115	140	165	190	215	240
450mm (18")	50	65	75	75	90	115	140	165	190	225	240
500mm (20")	50	65	75	100	115	115	140	165	200	225	240
600mm (24")	50	65	75	100	115	115	140	175	200	240	250
625mm (25")	50	65	75	100	115	115	140	175	200	240	250
650mm (26")	50	65	75	100	115	115	150	175	200	240	250
700mm (28")	50	65	75	100	115	115	150	175	215	240	300
800mm (32")	50	65	75	100	115	125	150	175	215	240	300
900mm (36")	50	65	75	100	115	125	150	175	215	240	300
950mm (38")	50	65	75	100	115	125	150	175	215	240	300
1000mm (40") & above flat Surfaces	50	65	75	100	115	140	170	215	250	300	350

REV. NO.	R0	R1			JOB NO. TCE. 5750A	CLIENT: RRVUNL	
PPD. BY	GS	AA				PROJECT: 2 x 660 MW, Super-Critical TPS, Stage-V, Suratgarh, Rajasthan	
CHD. BY	SN	SN					ISSUE R1
DATE	26-11-2009	30-05-2012					

SPECIFICATION NO. TCE.5750A-500-H-001 PART A	TATA CONSULTING ENGINEERS LIMITED		VOLUME: IIIA
	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATA SHEET A16 STG and its Auxiliaries PIPING MATERIALS		SHEET 1 OF 12
SL. NO.	ITEM	UNIT	

SPECIFIC REQUIREMENTS FOR PIPING							
SL. NO.	SERVICE	SIZE	PIPES	FITTINGS	FLANGES	GASKETS	LINE JOINT
1.1	STEAM TEMP. 550°C AND UPTO 600°C	NB 65MM & ABOVE	ASTM A335 - P91	ASTM A234 – WP91	ASTM A182 – F91	SPIRAL WOUND SS 316	BUTT WELDED
		NB 50MM & BELOW	ASTM A335 - P91	ASTM A182 – F91	ASTM A182 – F91	SPIRAL WOUND SS 316	SOCKET WELDED
1.2	STEAM TEMP. ABOVE 510°C AND UPTO 549°C	NB 65MM & ABOVE	ASTM A335 - P22	ASTM A234 – WP22	ASTM A182 – F22	SPIRAL WOUND SS 316	BUTT WELDED
		NB 50MM & BELOW	ASTM A335 - P22	ASTM A182 – F22	ASTM A182 – F22	SPIRAL WOUND SS 316	SOCKET WELDED
	STEAM TEMP.	NB 65MM	ASTM A335 -	ASTM	ASTM	SPIRAL	BUTT
REV. NO.	R0	R1		JOB NO.	CLIENT: RRVUNL		
PPD. BY	GS	AA		TCE. 5750A	PROJECT: 2 x 660 MW, Super-Critical TPS, Stage-V, Suratgarh, Rajasthan		
CHD. BY	SN	SN					
DATE	26-11-2009	30-05-2012					ISSUE R1

SPECIFICATION NO. TCE.5750A-500-H-001 PART A	TATA CONSULTING ENGINEERS LIMITED		VOLUME: IIIA
	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATA SHEET A16 STG and its Auxiliaries PIPING MATERIALS		SHEET 2 OF 12
SL. NO.	ITEM	UNIT	

1.3	400°C TO 510°C	& ABOVE	P11	A234 - WP11	A182 - F11	WOUND SS 316	WELDED
		NB 50MM & BELOW	ASTM A335 - P11	ASTM A182 - F11	ASTM A182 - F11	SPIRAL WOUND SS 316	SOCKET WELDED
1.4	STEAM BELOW 400°C	NB 65MM & ABOVE	ASTM A106 Gr.B	ASTM A234 – WPB	ASTM A105	SPIRAL WOUND SS 316	BUTT WELDED
		NB 50MM & BELOW	ASTM A106 Gr. B	ASTM A105	ASTM A105	SPIRAL WOUND SS 316	SOCKET WELDED
1.5	FEED WATER / CONDENSATE	NB 65MM & ABOVE	ASTM A106 Gr. C/B	ASTM A234 – WPC / WPB	ASTM A105	SPIRAL WOUND SS 316	BUTT WELDED
		NB 50MM & BELOW	ASTM A106 Gr. C/B	ASTM A105	ASTM A105	SPIRAL WOUND SS 316	SOCKET WELDED

REV. NO.	R0	R1			JOB NO. TCE. 5750A	CLIENT: RRVUNL	
PPD. BY	GS	AA					
CHD. BY	SN	SN				PROJECT: 2 x 660 MW, Super-Critical TPS, Stage-V, Suratgarh, Rajasthan	ISSUE R1
DATE	26-11-2009	30-05-2012					

SPECIFICATION NO. TCE.5750A-500-H-001 PART A	TATA CONSULTING ENGINEERS LIMITED		VOLUME: IIIA
	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATA SHEET A16 STG and its Auxiliaries PIPING MATERIALS		SHEET 3 OF 12
SL. NO.	ITEM	UNIT	

1.6	LUBE OIL AND CONTROL / HYDRAULIC OIL (UPSTREAM OF FILTER)	NB 65MM & ABOVE	ASTM A106 Gr. B	ASTM A234 - WPB	ASTM A105	GRAFOIL	BUTT WELDED
		NB 50MM & BELOW	ASTM A106 Gr.B	ASTM A105	ASTM A105	GRAFOIL	SOCKET WELDED
1.7	LUBE OIL & CONTROL / HYDRAULIC OIL (BEYOND FILTER)	NB 65MM & ABOVE	ASTM A 312 TP 316 (SEAM LESS)	ASTM A 403 GR. WP316	ASTM A182 F316	GRAFOIL	BUTT WELDED
		NB50MM & BELOW	ASTM A 312 TP 316 (SEAM LESS)	ASTM A 403 GR. WP316	ASTM A182 F316	GRAFOIL	SOCKET WELDED
1.8	DEMINERALI-SED WATER	NB 65MM TO 150	ERW, BLACK, IS 1239 (PT-	ASTM A 234 GR.	ASTM A 105	GRAFOIL	FLANGED
REV. NO.	R0	R1		JOB NO.	CLIENT: RRVUNL		
PPD. BY	GS	AA		TCE. 5750A	PROJECT: 2 x 660 MW, Super-Critical TPS, Stage-V, Suratgarh, Rajasthan		
CHD. BY	SN	SN					
DATE	26-11-2009	30-05-2012					ISSUE R1

SPECIFICATION NO. TCE.5750A-500-H-001 PART A	TATA CONSULTING ENGINEERS LIMITED		VOLUME: IIIA
	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATA SHEET A16 STG and its Auxiliaries PIPING MATERIALS		SHEET 4 OF 12
SL. NO.	ITEM	UNIT	

		200 TO 350	1)Heavy class Rubber lined IS 1978 ERW OR API 5L GR.B Rubber lined	WPB RUBBER LINED	RUBBER LINED		
		NB 50MM & BELOW	ASTM A312 TP 304(ERW)	A 182-F304	ASTM A 182 F304	GRAFOIL	SOCKET WELDED
1.9	AUXILIARY COOLING WATER (PASSIVATED DM WATER), SERVICE WATER SYSTEM (FRESH WATER APPLICATION), SERVICE AIR SYSTEM	NB 65 TO 150 200 TO 450	ERW, BLACK IS 1239 Heavy class (PT-1) ERW, IS 1978 (OR) API 5L GR. B (OR) IS 3589 FABRICATED FROM IS 2062	ASTM A234 Gr.WPB	ASTM A105 (A283GR-C FOR ABOVE NB 200 MM)	GRAFOIL	BUTT WELDED

REV. NO.	R0	R1			JOB NO.	CLIENT: RRVUNL	
PPD. BY	GS	AA			TCE. 5750A	PROJECT: 2 x 660 MW, Super-Critical TPS, Stage-V, Suratgarh, Rajasthan	ISSUE R1
CHD. BY	SN	SN					
DATE	26-11-2009	30-05-2012					

SPECIFICATION NO. TCE.5750A-500-H-001 PART A	TATA CONSULTING ENGINEERS LIMITED		VOLUME: IIIA
	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATA SHEET A16 STG and its Auxiliaries PIPING MATERIALS		SHEET 5 OF 12
SL. NO.	ITEM	UNIT	

		500 & ABOVE	IS 3589 FABRICATED FROM IS 2062 PLATES				
		NB 50 MM & BELOW	ERW, BLACK, IS 1239 (PT-1)	ASTM A105	ASTM A105	GRAFOIL	SOCKET WELDED
1.10	RIVER WATER CONDENSER COOLING WATER, AUXILIARY COOLING WATER (SECONDARY CIRCUIT)	NB 65 TO 150 NB 200 TO 800	ERW, BLACK IS 1239 Heavy class (PT-1) Rubber Lined (5 mm thk) ERW, IS 1978 (OR) API 5L GR. B (OR) IS 3589 FABRICATED FROM IS 2062 – Rubber Lined (5 mm thk)	ASTM A234 Gr.WPB – Rubber Lined (5 mm thk)	ASTM A105 (A283GR- C FOR ABOVE NB 200 MM) – Rubber Lined (5 mm thk)	GRAFOIL	BUTT WELDED
		NB 900 &	IS 3589				

REV. NO.	R0	R1			JOB NO. TCE. 5750A	CLIENT: RRVUNL	
PPD. BY	GS	AA				PROJECT: 2 x 660 MW, Super-Critical TPS, Stage-V, Suratgarh, Rajasthan	
CHD. BY	SN	SN					ISSUE R1
DATE	26-11-2009	30-05-2012					

SPECIFICATION NO. TCE.5750A-500-H-001 PART A	TATA CONSULTING ENGINEERS LIMITED		VOLUME: IIIA
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SL. NO.	ITEM	UNIT	

		ABOVE	FABRICATED FROM IS 2062 PLATES Gunnited with cement mortar				
		NB 50MM & BELOW	ASTM A312 TP 304 (ERW)	A 182-F304	ASTM A 182 F304	GRAFOIL	SOCKET WELDED
1.11	POTABLE WATER SYSTEM/ INSTRUMENT AIR SERVICE	NB 65 TO 150	ERW, BLACK, IS 1239 Heavy class (PT-1), GALVANISED	ASTM A234 Gr.WPB GALVANISED	ASTM A105 GALVANISED	GRAFOIL	FLANGED
		200 NB TO 450	IS 1978, ERW(OR) API 5L GR.B (OR) IS 3589 FABRICATED FROM IS 2062 PLATES (A LL GALVANISED)				

REV. NO.	R0	R1			JOB NO.	CLIENT: RRVUNL	
PPD. BY	GS	AA			TCE. 5750A	PROJECT: 2 x 660 MW, Super-Critical TPS, Stage-V, Suratgarh, Rajasthan	ISSUE R1
CHD. BY	SN	SN					
DATE	26-11-2009	30-05-2012					

SPECIFICATION NO. TCE.5750A-500-H-001 PART A	TATA CONSULTING ENGINEERS LIMITED		VOLUME: IIIA
	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATA SHEET A16 STG and its Auxiliaries PIPING MATERIALS		SHEET 7 OF 12
SL. NO.	ITEM	UNIT	

		NB 50 MM & BELOW	ERW, BLACK, IS 1239 (PT- 1), GALVANISED	ASTM A105 GALVANI- SED	ASTM A105 GALVANI- SED	GRAFOIL	SCREWED
1.12	LIGHT DIESEL OIL (LDO) / HEAVY FURNACE OIL (HFO) / HIGH SPEED DIESEL (HSD)	NB 65MM & ABOVE (SEAM LESS)	ASTM A 106 Gr. 'B'	ASTM A 234 WPB	ASTM A105	TEFLON	BUTT WELDED
		NB50MM & BELOW (SEAM LESS)	ASTM A 106 Gr. 'B'	ASTM A 105	ASTM A105	TEFLON	SOCKET WELDED

NOTES:-

1. All mandatory tests shall be carried out as per ASME Boiler & Pressure Vessel Code ASME Section-II,
2. Each length of pipe shall be hydro-tested at shop as per the Codes/Standards.
3. Blind flanges on SS Pipe lines shall be to ASTM A 240-TP 316. Stub ends shall be used at flanged connections.
4. All branch connections shall be wrought (seamless) or forged steel based on the size and availability based on ASTM Standards.
5. Piping System under Sl. No.1.1, 1.2, 1.3 & 1.4 shall have IBR Approval. Boiler feed discharge under item no.1.5 shall also be under IBR Approval.

REV. NO.	R0	R1			JOB NO. TCE. 5750A	CLIENT: RRVUNL	
PPD. BY	GS	AA					
CHD. BY	SN	SN				PROJECT: 2 x 660 MW, Super-Critical TPS, Stage-V, Suratgarh, Rajasthan	ISSUE R1
DATE	26-11-2009	30-05-2012					

SPECIFICATION NO. TCE.5750A-500-H-001 PART A	TATA CONSULTING ENGINEERS LIMITED		VOLUME: IIIA
	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATA SHEET A16 STG and its Auxiliaries PIPING MATERIALS		SHEET 8 OF 12
SL. NO.	ITEM	UNIT	

6. All painting with primer coats (2 coats each) shall be provided for the piping and all hangers.
7. IS 1239, pipes
8. Material selection for steam flow temperatures above 540 Deg C shall be selected based on feed back from performing supercritical units and austenitic steel shall be used wherever necessary.

SPECIFIC REQUIREMENT FOR VALVES

SL. NO.	SERVICE	SIZE	BODY/ BONNET	DISC	STEM	HAND WHEEL	VALVE ENDS
1	STEAM LINES (TEMP $\geq$ 550 $^{\circ}$ C And<600 $^{\circ}$ C)	$\geq$ 65NB	ASTM A217 C-12	ASTM A217 C-12	ASTM A182 Gr. F6a	ASTM A47 G Gr. 32510	BUTT WELDED.
		$\leq$ 50 NB	ASTM A182 Gr.F-91	ASTM A182 Gr F91	ASTM A182 Gr.F6a	ASTM A97 Gr.32510	SOCKET WELDED
2	STEAM LINES (TEMP >510 $^{\circ}$ C AND <550 $^{\circ}$ C)	$\geq$ 65NB	ASTM A217 WC-9	ASTM A217 WC- 9	ASTM A182 Gr. F6a	ASTM A47 G Gr. 32510	BUTT WELDED.
		$\leq$ 50 NB	ASTM	ASTM	ASTM		SOCKET

REV. NO.	R0	R1			JOB NO. TCE. 5750A	CLIENT: RRVUNL	
PPD. BY	GS	AA					
CHD. BY	SN	SN				PROJECT: 2 x 660 MW, Super-Critical TPS, Stage-V, Suratgarh, Rajasthan	ISSUE R1
DATE	26-11-2009	30-05-2012					

SPECIFICATION NO. TCE.5750A-500-H-001 PART A	TATA CONSULTING ENGINEERS LIMITED		VOLUME: IIIA	
	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATA SHEET A16 STG and its Auxiliaries PIPING MATERIALS		SHEET 9 OF 12	
SL. NO.	ITEM		UNIT	

			A182 Gr.F-22	A182 Gr F22	A182 Gr.F6a	ASTM A97 Gr.32510	WELDED
3	STEAM LINES (TEMP>400 ^o C AND ≤510 ^o C)	≥65NB	ASTM A217 WC-6	ASTM A217 WC- 6	ASTM A182 Gr. F6a	ASTM A47 G Gr. 32510	BUTT WELDED.
		≤ 50 NB	ASTM A182 Gr.F-11	ASTM A182 Gr F11	ASTM A182 Gr.F6a	ASTM A97 Gr.32510	SOCKET WELDED
4	STEAM LINES (TEMP≤400 ^o C), CONDENSATE BLOW DOWN, BOILER FEED SUCTION LINE	≥65NB	ASTM A216 Gr WCB ASTM A105	ASTM A216 Gr WCB ASTM A182 Gr F6a	ASTM A182 Gr F6a ASTM A182 Gr F6a	ASTM A47 Gr 32510 ASTM A47 Gr 32510	BUTT WELDED SOCKET WELDED
		≤ 50 NB					
5	BOILER FEED DISCHARGE & RECIRCULATION SYSTEMS	≥ 65	ASTM A 216 Gr. WCB/C ASTM A 105	ASTM A 216 Gr. WCB/C ASTM A	ASTM A 182 Gr. F6a	ASTM A 47 Gr. 32510	BUTT WELDED

REV. NO.	R0	R1			JOB NO. TCE. 5750A	CLIENT: RRVUNL	
PPD. BY	GS	AA				PROJECT: 2 x 660 MW, Super-Critical TPS, Stage-V, Suratgarh, Rajasthan	
CHD. BY	SN	SN					
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SPECIFICATION NO. TCE.5750A-500-H-001 PART A	TATA CONSULTING ENGINEERS LIMITED		VOLUME: IIIA
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SL. NO.	ITEM	UNIT	

		≤ 50		182 Gr. F6a	ASTM A 182 Gr. F6a	ASTM A 47 Gr. 32510	SOCKET WELDED
6.	LUBE OIL, SLUDGE, OILY WATER DRAINS (UPTO FILTER)	$\geq 65\text{NB}$	ASTM A216 Gr WCB ASTM A105	ASTM A216 Gr WCB ASTM A479 Type 410- 2	ASTM A479 Type 410-2 ASTM A479 Type 410-2	ASTM A47 Gr 32510 ASTM A47 Gr 32510	BUTT WELDED SOCKET WELDED
7.	LUBE OIL & CONTROL OIL / HYDRAULIC OIL (BEYOND FILTER)	$\geq 65\text{NB}$	SS 410 SS410	SS 410	SS 410	ASTM A47 GR. 32510 ASTM A47 GR. 32510	BUTT WELDED SOCKET WELDED
8.	CONDENSER COOLING WATER, AUXILIARY COOLING WATER, POTABLE	≥ 65	A126 CLASS B	A126 CLASS B	ASTM B 124 C 37700	ASTM A47 GR. 32510	FLANGED FLAT FACE

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PPD. BY	GS	AA			TCE.	PROJECT: 2 x 660 MW, Super-Critical TPS, Stage-V, Suratgarh, Rajasthan	ISSUE R1
CHD. BY	SN	SN			5750A		
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SL. NO.	ITEM	UNIT	

	WATER						
		≤ 50	ASTM B62	ASTM B62	ASTM B 312 GR.A	ASTM A47 GR. 32510	SCREWED TYPE
9	INSTRUMENT AIR	≥65NB	ASTM A 216 GR.WCB ASTM A 105	ASTM A 216 GR. WCB 13% Cr Steel (Ball)	ASTM A479 Type 410-2 ASTM A479 Type 410-2	ASTM A47 Gr 32510 ASTM A47 Gr 32510	FLANGED RAISED FACE SCREWED TYPE
10	DM WATER	≥65NB	ASTM A 126 Class B RUBBER LINED ASTM A 182 F316L	ASTM A 126 Class B RUBBER LINED ASTM A182 F316L	ASTM A479 Type 410-2 ASTM A479 Type	ASTM A47 Gr 32510 ASTM A47 Gr 32510	FLANGED RAISED FACE SCREWED TYPE

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PPD. BY	GS	AA			TCE. 5750A	PROJECT: 2 x 660 MW, Super-Critical TPS, Stage-V, Suratgarh, Rajasthan	ISSUE R1
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SL. NO.	ITEM	UNIT	

					410-2		
11	RIVER WATER	≥65NB	ASTM A 743 CF 8M	ASTM A 743 CF 8M	A 479 Type 316 L	ASTM A47 Gr 32510	FLANGED RAISED FACE
		≤ 50 NB	ASTM A 182 F 316 L	ASTM A 182 F 316 L	ASTM A 182 F 316 L	ASTM A47 Gr 32510	SCREWED TYPE

NOTES:-

1. Testing of body, seat and back seat shall be as per ANSI B16.34
2. For water system covered under sl.no.8 for sizes 150NB and above and sl.no.10 for sizes 65NB and above, butterfly valves shall be used and shall conform to AWWA C-504.
3. Ball valves or plug valves shall be provided for oil systems.
4. All shut off valves on oil system shall have leakage ANSI B 16.104 class VI.
5. Ball valves shall be used for instrument air system up to 50NB size.
6. IBR approval for valves shall be included wherever applicable.
7. Leakage class of valves in steam service for above 500 deg C shall be class V or VI for metal to metal contact seats as per ANSI/FCI-70-2-1976(R1982)

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PPD. BY	GS	AA			TCE. 5750A	PROJECT: 2 x 660 MW, Super-Critical TPS, Stage-V, Suratgarh, Rajasthan	ISSUE R1
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	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATA SHEET A17 STG and its Auxiliaries CONDENSATE POLISHING UNITS	SHEET 1 OF 7

	<u>CPU PLANT</u>		
	Design code for tanks and vessels		IS 2825 /ASME Sec VIII Div1
1.0	<u>Deep Mixed Bed Units</u>		
	(a) Total No.		Four (2x50% for each unit)
	(b) Type		Vertical (Cylindrical) / Spherical
	(c) Capacity per stream	Cu.m/hr.	By bidder
	(d) Design surface flow rate	Cu.m/hr.s q.m	120 for cylindrical and 100 for spherical
	(e) Design Temperature	°C	60 (max), 45 (normal)
	(f) Design Pressure	kg/sq.cm (g)	Shut off head + 20% of preceeding pump
	a) Pressure drop (clogged condition)		3.5 kg/sq cm(max, including valves and fittings & resin traps connected with the unit)
	b) Pressure drop (clean condition)		2.1 kg/sq.cm
	c) Material of construction (shell & dished ends)		SA 516 Gr.70 WITH 4.5 mm (3 x 1.5mm) THK

REV. NO.	R0			PPD. BY:	JOB NO.	CLIENT: RRVUNL
DATE				CHD. BY:	5750A	
REV. BY				DATE: JULY 09		PROJECT: 2 X 660MW, Stage-V, Suratgarh Super-Critical, TPS, Rajasthan

SPEC.NO. TCE.5750A-H-500-001 PART A	TATA CONSULTING ENGINEERS LIMITED	VOLUME IIIA
	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATA SHEET A17 STG and its Auxiliaries CONDENSATE POLISHING UNITS	SHEET 2 OF 7

	d) Air Blowers		2 x 100% capacity
	Type		Centrifugal / Twin Lobe
	Material		Cast Iron With suction air filters,relief valves and associated items.
	Duty		Intermittent
	Capacity & head		To suit.
1.1	<u>External Regeneration Facility</u>		
	Minimum Design Pressure for Pressure Vessels	Kg/sq.cm (g)	10
	(a) Resin Separation & Cation Regeneration Vessel		One (1)
	(b) Anion Regeneration Unit		One (1)
	(c) Mixed Resin Storage Unit		One(1) with initial fill of regenerated resins
	(c) Type		Vertical (Cylindrical)
	(d) Pressure drop (clogged condition)		3.5 kg/sq cm(max including valves and fittings connected with the unit)
	Pressure drop (clean condition)		2.1 kg/sq.cm
	(f) Material of construction (shell & dished ends)		SA 516 Gr 70 WITH 4.5 mm (3 x 1.5mm) THK

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DATE				CHD. BY:	5750A	
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	(g) Air Blowers		2 x 100%
	Type		Centrifugal / Twin Lobe
	Material		Cast Iron with suction air filters, relief valves and associated items.
	Duty		Intermittent
	Capacity & head		To suit.
	(h) Resin Make up Hopper		One (1) no. Sized for one fill of resin OR based on maximum attrition loss, whichever is higher
	(i) Alkali solution Preparation Tank		One (1) Capacity : To suit
	(j) Activated Carbon Filter		One (1) Capacity : To suit
	(k) DM regeneration pumps		2 x 100%
	(l) Alkali Measuring Tank		One (1) Capacity : 120% of one regeneration
	(m) Acid Measuring Tank		One (1) Capacity : 120% of one regeneration
	(n) Acid metering pumps		2 x 100% Capacity : To suit Head : To suit
	(o) Alkali Metering pumps		2 x 100% Capacity : To suit Head: To suit
	(p) Hot water tank		One (1)

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	(q) Bulk Acid Tank		Capacity: 2 x 50 % heaters to heat alkali diluent water to 50 deg C in 2.5 hours.
	(r) Bulk Alkali Tank		Common for CPU & DM Plant
	(s) Acid unloading pumps		Common for CPU & DM Plant
	(t) Alkali Unloading Pumps		Common for CPU & DM Plant
	(u) Neutralised Effluent Transfer Pumps		Common for CPU & DM Plant
1.3	Regeneration Equipment		
	a) Regenerant Chemicals		33% HCl and 48% NaOH
	b) Acid & Caustic Dilution Stations		Dilution tanks adequate for one regeneration, with 20% margin on capacity, online mixing tees with block & bleed, and ejectors. Each tank to be provided with fume absorber and seal pot.
	c) Materials of construction of chemical tanks		MSRL
1.4	RESINS		MONOSPHERE, UPS
	Cation Resin		Strongly Acidic with sulphonic acid as functional group

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	Anion Resin		Strong Base with quarternary amines as functional group
	Inert Resin		Non Ionic, compatible with SAC & SBA resins.
	Volumetric Ratio		SAC Resin / SBA Resin = 2 :1

SERVICE	MATERIAL OF CONSTRUCTION	STANDARD

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Service Vessels	CSRL	SA 516 Gr.70 ASME Sec VIII
Pressure vessels (other than service vessel)	CSRL	SA 516 Gr.70 ASME Sec VIII
Lining Material	Semi Hard Rubber	45-70 on D scale - Durometer Reading
Inlet Water & Regenerant Distributor	(AS PER MANUFACTURER'S STANDARD)	
Resin Traps	CSRL with internals of SS316	
Resin Transfer Piping & Fittings	SS	SS304
DM water pumps for regeneration	SS	SS316
Acid day tank/bulk acid storage tank , alkali day tank/alkali solution preparation tank/bulk alkali storage tank and hot water tank	CSRL	IS 2062 Gr.B for CS
Acid unloading pumps	Poly Propylene	
Alkali unloading pumps	SS	SS304
Rinse water piping	CS	ASTM A 106 Gr.B
Piping to CPU, CPU outlet, CPU bypass, CPU drain & rinse water piping	CS	ASTM A 106 Gr.B

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Activated Carbon Filter	MSRL	IS 2062 Gr.B
Acid / Alkali piping	MSRL	IS 1239 Gr.B
Instrument Air piping	MS Galvanised	IS 1239 Galvanised
DM water piping	SS(For 50 NB & below) MSRL(65 NB & above)	SS304 IS1239 Gr.B
Effluent disposal piping from N-pit to guard pond	HDPE	IS 4984 PN10
VALVES on CPU Service Vessel Inlet line	Manual BFV – CS Pneu. BFV – CS Motor. Op. BFV – CS Pneu. Ball Valves – SS Motor.Op. Ball Valves-SS	A216 WCB A216 WCB A216 WCB SS 316 SS 316
VALVES on CPU Service Vessel Outlet line	Manual BFV – SS Pneu. BFV – SS Motor. Op. BFV – SS Pneu. Ball Valves – SS Motor.Op. Ball Valves-SS	SS 316 SS 316 SS 316 SS 316 SS 316
VALVES on DM Water Lines	Butterfly Valves (Double Flanged) Diaphragm Valves (Double Flanged)	SS 316 or CI+RL
Valves on Acid, Alkali, Neutralised Effluent lines	Diaphragm Valves (Double Flanged)	SS 316 or CI+RL

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DATA SHEET B
(STG AND ITS AUXILIARIES)

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

1.1	GENERAL		
1.1.1	Manufacturer		
1.1.2	Model No.	No.	
1.3	Design and Performance Data		
1.3.1	Maximum continuous rating at generator terminals at 1 % MU and design CWT	MW	
1.3.2	Performances guarantee 100% TG MCR heat balance No. : ----- ----- (Heat balance diagram containing the values for Pressure, Temperature, flow and enthalpy values at the entry and exit of each equipment shall be enclosed)		
	a) 1% make up at design CWT		
	b) 0% make up at design CWT		
1.3.3	Guaranteed 80% TG MCR output heat balance No. ----- ----- (Heat balance diagram containing the values for Pressure, Temperature, Flow and Enthalpy at the entry and exit of each equipment shall be enclosed)		
	a) 1% make up		

NOTES TO BIDDER 1. ITEMS WHICH DEVIATE FROM THE SPECIFICATION SHOULD BE MARKED WITHIN ASTERISK (*) AND DETAILS TO BE GIVEN IN SCHEDULE OF DEVIATIONS. 2. THIS DATA SHEET SHALL BE FILLED UP COMPLETELY AND A COPY SHALL BE ENCLOSED WITH EACH COPY OF THE BID.	SIGNATURE OF BIDDER & DATE	
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	b) 0% make up		
1.3.4	60% TG MCR heat balance No. ----- ----- (Heat balance diagram containing the values for Pressure, Temperature, Flow and Enthalpy at the entry and exit of each equipment shall be enclosed)		
	a) 1% make up at design CWT		
	b) 0% make up at design CWT		
1.3.5	TG VWO with 0% makeup & minimum CWT heat balance No. ----- ----- (Heat balance diagram containing the values for Pressure, Temperature, Flow and Enthalpy at the entry and exit of each equipment shall be enclosed)		
NOTES :	1. Heat balance asked under 1.3.1 will be used for output guarantee. 2. Heat balances asked under 1.3.2 (b) and 1.3.3 (b) will be used for guarantee weighted heat rate of TG unit.		
1.3.6	TG VWO with 1% makeup & design cooling water temperature heat balance No. ----- (Heat balance		

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	diagram containing the values for pressure, temperature, flow and enthalpy at the entry and exit of each equipment shall be enclosed)		
1.3.7	Turbine rated speed	rpm	
1.3.8	Operating frequency range for turbine and auxiliaries	hz	
1.3.9	Steam turbine maximum flow passing ability with turbine control valves in valve wide open (VWO) position	t/h	
a)	Minimum continuous steam flow through turbine at rated speed	t/h	
b)	Power generated during minimum steam flow	MW	
c)	Maximum continuous capability of turbine	MW	
d)	Design pressure / temperature of casing		
1.3.10	No-load steam flow through	t/h	
1.3.11	Shaft vibration measured at each bearing housing (peak to peak) Velocity	microns mm/sec.	
1.3.12	Critical speed for each rotor assembly	rpm	

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	(The contractor will tabulate the above value for all modes of vibration (critical speed) of the shaft assembly in the range up to 4000 rpm)		
1.3.13	Critical speeds of turbine and generator rotors together assembled	rpm	
1.3.14	Maximum allowable temperature at LP turbine exhaust hood	⁰ C	
1.3.15	Set value for exhaust hood spray valve to open	⁰ C	
1.3.16	Coast-down time after turbine trip		
1.3.16.1	With vacuum	Min	
1.3.16.2	With vacuum breakers opened	Min.	
1.3.17	Mode of governing		
1.3.18	Type of governor		
1.3.19	Dead band of the governor	%	
1.3.20	Percentage regulation and its range of adjustability of governing system	%	
1.3.21	Main steam admission valves		
	i) Number ii) Size iii) Type of method of actuation iv) No. of limit switches v) Provision for onload testing vi) Provision for remote operation		

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	vii) Permanent strainer type		
	viii) Type of sealing		
a)	Opening through full travel	Sec	
b)	For closing through full travel	sec	
1.3.22	Reheat Steam admission valves i) Number ii) Size iii) Type of method of actuation iv) No. of limit switches v) Provision for onload testing vi) Permanent strainer type vii) Provision for remote operation viii) Type of sealing		
a)	Opening through full travel	Sec	
b)	For closing through full travel	Sec	
1.3.23	<u>Extraction valves including NRVs (Bidder to indicate depending on the no. of extractions)</u> i) Number ii) Size iii) Type of method of actuation iv) No. of limit switches v) Provision for onload testing		

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
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1.3.24	<u>On-load throw-off :</u>		
a)	Temporary speed rise (TSR)	%	
b)	Permanent speed rise	%	
1.3.25	Range of adjustability of speeder gear	%	
1.3.26	<u>Lube oil system</u>		
a)	Type of turbine oil		
b)	Specification of oil		
c)	Total quantity of oil in the system	m ³	
d)	Sight flow indicator		
	i) Type		
	ii) Number		
e)	Oil make up quantity/periodicity		
f)	Normal lube oil pressure	kg/cm ² (a)	
g)	Normal control oil pressure	kg/cm ² (a)	
h)	Degree of cleanliness to be maintained for the lube oil for satisfactory operation		
1.3.26.1	<u>Main oil tank</u>		
	i) Capacity		

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

	ii) Size iii) Local level indicator iv) Alarm for oil level v) Internal strainers vi) Relief and access doors vii) Mountings	Litres mm	
1.3.26.1.1	Permissible suspended particle size	microns	
1.3.26.1.2	Permissible water content in oil by volume	%	
1.3.26.2	Turbine shaft driven main oil pump		
	(i) Type		
	(ii) Capacity	m ³ /h	
	(iii) Total dynamic head	mlc	
	(iv) Method of providing positive suction pressure		
1.3.26.3	<u>Auxiliary oil pumps :</u>		
	(i) Type		

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
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	(ii) Number of pumps in service	No.	
	(iii) Number of standby pumps	No.	
	(iv) Capacity of each pump	m ³ /h	
	(v) Total dynamic head	mlc	
	(vi) Drive motor rating	kW	
1.3.26.4	Turning gear system		
	(i) Type		
	(ii) Speed of turbine during turning gear operation	rpm	
1.3.26.5	Jacking oil pumps		
	(i) Type		
	(ii) Number of pumps	No.	
	(iii) Capacity of each pump	m ³ /h	
	(iv) Total dynamic head	mlc	
	(v) Drive motor rating	kW	
1.3.26.6	<u>Control oil pump and system (if provided)</u>		
	(i) Type		
	(ii) Number of pumps	No.	
	(iii) Capacity of each pump	m ³ /hr	

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	(iv) Total dynamic head	mlc	
	(v) Drive motor rating	kW	
	(VI) Other details of the system like oil cleaning system, Coolers etc.		
1.3.26.7	Oil Cooler i) Number , working / standby ii) Type iii) Capacity of Cooling the oil iv) Cooling water requirement - quantity Pressure drop across cooler – water side Oil side v) Water temp. rise vi) Oil inlet temp. vii) Oil outlet temp. viii) Tube size ,OD x thickness ix) Mountings	Litre/min. Litre/min. kg/cm ² kg/cm ² Deg. C Deg. C Deg. C mm	
1.3.26.8	<u>Main Oil tank Filter</u> i) Number ii) Type iii) Filtration size iv) Location v) Is Removable during operation?	micron	

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1.3.26.9	Duplex oil filter i) Filtration type ii) Maximum allowable differential pressure		
1.3.26.9	Vapour extractors		
	(i) Number	No.	
	(ii) Capacity	Nm ³ /h	
	(iii) Type		
	(iv) Drive motor rating	kW	
	(v) Is lube. oil moisture eliminator provided?		
1.3.26.11	Pressure, Temperature & Level switches for interlocking signalling and protection for the Oil system i) Number ii) Set point and adjustment range iii) Contact type and ratings iv) Location v) Is oil sight flow indicators at all bearings provided?		

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1.3.26.12	<u>Lube Oil Conditioning Equipment</u>		
	(i) Type of conditioner		
	(ii) Capacity of unit	m ³ /h	
	iii) Size of solids in the purified oil at the outlet of the polishing filter at rated capacity (specify also the max. water content in %)	microns % moisture	
	iv) Size of solids in the oil at the outlet of the centrifuge but before the polishing filter at rated capacity (specify also the max. water content in %)	microns % moisture	
	v) Centrifuging temperature	deg C	
13.26.13	Oil Pumps		
a)	Type		
b)	Manufacturer		
c)	Capacity	Lit/min	
d)	Total head	kg/cm ²	
e)	Max. permissible suction lift at rated capacity	mlc	
f)	Pump speed	rpm	
g)	Power required at the rated operating conditions	kW	
h)	Efficiency of the pump at the		

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	operating conditions		
i)	Relief valve		
	a) capacity	Lit/min	
	b) setting pressure range	kg/cm ²	
1.3.26.14	<u>Centrifuge</u>		
a)	Manufacturer		
b)	Type and model number		
c))	Bowl capacity	Lit.	
d)	Speed of the centrifuge		
e)	Motor rating	kW	
f)	Method of signalling loss of water seal in centrifuge and/or excessive water in oil		
1.3.26.15	<u>Oil heater</u>		
a)	Manufacturer		
b)	Type and model number		
c)	Rated capacity	Litre	
d)	Design oil inlet temp.	Deg.C	
e)	Design oil outlet temp.	Deg.C	
f)	Is gauge glass provided		

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SL. NO.	ITEM	UNIT	

1.3.26.16	<u>Heating elements</u> a) number & rating b) Type of construction c) power supply d) no. of thermostat -		
1.3.26.17	<u>Polishing filter</u>		
a)	Manufacturer		
b)	Type and model number		
c)	Rated capacity	Lit/hr	
d)	Pressure drop at rated capacity - normal - maximum	KSC	
e)	Filtering surface	m ²	
f)	Filtering elements - type - is reusable after cleaning?		
g)	Filter vessel - dimensions (OD x height)	mm	
1.3.26.18	<u>Central oil storage tank</u>		
a)	Capacity	Lit.	
b)	No. of compartment		

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c)	Overall dimension		
d)	Level gauge details		
e)	Weight	kg	
1.3.26.19	<u>Oil pumps</u>		
a)	Type		
b)	Manufacturer		
c)	Capacity	Lit/min	
d)	Total head	kg/cm ²	
e)	Max. permissible suction lift at rated capacity	mlc	
f)	Pump speed	rpm	
g)	Power required at the rated operating conditions	kW	
h)	Efficiency of the pump at the operating conditions	%	
1.3.27	Gland Seal System		
a)	Sources of gland sealing steam		
	(i) During normal operation		
	(ii) During low load operation (indicate range of load also)		

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	(iii) Type of shaft seals		
	(iv) Type of seal rings		
	(v) Automatic seal regulator a) Quantity of sealing steam b) Pressure of sealing steam c) Type of Seal steam pressure regulator d) Point of steam tapping		
1.3.28	<u>Gland steam Condenser</u> i) Type ii) Capacity iii) Maximum condensate flow, iv) Water velocity maximum in the tubes. v) Tube side design pressure vi) Condensate pressure drop vii) Heat transfer surface, tube side viii) Accessories	t/h m/sec. kg/cm ² kg/cm ² m ²	
b)	Minimum condensate flow required through full condensate flow gland steam condenser	t/h	
c)	Exhauster for gland steam condenser		
	i) Type ii) Number iii) Speed	No rpm	

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	iv) Drive motor rating	kW	
1.3.29	Flash tanks i) Number ii) Type iii) Size iv) Are distributors provided?	no mm	
1.3.30	Turbine Control & Protection System		
a)	Main Governor i) Type ii) Steady state speed regulation iii) Steady state incremental speed regulation - First 15% of rated power - Last 10% of output iv) Speed regulator dead band v) Governing range		
b)	Speed changer i) Type		

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	ii) Synchronising range iii) Range of adjustment of load		
c)	Load limit devices: i) Type ii) Range of adjustment of load limit		
d)	Initial pressure regulator (if provided as part of EHG) : i) Type ii) Set pressure of operation		
e)	Vacuum unloading device (if provided as part of EHG) I) Type II) Set value of condenser pressure for operation		
f)	<u>Emergency overspeed trip governor</u> i) Type ii) No. of independent devices iii) Set operating speed iv) Range of adjustment v) No. of actuation signalling contacts provided vi) Is arrangement for testing with unit in operation (on-load test) made?		

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g)	<u>Thrust bearing excess wear trip</u>		
h)	<u>Condenser very low vacuum trip</u>	kg/cm ² (a)	
j)	Lube oil pressure very low trip	kg/cm ² (a)	
k)	Control oil pressure very low trip	kg/cm ² (a)	
l)	Relative vibration high trip	Microns	
m)	Main steam temperature high trip	⁰ C	
n)	<u>High exhaust hood temperature trip</u>	⁰ C	
o)	Top and bottom casing differential temperature high trip	⁰ C	
p)	<u>HP exhaust steam temperature high trip</u>	⁰ C	
q)	Top and bottom casing differential expansion high trip	mm	
r)	<u>Bearing metal temperature high trip</u>	⁰ C	
s)	Is manual trip from control room and local provided?		
t)	Turbine Shaft vibration very high trip	microns	
u)	Is manual trip lever provided on		

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	turbine front pedestal		
1.3.30.1	Pressure relief disc		
a)	Type		
b)	Number		
c)	Lifting pressure	kg/cm ² (a)	
1.3.31	<u>Load limitations, in percent of rated load, if any, for testing full closure of</u>		
a)	Main stop valves	%	
b)	HP turbine governor valves	%	
c)	Interceptor valves	%	
1.3.32	HP / LP Bypass Valves		
a)	Number		
b)	Manufacturer		
c)	Type of actuator		
d)	Capacity per valve	t/h	
e)	Opening time of each valve	secs	
f)	Closing time of each valve	secs	
g)	Spray valves		
	i) Type		

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	ii) Size iii) Spray quantity at different loads iv) Spray water pressure v) Type of pressure control vi) Type of temperature control	m ³ /hr kg/cm ²	
h)	Type of actuator of main valves		
i)	Type of actuator of spray valves		
j)	Oil supply unit i) Type ii) No. of pumps iii) Capacity of tank iv) Method of purification of oil v) Capacity of accumulator	no m ³ m ³	
1.3.33	Steam turbine generator capability under different combinations of more than one closed feed water heater out of service (either adjacent or non-adjacent) <u>Rated output.</u> i) Turbo generator rated output with design extraction flow ii) Turbo generator rated output with no extraction flow iii) Turbo generator rated output with no extraction flow to HP	MW MW MW MW	

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SL. NO.	ITEM	UNIT	

	heaters		
1.3.34	Turbine supervisory instrument		
a)	Bearing vibration (Amplitude/ Velocity) i) Type of sensing element ii) Type of indicator iii) Type of Recorder		
b)	Axial shift of rotor i) Type of sensing element ii) Type of Indicator iii) Type of Recorder		
c)	Casing & differential expansion i) Type of sensing element ii) Type of Indicator iii) Type of recorder		
d)	Shaft Eccentricity i) Type of sensing element ii) Type of recorder iii) Type of indicator		
e)	Control valve position i) Type of sensing element		

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	ii) Type of recorder iii) Type of indicator		
f)	Turbine speed i) Type of sensing element ii) Type of recorder iii) Type of indicator		
g)	Turbine Acceleration i) Type of sensing element ii) Type of indicator		
h)	Metal Temperatures i) Type of sensing element ii) Type of recorder iii) Location of sensing element		
1.3.35	Materials of Construction (Indicate to which standard it conforms to)		
1.3.35.1	Turbine Casings		
	(i) HP outer casing / barrel casing		
	(ii) HP inner casing and blade carriers		
	(iii) IP inner/outer casing		

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	(iv) LP outer casing		
	(v) LP inner casings and blade carriers		
1.3.35.2	<u>Turbine Shaft</u>		
1.3.35.3	Moving Blades		
	(i) Turbine first stages		
	(ii) Turbine other stages i) ____ to ____		
	ii) ____ to ____		
1.3.35.4	Fixed Blades		
	(i) Turbine first stages		
	(ii) Turbine other stages i)____ to ____		
	ii)____ to ____		
1.3.35.5	Casing Joint bolts		
	- Type		

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

	- Number - Diameter, - Kinds of threads - Material of bolts - Steam heating of bolts - Allowable stress at 500 Deg.C	mm	
1.3.35.6	<u>Shaft Couplings bolts</u>		
1.3.35.7	<u>Sealing Strips</u> - Casing - Fixed blades - Rotor		
1.3.35.8	<u>Main Steam Admission Valves</u>		
	(i) Valves body		
	(ii) Valve spindle		
	(iii) Valve seat		
1.3.35.9	<u>Reheat Steam Admission Valves</u>		
	(i) Valve body		
	(ii) Valve spindle		
	(iii) Valve seat		
1.3.35.10	HP / LP Bypass valves		
	(i) Valve body		
	(ii) Valve spindle		
	(iii) Valve seat		
1.3.35.11	CRH valves		

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	(i) Valve body		
	(ii) Valve spindle		
	(iii) Valve seat		
1.3.35.12	Extraction valve		
	(i) Valve body		
	(ii) Valve spindle		
	iii) Valve seat		
1.3.35.13	Gland steam condenser (i) Shell (ii) Tube (iii) Tube sheet		
1.3.35.14	Gland steam exhauster (i) Impeller (iii) Shaft (iii) Casing		
1.3.35.15	Main oil tank		
1.3.35.16	Main oil pump (i) Shaft (ii) Impeller/runner		

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	(iii) Casing		
1.3.35.17	Auxiliary oil pump (i) Shaft (ii) Impeller/runner (iii) Casing		
1.3.35.18	Turning gear (i) Nozzle (ii) Runner blades		
1.3.35.19	Jacking oil pump (i) Shaft (iii) Runner/impeller (iii) Casing		
1.3.35.20	<u>Control oil pump (if provided)</u> (i) Shaft (ii) Impeller/runner (iii) Casing		
1.3.35.21	Oil cooler		

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	(i) Shell (ii) Tube		
1.3.35.22	Lube oil piping from oil cooler to turbine bearings		
1.3.35.23	MOT oil filter Filter element		
1.3.35.24	Duplex filter Filter element		
1.3.35.25	Oil vapour extractor (i) Shaft (ii) Impeller (iii) Casing		
1.3.35.26	Centrifuge (i) Casing (ii) Shaft (iii) Bowl and internals		
1.3.35.27	Oil filter (i) Shell (ii) Tube		

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	(iii) Heating element		
1.3.35.28	Polishing filter (i) Element (ii) Vessel		
1.3.35.29	Central oil storage (i) Tank (ii) Pumps (iii) Shaft (iv) Runner/impeller (v) Casing		
1.3.35.30	Lube oil conditioning equipment <u>Pumps</u> (i) Shaft (ii) Impeller (iii) Casing		
1.3.35.31	Flash tank (i) Shell (ii) Nozzle		
1.4	Construction Features and Other		

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	Data		
1.4.1	Number of cylinders		
1.4.2	Bearing i) Journal bearings (ii) Number (iii) Size (iv) Type (v) Optimum operating Temp. (vi) Lining material (vii) Thrust bearings: – Number – Size – Type – Optimum operating Temp. – Lining material – High wear or failure detector		
1.4.3	Number of Turbine stages		
	a) Number of impulse stages	No.	
	b) Number of reaction stages	No.	
	Method of construction		
	Diameter of the tips of the first row of blades		

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1.4.4	First stage diameter	mm	
1.4.5	Length of last LP blades	mm	
1.4.6	Tip diameter of last LP blade	mm	
1.4.7	Maximum peripheral velocity of last LP blades	m/sec	
1.4.8	Annulus area of last LP stage	m ²	
1.4.9	Method of moisture removal in last LP stage		
1.4.10	Type of blade protection against moisture erosion in LPT		
1.4.11	Number of low pressure stages of LPT protected against moisture erosion		
1.4.12	External connections i) Main steam ii) Cold reheat iii) Hot reheat iv) 1 st extraction E1 v) 2 nd extraction E2 vi) 3rd extraction E3 vii) 4 th extraction E4 viii) 5 th extraction E5 ix) 6 th extraction E6		

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	x) 7 th extraction E7 xi) Inter-stage drains xii) Outlet connection		
1.4.13	<u>Permissible forces & moment at turbine connection flange</u> <u>(furnish the following data for each connection separately)</u> i) <u>Forces in kgs.</u> - Fx (Axis of turbine rotor) +/- - Fy (Lateral) +/- - Fz (Vertical) +/- ii) <u>Moment in kg-m</u> - Mx - My - Mz iii) Movements in directions - X - Y - Z		
1.4.14	Turbine movements i) Location of turbine anchor point ii) Movement of the connection flanges for main steam during		

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	heating up of the turbine, mm – Indicate for each module of the turbine Indicate Direction (For each separately) DEL X DEL Y DEL Z		
1.4.15	Type of joint to the condenser		
1.4.16	Type of antifriction material used in bearings		
1.4.17	Couplings i) Number ii) Location iii) Type iv) Size v) No. and size of bolts		
1.4.18	Schedule of major overhauling and minor over hauling of main turbine, bearings, main stop/control valves etc.		
1.5	<u>Codes and Standards for</u>		
1.5.1	Fluctuations / limitation or variations of pressure / temperature at turbine throttle and reheat inlet steam		

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	temperature		
1.5.2	Governor performance characteristics		
1.5.3	Design and construction code for turbine		
1.5.4	Specification for turbine lubrication oil		
1.5.5	Specification for turbine control fluid		
1.5.6	Performance testing of steam turbine		
1.5.7	Any other Codes / Standards		
1.6	Weights		
1.6.1	Name and weight of the heaviest piece to be handled during erection	Tonnes	
1.6.2	Name and weight of the heaviest piece to be handled by the station EOT crane during maintenance	Tonnes	
1.6.3	Total Weight of the equipment	Tonnes	
1.7	Turbine maintenance schedule a) Interval of minor maintenance (without opening the casing) -Maintenance work to be carried out b) Interval of major overhaul - Maintenance work to be carried out c)Recommended duration of Major overhaul .	Days	

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	d) Recommended duration of minor overhaul.	Days	

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1.1	General		
1.1.1	Manufacturer		
1.1.2	Type of condenser		
1.1.3	Orientation of condenser tube axis		
1.1.4	Number of surface condensers per ST unit	No.	
1.1.5	Number of passes	No.	
1.2	<u>Shell Side Design Conditions</u>		
1.2.1	Steam from turbine exhaust at turbine VWO condition at design cooling water temperature and 0% make-up.		
a)	Quantity	t/h	
b)	Pressure	kg/cm ² (a)	
c)	Temperature	⁰ C	
d)	Enthalpy	kcal / kg	
1.2.1	Steam from HP & LP bypass : (during turbine bypass operation)		
a)	Quantity	t/h	
b)	Pressure	kg/cm ² (a)	
c)	Temperature	⁰ C	
d)	Enthalpy	kcal / kg	
1.2.3	Drains from feed cycle at turbine VWO		

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	condition at design cooling water temp. and 0% make-up		
a)	Quantity	t/h	
b)	Pressure	kg/cm ² (a)	
c)	Temperature	° C	
d)	Enthalpy	kcal / kg	
1.2.4	Condensate make-up at turbine VWO condition at cooling water temp of 36 degree centigrade		
a)	Quantity	t/h	
b)	Temperature	° C	
1.2.5	Other steam / drains through flash box or directly to condenser at turbine VWO condition at design cooling water temp. and 0% make-up		
a)	Source		
b)	Quantity	t/h	
c)	Pressure	kg/cm ² (a)	
d)	Temperature	° C	
e)	Enthalpy	kcal / kg	

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1.2.6	Design heat load corresponding to turbine VWO condition with 5% margin	kcal / hr	
1.2.7	Design condenser back pressure	kg/cm ² (a)	
1.2.8	Condensate temperature at hot well outlet	⁰ C	
1.2.9	Temperature of air vapour mix at air cooler section	⁰ C	
1.3	Cooling water design parameters		
1.3.1	Flow quantity	m ³ /h	
1.3.2	Outlet temperature	⁰ C	
1.3.3	Cleanliness factor	%	
1.3.4	Velocity of water in tubes	m/sec	
1.3.5	Cooling surface	m ²	
1.4	Total friction loss across condenser	mlc	
	Tube Side Design Conditions		
1.5	Design Pressure and Temperature		
1.5.1	Design pressure (shall be equal or greater than shut off head of CW pumps)	kg/cm ² (g)	
1.5.2	Design temperature	⁰ C	

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1.5.3	Water box design pressure	kg/cm ² (g)	
1.5.4	Pressure drop across the tubes	kg/cm ²	
1.5.5	Terminal temperature difference /LMTD of condenser	⁰ C	
1.6	<u>Materials of Construction</u> (Indicate to which standard it conforms to)		
1.6.1	Shell		
1.6.2	Shell flanges		
1.6.3	Condenser neck		
1.6.4	Water boxes		
1.6.5	Tube sheets		
1.6.6	Tubes in condensing zone		
1.6.7	Tubes in air cooling zone		
1.6.8	Tube support plates		
1.6.9	Structural parts		
1.6.10	Bolts		
1.6.11	Nuts		
1.6.12	Gaskets on water side		
1.6.13	Water box lining and thickness of lining		
1.6.14	Impingement baffles		
1.6.15	Coating material on tube sheets and		

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	thickness of coating		
1.6.16	Hot well		
1.6.17	expansion joint		
1.6.18	Internal piping		
1.7	Construction Features		
1.7.1	Connection between turbine exhaust and condenser		
1.7.2	Vertical expansion taken by		
1.7.2A	Details and number of support springs(if provided) Movement of springs in hot condition and when condenser is filled with water Details of condenser neck welding/fixing of LP cylinder exhaust		
1.7.3	Protection of condenser tubes from erosion by exhaust steam impingement		
1.7.4	Method of dispersing drains, make-up water etc., into condenser		
	(a) Whether steam throw-off device is provided for bypass steam entry into condenser		
	(b) Details of same		
1.7.5	Provision made to take differential expansion between tubes and shell		

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1.7.6	Attachment of tube sheets to shell		
	<u>Shell</u> a) Thickness of plates, b) Nozzles provided in the shell c) Expansion joints provided in the shell d) Overall dimensions	mm (mm x mm)	
1.7.7	Details of tubes in condensing section :		
a)	Outer diameter	mm	
b)	Thickness	BWG	
c)	Total number	No.	
d)	Tolerance on OD and wall thickness		
1.7.8	Details of tubes in air cooling section :		
a)	Outer diameter	mm	
b)	Thickness	BWG	
c)	Total number	No.	
1.7.9	Effective condenser tube length (length between faces of tube sheets)	mm	
a)	Are the tubes individually tested at shop "by Ultrasonic test."		
b)	Individual tube hydrotest pressure at shop	kg/cm ²	
c)	Tube sheet thickness		

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d)	Size of tube sheet		
1.7.10	Method of securing tubes to tube sheets		
1.7.11	Are tubes belled at inlet end .		
1.7.12	Do tubes at exit end protrude beyond face of tube sheet? If so, give length of protrusion		
1.7.13	Details of tube support plates :		
a)	Minimum spacing	mm	
b)	Maximum spacing	mm	
c)	Thickness	mm	
d)	No. of tube support plates	Nos.	
1.7.14	Details of water boxes :		
a)	Shape of water boxes		
b)	Depth	m	
c)	Type of connection between water box and shell		
d)	Are water boxes divided?		
e)	Are water box manhole covers hinged for quick opening ?		
1.7.15	Size of C.W. connection		
	(i) Inlet nozzles	mm	
	(ii) Outlet nozzles	mm	

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1.7.16	Are suitable drain and vent connection complete with necessary no. of valves provided for all water box compartments?		
1.7.17	Are safety guards provided in the CW connections which run vertically down from water boxes to prevent personnel from falling in?		
1.7.18	Details of hotwell :		
a)	Length	m	
b)	Breadth	m	
c)	Depth	m	
d)	thickness	mm	
e)	Volume of condensate stored at normal level	m ³	
f)	Is hotwell divided ?		
g)	Is provision made for installing conductivity cell in each section of hotwell?		
h)	Is screen provided at the outlet of hotwell (suction to condensate extraction pump)?		
i)	Details of level instruments for hot well		

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SPECIFICATION NO. TCE.5750A-H-500-001	TATA CONSULTING ENGINEERS LIMITED		VOLUME III
	RRVUNL RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATA SHEET B 2 STG and their auxiliaries SURFACE CONDENSER AND ACCESSORIES		SHEET 9 OF 9
ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

j)	No. and size of condensate outlet nozzle		
k)	No. and size of access door for hot well		
1.8	Bosses for anodes of cathodic protection		
1.9	Weights		
1.9.1	When equipment completely filled with water	kg	
1.9.2	Empty	kg	
1.9.3	Water boxes	kg	
1.10	Codes and Standards		
1.10.1	Heat Exchange Institute Standards for Steam Surface Condenser		
1.10.2	American Society of Mechanical Engineers		
1.10.3	ASME Performance Test Code for Condensers		
1.10.4	American Society for Testing Materials		
1.10.5	Any other Codes & Standards		

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	RRVUNL RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATA SHEET B 3 STG and their auxiliaries CONDENSER AIR EVACUATION EQUIPMENT AND ACCESSORIES	SHEET 1 OF 3

ENQUIRY/SPECIFICATION NO.:	BIDDER:

SL. NO.	ITEM	UNIT	

1.1	Number of vacuum pump sets per STG	Nos.	
1.2	Manufacturer		
1.3	Model number	No.	
1.4	Guaranteed capacity of pump	scfm	
1.5	Speed of pump	rpm	
1.6	Number of stages per pump	Nos.	
1.7	Is ejector provided?		
1.8	Volume of surface condenser, turbine steam space and piping	m ³	
1.9	HEI standard conditions for air suction		
1.10	Source of sealing water		
1.11	Cooling water		
1.11.1	Quality		
1.11.2	Design temperature	⁰ C	
1.11.3	Design pressure	kg/cm ² (g)	
1.12	Type of coupling		
1.11	Guaranteed noise level at 1.5 m from outline of the equipment	dBA	
1.14	Guaranteed vibration level	microns	
1.15	Seal water circulation pumps		

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

1.17.2	HEI Standards Performance Standard for Liquid Ring Vacuum pumps		
1.17.3	ASME Standards		
1.17.4	TEMA Standards		
1.17.5	Hydraulic Institute Standards		
1.17.6	Any other Codes & Standards		

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	RRVUNL RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATA SHEET B 4 STG and their auxiliaries CONDENSER EXTRACTION PUMPS AND ACCESSORIES		SHEET 1 OF 5
ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

1.1	General		
1.1.1	Manufacturer		
1.1.2	Model Number	No.	
1.1.3	Number of pumps offered per ST Unit	No.	
1.1.4	Type of pump		
1.2	Design Data		
1.2.1	Design capacity per pump	m ³ /h	
1.2.2	Runout flow per pump	m ³ /h	
1.2.3	Minimum flow per pump	m ³ /h	
1.2.4	Maximum temp. rise under minimum flow	Deg.C	
1.2.5	Suction pressure at design capacity	mlc	
1.2.6	Discharge pressure at design capacity	mlc	
1.2.7	Total head at design capacity	mlc	
1.2.8	Shut-off head	mlc	
1.2.9	NPSH available (at minimum hot well level)	mlc	
1.2.10	NPSH required		
1.2.10.1	at design point	mlc	
1.2.10.2	at run out point	mlc	

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

1.2.10.3	Total head loss in the suction line	mlc	
1.2.11	Rated speed	rpm	
1.2.12	Pump efficiency at design point	%	
1.2.13	Pump power requirement at design point	kW	
1.2.11	Drive motor rating	kW	
1.2.15	Suction specific speed	US units	
1.2.16	Critical speed	rpm	
1.2.17	Maximum vibration level	mm/s	
1.2.19	Noise level	dBA	
1.2.20	Sealing water requirement	m ³ /hr	
	Cooling water requirement a)Flow b) Inlet temperature c)Supply pressure	m ³ /h °C kg/cm ² (g)	
1.3	Liquid Data		
1.3.1	Liquid handled		
1.3.2	Temperature range	° C	
1.3.3	pH value		

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ENQUIRY/SPECIFICATION NO.:	BIDDER:

SL. NO.	ITEM	UNIT	

1.5	Construction Features		
1.5.1	Number of stages	Nos.	
1.5.2	Internal element offered		
1.5.3	Type of suction impeller		
1.5.4	Type of coupling offered		
1.5.5	Location of suction nozzle		
1.5.6	Type of seal offered		
1.5.7	Type of lubrication		
1.5.8	Suction & Discharge connection size,	mm	
1.5.9	Maximum reverse runway speed	rpm	
1.5.10	a) <u>Pump bearing</u> (i) Manufacturer (ii) Type b) <u>Thrust bearing</u> (i) Manufacturer (ii) Type (iii) Whether provided on the pump?		
1.5.11	Weight a) Completely assembled pump b) Rotating assembly c) Motor	kg kg kg	

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ENQUIRY/SPECIFICATION NO.:			BIDDER:	
SL. NO.	ITEM	UNIT		

1.15.12	Dimensions a)Overall height b)Length of pump canister c) O.D. of pump canister d) Required pit dimension	mm mm mm mm	
1.6	Materials of Construction (Indicate to which standard it conforms)		
1.6.1	Mounting flange		
1.6.2	Discharge elbow		
1.6.3	Column pipe		
1.6.4	Suction bell		
1.6.5	Bowl or casing		
1.6.6	Suction strainer		
1.6.7	Diffuser and guide vane		
1.6.8	Impeller - first stage		
1.6.9	Impeller - other stages		
1.6.10	Shaft sleeves		
1.6.11	Canister		
1.6.12	Pump shaft		
1.6.13	Wearing rings		

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

1.6.11	Shaft seal		
1.6.15	Coupling		
1.6.16	Bolts & Nuts		
1.6.17	Gaskets		
1.7	<u>Codes and Standards</u>		
1.7.1	Condensate extraction pump		
a)	Mechanical design		
b)	Hydraulic design		
1.7.2	Design of pressure parts		
1.7.3	Testing of CEP		
1.7.4	Any other codes / standards		

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1.1	<u>General</u>		HP Heater	LP Heater
1.1.1	Model no.			
	No. of heaters	Nos.		
1.1.2	Heater manufacturer			
1.1.3	Type			
1.1.4	Orientation			
1.1.5	Type of extraction			
1.1.6	Number of tube passes			
1.2	<u>Design Data</u>			
1.2.1	Heat balance diagram number			
1.2.2	Shell Side Data			
a)	Design pressure	Kg/cm ² (g)		
b)	Design vacuum	mmHg (a)		
	Design flow normal	m ³ /h		
	abnormal	m ³ /h		
c)	Test pressure <u>Skirt</u> Shell	kg/cm ² (g)		
d)	Design temperature <u>Skirt</u>	⁰ C		

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	RRVUNL RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATA SHEET B 5 STG and their auxiliaries CLOSED FEED WATER HEATERS AND ACCESSORIES	SHEET 2 OF 9

ENQUIRY/SPECIFICATION NO.:	BIDDER:

SL. NO.	ITEM	UNIT	

	Shell			
e)	Fouling resistance	h-m^2 $^{\circ}\text{C/kcal}$		
1.2.3	Tube Side Data			
a)	Design pressure	kg/cm^2 (g)		
b)	Test pressure	kg/cm^2 (g)		
c)	Design temperature	$^{\circ}\text{C}$		
d)	Fouling resistance	H-m^2 $^{\circ}\text{C/kcal}$		
e)	Feed water/Condensate velocity through tubes at average operating temperature	m/sec		
1.2.4	De-superheating Section			
a)	LMTD	$^{\circ}\text{C}$		
b)	Heat Transfer Coefficient	kcal / h- $\text{m}^2^{\circ}\text{C}$		
c)	Heat transfer surface	m^2		
1.2.5	Condensing Section			
a)	LMTD	$^{\circ}\text{C}$		
b)	Heat Transfer Coefficient	kcal / h- $\text{m}^2^{\circ}\text{C}$		

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

c)	Heat transfer surface	m ²		
1.2.6	Drain Cooling Section			
a)	LMTD	⁰ C		
b)	Heat Transfer Coefficient	kcal / h- m ² ⁰ C		
c)	Heat transfer surface	m ²		
1.2.7	Whether heater is designed to handle additional thermal and hydraulic loads during abnormal operating conditions as specified			
1.3	Drain cooler for LP heaters			
1.3	General			
1.3.1	Model no.			
1.3.2	Manufacturer			
1.3.3	Type			
1.3.4	Orientation			
1.3.5	Number of tube passes			
1.3.6	Design Data			

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

1.3.6.1	Heat balance diagram number		
1.3.6.2	Shell Side Data		
a)	Design pressure	kg/cm ² (g)	
b)	Design vacuum	mmHg (a)	
c)	Test pressure <u>Skirt</u> Shell	kg/cm ² (g)	
d)	Design temperature <u>Skirt</u> Shell	° C	
e)	Fouling resistance	h-m ² ° C/kcal	
1.3.7	Tube Side Data		
a)	Design pressure	kg/cm ² (g)	
b)	Test pressure	kg/cm ² (g)	
c)	Design temperature	° C	
d)	Fouling resistance	h-m ² °C/kcal	
e)	Condensate velocity through tubes at average operating temperature	m/sec	

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ENQUIRY/SPECIFICATION NO.:	BIDDER:

SL. NO.	ITEM	UNIT	

1.3.8	Construction Features			
1.3.8.1	Shell			
a)	Outside diameter (OD)	mm		
b)	Thickness	mm		
1.3.8.2	Overall length of heater	mm		
1.3.8.3	Type of joint between shell and tube sheet			
1.3.8.4	Type of joint between tube sheet and channel			
1.3.8.5	Type of joint between tube and tube sheet			
1.3.8.6	Corrosion allowance			
1.3.8.6.1	Shell side	mm		
1.3.8.6.2	Channel side excluding tubes	mm		
1.3.8.7	<u>Tubes</u>			
1.3.8.7.1	Tube type			
1.3.8.7.2	Total number of tubes	No.		
1.3.8.7.3	Tube OD	mm		
1.3.8.7.4	Tube thickness	mm		
1.3.8.7.5	Effective length of tubes	mm		
1.3.8.7.6	Tube Sheet thickness	mm		

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ENQUIRY/SPECIFICATION NO.:	BIDDER:

SL. NO.	ITEM	UNIT	

1.3.8.7.7	Minimum cladding thickness_in tube sheet	mm		
1.3.8.8	<u>Channel</u>			
1.3.8.8.1	Type			
1.3.8.8.2	Shape			
1.3.8.8.3	Removable partition			
1.3.8.8.4	Channel pass partition plates thickness	mm		
1.3.8.9	Shell Relief Valves			
1.3.8.10	Channel Relief Valves			
1.3.8.11	Is gauge glass and other instruments provided			
1.3.8.12	<u>Corrosion allowance</u>			
1.3.8.12.1	<u>Channel side excluding tubes</u>			
1.3.8.12.2	<u>Shell side</u>			
1.3.8.12.3	Whether safety valve provided on tube and shell side.?			
1.4	<u>Drain Cooler</u>			

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

1.4.1	Shell a)Outside diameter b) thickness	mm mm	
1.4.2	Tube a) type b) total number c) O.D and thickness d) Length of tubes	nos mm mm	
1.4.3	Channel a) Type b) Shape c) Type of joint between tube sheet and channel		
1.4.4	<u>Terminal temperature difference or LMTD</u>		
1.5	<u>Materials of Construction</u> (Indicate to which standard it conforms to)		
1.5.1	Shell		
1.5.2	Shell skirt		
1.5.3	Shell cover		
1.5.4	Shroud of desuperheating zone		

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ENQUIRY/SPECIFICATION NO.:	BIDDER:

SL. NO.	ITEM	UNIT	

1.5.5	Shroud of drain cooling zone			
1.5.6	Shell flange			
1.5.7	Cross baffles			
1.5.8	Support plates			
1.5.9	Tie rods			
1.5.10	Spacers			
1.5.11	Shell nozzles			
1.5.12	Shell nozzles flanges			
1.5.13	Tubes			
1.5.14	Tube sheet			
1.5.15	Tube sheet cladding material			
1.5.16	Channel cover			
1.5.17	Access cover			
1.5.18	Channel pass partition plate			
1.5.19	Channel nozzles			
1.5.20	Gaskets			
a)	Steam side			
b)	Water side			
1.5.21	Bolting material			
a)	Bolts			
b)	Nuts			

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

1.5.22	Drain Cooler a) Shell b) Tube c) Channel d) Tube sheet		
1.6	Codes and Standards		
1.6.1	Thermal design		
1.6.2	Mechanical design		
1.6.3	Design of pressure parts		
1.6.4	Any other codes / standards		

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	RRVUNL RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATA SHEET B 6 STG and their auxiliaries DEAERATOR , FEED WATER TANK AND ACCESSORIES	SHEET 1 OF 6

ENQUIRY/SPECIFICATION NO.:	BIDDER:

SL. NO.	ITEM	UNIT	

1.1	General		
1.1.1	Type of deaerating feed water heater		
1.1.2	Number of deaerating feedwater heater(s) per steam turbine unit	No.	
1.1.3	Manufacturer		
1.2	Design Conditions		
1.2.1	Feed water outflow	t/h	
1.2.2	Temperature of deaerated water	⁰ C	
1.2.3	Condensate inflow	t/h	
1.2.4	Temperature of condensate inflow	⁰ C	
1.2.5	Heating steam quantity	t/h	
1.2.6	Heating steam pressure	kg/cm ² (a)	
1.2.7	Heating steam temperature	⁰ C	
1.2.8	Steam / flashed drains into deaerator		
	<u>Description</u>	t/h	⁰ C kg/cm ² (a)
(a)			
(b)			
1.2.9	Steam / flashed drains into deaerating feedwater storage tank		

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

(a)					
(b)					
(c)					
1.2.10	Deaerating heater operating pressure	kg/cm ² (a)			
1.2.11	Pegging steam pressure at low loads / part loads	kg/cm ² (a)			
1.2.12	Pegging steam temperature at low loads / part loads	⁰ C			
1.2.13	Load range as percent of TG MCR for pegging steam	%			
1.2.14	Whether heating steam rakes are provided in deaerating feed water storage tank, if applicable?				
1.2.15	Is a separate, initial heating steam rake provided? (if applicable)				
			Deaerator	Feed water storage tank	
1.2.16	Design pressure	kg/cm ² (g)			
1.2.17	Design temperature	⁰ C			
1.2.18	Terminal temp difference or LMTD	⁰ C			

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ENQUIRY/SPECIFICATION NO.:	BIDDER:

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1.3	Sprayer Assembly Details			
1.3.1	Number of sprayer assemblies	No.		
1.3.2	Sprayer assembly type			
1.3.3	Manufacturer of sprayer assembly			
1.3.4	Condensate flow through each spray assembly	t/h		
1.3.5	Pressure drop under design condensate flow	kg/cm ²		
1.3.6	Material of sprayer assembly			
1.3.7	Material of splash plate			
1.3.8	Material of Spray valve assembly			
1.4	(Tray Details)			
1.4.1	Construction			
1.4.2	Tray thickness	mm		
1.4.3	Number of horizontal trays in one stack and number of stacks	No.		
1.4.4	Total number of trays	No.		
1.4.5	Material			
1.5	Vent System Details			
1.5.1	Deaerating feedwater heater vent steam flow	t/h		

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1.5.2	Number of uncontrolled vents	No.		
1.5.3	Number of controlled vents	No.		
	Construction details			
		mm		
	Length of storage tank	mm		
	Diameter storage tank	mm		
	Internal diameter	mm		
	Overall length	mm		
	Shell plate thickness	mm		
	Domed head thickness	m ³		
	Normal level capacity	m ³		
	High high level capacity	m ³		
	Low low level capacity	m ³		
	Total capacity	kg		
	Empty weight	kg		
	Flooded weight	kg		
	Operation weight	kg		
	Hydraulic test weight	mm		
	Corrosion allowance			
1.6	<u>Deaerator Details</u>			
1.6.1	Material of shell			
a)	Whether any portion of shell is clad?			

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1.7	<u>Feed Water Storage Tank Details</u>		
1.7.1	Supports for feed water storage tank		
	(a) Sliding type	No.	
	(b) Fixed type	No.	
1.7.2	Manholes		
	(a) Number	No.	
1.7.3	Material of shell and dished ends		
1.7.4	Material of splash plates		
1.7.5	Material of baffles		
1.7.6	Material of steam pipes		
1.7.7	Material of Internal bolting		
1.7.8	Material of Gaskets		
1.7.9	Material of Bolts and Nuts		
1.7.10	Are Gauge glass and other instruments as desired provided?		
1.7.11	Safety valve		
1.7.11.1	Capacity		
1.7.11.2	Setting pressure range		
1.7.11.3	Material		
a)	• Body		
b)	• Trim		

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c)	• Spring		
1.7.12	Is Overflow arrangement provided?		
1.7.13	Is vacuum breaking valve provided?		
	<u>Weight of total Deaerator</u>	MT	
1.8	Codes and Standards (Bidder to indicate the standard to which material of construction conforms.)		
1.8.1	Thermal design		
1.8.2	Mechanical design		
1.8.3	Design of pressure parts		
1.8.4	Any other codes / standards		

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

1.1	General			
1.1.1	Model No.	No.		
	Type			
1.1.2	Manufacturer			
1.1.3	Number of BFP sets per STG unit	Nos.		
1.1.4	Liquid handled			
1.2	Design and Performance Data		Main BFP pump	Booster pump
1.2.1	Design temperature of feed water	⁰ C		
1.2.2	Rated capacity	m ³ /h		
1.2.3	Inlet flow	m ³ /h		
1.2.4	Minimum flow through the pump	m ³ /h		
1.2.5	Runout flow (one pump at design speed)	m ³ /h		
1.2.6	Frequency range for the operation of the pump under rated flow			
1.2.7	Suction pressure at rated capacity	kg/cm ² (a)		
1.2.8	Discharge pressure at rated capacity	kg/cm ² (a)		
1.2.9	Total dynamic head at rated speed and capacity	mlc		
1.2.10	Interconnecting pipe losses including flow measuring device	mlc		

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1.2.11	Maximum shut off head	mlc		
1.2.12	NPSH required			
	(a) At design flow	mlc		
	(b) At best efficiency point	mlc		
	(c) At runout flow (one pump at design speed)	mlc		
	(d) during transient operation	mlc		
1.2.13	Efficiency at design point	%		
1.2.14	Power input to pump set (main pump, booster pump and lube oil pumps) at rated flow & head	kW		
1.2.14A	Time required for BFP to reach full flow condition from the time of getting ON signal	minutes		
1.2.15	Suction specific speed	US Units		
1.2.16	Critical speeds for pump & motor assembly	rpm		
1.2.17	Vibration - based on double amplitude at shaft near bearing housing at fundamental and its multiple frequencies	microns		
1.2.18	Type of coupling between :			
	a) Motor and BFP			
	b) Motor and booster pump			

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
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	Oil recommended		
1.2.19	<u>Duplex oil Filter</u>		
	Type		
	Make		
	Material		
	• Casing		
	• Filtering element		
1.2.20	Oil tank storage capacity		
1.2.21	oil cooler		
	a) Type		
	b) Shell material		
	c) Channel material		
	d) Tube sheet material		
	e) Tube material		
1.2.22	Oil pumps		AC Driven DC Driven
a)	Numbers		
b)	Type		
c)	Design capacity		
d)	Total head		
e)	Material		
	(i) Casing		
	(ii) Impeller		

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	(iii) Shaft			
1.2.23	Cooling water requirement	m ³ /h		
1.2.24	Noise level	dBA		
1.2.25	Maximum speed of BFP unit during reverse rotation due to back flow of water	rpm		
1.2.26	Permissible variation in load sharing between pumps	%		
1.3	Recirculation control a) Type b) Manufacturer c) Temperature raise when pump is operating under recirculation only	Deg. C		
1.4	<u>Construction Features of Boiler Feed Pump</u>		Main BFP pump	Booster pump
1.4.1	Casing type			
	Type of impeller			
1.4.2	Impeller arrangement			
1.4.3	Number of stages			
	Shaft seal			
	Cooling arrangement of seal			
1.4.4	Journal bearings, type			
1.4.5	Thrust bearing, type			

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

1.4.6	Type of axial balancing device			
1.4.7	BFP suction strainer			
	(a) Type			
	(b) Strainer mesh size, coarse / fine			
1.4.8	Type of foundation			
1.5	<u>Materials of Construction</u> (Indicate to which standard it conforms to)			
1.5.1	Inner casing			
1.5.2	Outer casing			
1.5.3	Impellers			
1.5.4	Diffusers / Volute			
1.5.5	Casing wearing rings material / hardness (BHN)			
1.5.6	Impeller wearing rings material / hardness (BHN)			
1.5.7	Shaft			
1.5.8	Shaft nuts			
1.5.9	Shaft sleeves			
1.5.10	Shaft sleeve nuts			
1.5.11	Stuffing box			
1.5.12	Stuffing box bushing			

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1.5.13	Balancing device			
1.5.14	Pressure bolting studs			
1.5.15	Nuts			
1.5.16	Base plate			
1.5.17	Suction and Discharge nozzle			
1.5.18	Suction strainer mesh			
1.6	Lubricating Oil System for each BFP			
1.6.1	Type of pump			
1.6.2	Number of pump	Nos.		
1.6.3	Pump speed	rpm		
1.6.4	Motor rating of pumps	kW		
1.6.5	Pump casing material			
1.6.6	Pump impeller material			
1.6.7	Number of full capacity lube oil coolers			
a)	Shell material			
b)	Channel material			
c)	Tube sheet material			
d)	Tube material			
1.7	Details of VFD provided in the bid			
1.8	Whether details of VFD indicated in the drawings enclosed with the offer			
1.9	Idle pump warmup system			

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
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1.10	Acoustic Enclosure		
1.11	Codes & Standards		
1.11.1	BF Pump & Booster pump		
	(a) Mechanical design		
	(b) Hydraulic design		
1.11.2	Design of pressure parts		
1.11.3	Testing of BFP		
1.11.4	Any other codes/standards		
1.12	<u>LP drain condensate pumps, (if applicable)</u>		
a)	Type of pump		
b)	Number of pumps for each unit		
c)	Capacity of each pump	m ³ /h	
d)	Type of bearing		
e)	No. of stages	no	
f)	Type of lubrication		
g)	Type of coupling		
h)	Type of seal		
i)	Thrust bearing type		
j)	Discharge pressure	kg/cm ²	
k)	Suction pressure	kg/cm ²	

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l)	NPSH	mlc	
m)	Shut off pressure	kg/cm ²	
n)	Motor rating	kW	
o)	Speed	rpm	
p)	Material (i) Casing (ii) Diffuser (iii) Impeller (iv) Shaft sleeves (v) Shaft (vi) Wearing rings		
1.12.1	Codes and standards		
a)	Mechanical Design		
b)	Hydraulic design		
c)	Testing of LP drain condensate pumps		
1.13	Hotwell makeup pumps		
1.13.1	Type of pump		
1.13.2	Number of pumps for each unit		
1.13.3	Capacity of each pump	m ³ /hr	
1.13.4	Discharge pressure	kg/cm ²	
1.13.5	Suction pressure	kg/cm ²	

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1.13.6	Total pump head	mlc	
1.13.7	Motor rating	kW	
1.13.8	Type of bearing		
1.13.9	Type of lubrication		
1.13.10	Type of seal		
1.13.11	Type of coupling		
1.13.12	No. of stages		
1.13.13	Speed		
1.13.14	<i>Material</i> a) Casing b) Impeller c) Shaft d) Shaft sleeves e) <i>Wearing rings</i>		
1.13.15	Codes and standards		
a)	Mechanical Design		
b)	Hydraulic design		
c)	Testing of hotwell makeup pumps		

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1.14	Condensate storage tank (CST)		
1.14.1	Number provided		
1.14.2	Capacity (effective)		
1.14.3	Type of tank		
1.14.4	Design pressure		
1.14.5	Design temperature		
1.14.6	Materials of construction		
1.14.6.1	Shell		
1.14.6.2	Nozzle		
1.14.7	Nozzle end connections provided		
1.14.8	Valves		
a)	Valve end connections		
1.14.9	<i>Protection provided</i>		
a)	<i>Internal surface of the tank</i>		
b)	<i>External surface of the tank</i>		
1.14.10	<i>Details of nozzles provided on the tank (Bidder to list the nozzles with service)</i>		

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SL. NO.	ITEM	UNIT	

1.14.11	<i>Type of ladder provided for the CST</i>		
1.14.12	<i>Details of level switches provided</i>		
	Steam turbine drives for BFP		
1.15	General		
1.15.1	Manufacturer		
1.15.2	Number of drive turbines offered	No.	
1.15.3	Steam admission		
1.15.4	Maximum noise level	dBA	
1.15.5	Operating speed range	RPM	
1.16	Design and Operating Conditions		
1.16.1	Steam Source		

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1.16.2	a) Steam condition at drive turbine inlet at full load i) Pressure ii) Temperature b) Minimum pressure, temp and flow required to roll the turbine ?	kg/cm ² (a) °C TPH	
1.16.3	Drive turbine operating speed	RPM	
1.16.4	Shaft Power	kW	
1.16.5	Steam consumption	TPH	
1.16.6	<i>Exhaust steam</i> i) Exhaust pressure at BFPTD outlet ii) Dryness fraction	kg/cm ² (a) X	
1.16.7	<i>Is drive turbine designed for full arc admission during start-up.</i>	Yes/No	

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SPECIFICATION NO. TCE.5750A-H-500-001	TATA CONSULTING ENGINEERS LIMITED		VOLUME III
	RRVUNL RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATA SHEET B 7 STG and their auxiliaries BOILER FEED PUMP AND ACCESSORIES		SHEET 13 OF 16
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SL. NO.	ITEM	UNIT	

1.16.8	Maximum allowable temperature at exhaust	°C	
1.17	Lube oil and control system		
1.17.1	Type of turbine oil		
1.17.2	Total oil system capacity	Lit	
1.17.3	Oil tank capacity	Lit	
1.17.4	Normal lube oil pressure	kg/cm ² (g)	
1.17.5	Oil flow through lubrication system	Lt/min	
1.17.6	When lube oil is used as the control fluid		
	i) Normal governing oil pressure	kg/cm ² (g)	
	ii) Oil flow through governing system	Lit/min	
1.17.8	Oil Pumps Type, Number and drive for i) Main oil pump ii) Auxiliary oil pump		

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	iii) Emergency oil pump		
1.17.9	Lube oil coolers a) Number of coolers furnished b) Numbers normally working		
	Note:- In case separate control oil system is offered by the Bidder, the information asked for lube oil system shall be submitted for control oil system also as applicable.		
1.17.10	Vapour extractor for lube oil tank		
a)	Number of extractors furnished		
b)	Numbers, normally working		
1.18	Materials of Construction of ST a) Casing b) Rotor c) Disc(if separately shrunk on to rotor) d) First stage moving blades e) First stage fixed blades f) Other stages fixed blades		

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

1.19	Construction features other data		
1.19.1	Journal Bearings a) Number & Location b) Type		
1. 19.2	Thrust Bearings a) Number & Location b) Type c) Provision for wear alarm furnished		
1.20	Tests		
1.20.1	Shop tests as specified		
1.20.2	Field and performance Tests		
	a) Turning gear running tests		
	b) Balancing tests and vibration checks c) Overspeed and tripping tests.		
	d) Demonstration of operation of governing system, on-load testing devices and other protective devices.		
	e) Full load rejection tests		
	f) Check for mechanical excellence and operational behaviour.		
	g) Tests to prove guaranteed performance		

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

	h) Quick start tests.		
1.21	Codes and Standards		
1.21.1	Design and construction code for drive turbines		
1.21.2	Performance testing of drive turbine		
1.22	Weights and Dimensions		
1.22.1	Overall length of drive turbine from the front standard to the turbine coupling.	m	

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

1.0	GENERAL		
1.1	Designation		
1.2	Manufacturer		
1.3	Type		
1.4	Number supplied and Number normally operating		
2.0	DESIGN DATA PER PUMP		
2.1	Capacity	m ³ /hr	
2.2	Total dynamic head	mlc	
2.3	Operating temperature range	°C	
2.4	Suction head	mlc	
2.5	Efficiency	%	
2.6	Speed	rpm	
2.7	Motor rating	kW	
2.8	Maximum allowable suction lift	mlc	
3.0	CONSTRUCTION FEATURES		

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

3.1	Type of coupling		
3.2	Packing type		
3.3	Type of bearing used	Int. / Ext.	
4.0	MATERIALS OF CONSTRUCTION		
4.1	Casing		
4.2	Rotor / Shaft		
4.3	Shaft sleeves		
4.4	Base plate		
4.5	Wearing rings (If required)		
5.0	Any other data – List Items		
6.0	All startup spares included as required		
7.0	All special maintenance tools as required		

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

1.0	HP BYPASS VALVES		HP		LP	
			Block valve	Control valve	Block valve	Control valve
1.1	Number					
1.2	Manufacturer					
1.3	Type of actuator					
1.4	Capacity per valve	t/h				
1.5	Opening time of each valve	secs				
1.6	Positioning time of each valve	secs				
1.7	Design pressure of each valve	Kg/cm ² (a)				
1.8	Design temperature of each valve	^o C				
1.9	Leakage class offered					
2.0	<u>MATERIAL OF CONSTRUCTION</u>					
2.1	Valve body					
2.2	Valve spindle					
2.3	Valve seat					
2.4	Valve stem					

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SL. NO.	ITEM	UNIT	

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

1.0	GENERAL		
1.1	Designation		
1.2	Manufacturer		
1.3	Tube supplier		
1.4	Type		
1.5	Number of gland steam condenser	Nos.	
1.6	Orientation		Vertical / Horizontal
1.7	Location		Indoor
1.8	Number of tube passes		
2.0	DESIGN DATA		
2.1	Shell Side Data		
2.1.1	Gland Steam		
	(a) Flow	t/h	
	(b) Inlet Temperature	°C	
	(c) Shell inlet pressure	kg/cm ² (a)	
	(d) Enthalpy	kcal/kg	

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

2.1.2	Drains leaving :		
	(a) Flow	t/h	
	(b) Temperature	⁰ C	
	(c) Enthalpy	kcal/kg	
2.1.3	Design pressure	kg/cm ² (g)	
2.1.4	Design vacuum	mmHg (a)	
2.1.5	Shell side test pressure	kg/cm ² (a)	
2.1.6	Shell side design temperature	⁰ C	
2.1.7	Fouling resistance	h.m ² ⁰ C / kcal	
2.2	Tube Side Data		
2.2.1	(a) Flow	t/h	
	(b) Inlet Temperature	⁰ C	
	(c) Outlet Temperature	⁰ C	
	(d) Inlet pressure	kg/cm ² (a)	
2.2.2	Design pressure	kg/cm ² (a)	
2.2.3	Test pressure	kg/cm ² (a)	

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

2.2.4	Design temperature	⁰ C	
2.2.5	Fouling resistance	h.m ² ⁰ C / kcal	
2.2.5a	Terminal temperature difference	⁰ C	
2.2.6	Condensate velocity through tubes	m/s	
2.3	Condensing section heat transfer surface	m ²	
3.0	GUARANTEED PERFORMANCE DATA		
3.1	Overall pressure drop on the tube side at the average operating temperature	kg/cm ²	
4.0	CONSTRUCTION FEATURES		
4.1	Shell		
4.1.1	Outside diameter (OD)	mm	
4.1.2	Thickness	mm	
4.2	Overall length of GSC	mm	
4.3	Type of joint between shell and tube sheet		

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

4.4	Type of joint between tube sheet and channel		
4.5	Type of joint between tube and tube sheet		Welded / Flanged
4.6	Corrosion allowance	mm	Welded / Flanged
	(a) Shell side		
	(b) Channel side excluding tubes		
4.7	Tubes		
4.7.1	Tube type		
4.7.2	Total number of tubes		
4.7.3	Tube OD	mm	
4.7.4	Tube gauge	BWG	
4.7.5	Tube length	mm	
4.8	Tube sheet thickness	mm	
4.9	Channel		
4.9.1	Type		Removable / Welded

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

4.9.2	Shape		
4.9.3	Thickness	mm	
4.10	Shell Relief valves		Included / Not included
4.11	Channel Relief Valves		Included / Not included
5.0	MATERIALS OF CONSTRUCTION		
5.1	Shell		
5.2	Shell cover		
5.3	Shell flange		
5.4	Cross baffles		
5.5	Support plates		
5.6	Tie rods		
5.7	Spacers		
5.8	Shell nozzles		
5.9	Shell nozzles flanges		
5.10	Tubes		

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

5.11	Tube sheet		
5.12	Channel		
5.13	Channel cover		
5.14	Access cover		
5.15	Channel nozzles		
5.16	Channel nozzle flanges		
5.17	Gaskets		
	(a) Steam side		
	(b) Water side		
5.18	Bolting Material		
5.18.1	Bolts		
5.18.2	Studs		
5.18.3	Nuts		
6.0	All accessories included to make system complete		Yes / No

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

7.0	Start-up spares as required		Included / Not included
8.0	Essential spares as specified		Included / Not included
9.0	Maintenance tools as required (BIDDER to furnish list)		Included / Not included
10.0	Special maintenance tools as required (BIDDER to furnish list)		Included / Not included
11.0	Deviations from specification if any ? (If yes, BIDDER shall include deviations in Schedule of Technical Deviations)		Yes / No
12.0	CODES AND STANDARDS		
12.1	Thermal design		
12.2	Mechanical design		
12.3	Design of pressure parts		
12.4	Any other codes / standards used. If yes, name the codes / standards		Yes / No

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SL. NO.	ITEM	UNIT			

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

1.0	GENERAL		
1.1	Designation		
1.2	Heater manufacturer		
1.3	Tube supplier		
1.4	Type		Shell / tube bundle removable
1.5	Orientation		Vertical / Horizontal
1.6	Location		Outdoor / Indoor
1.7	No. of heat exchanger		
2.0	DESIGN DATA		
2.1	Shell side medium		
2.2	Shell side flow	m ³ /h	
2.3	Shell side fluid inlet temperature	°C	
2.4	Shell side fluid outlet temperature	°C	
2.5	Shell side fouling resistance	h °C m ² /kcal	

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

2.6	Tube side medium		
2.7	Tube side flow	m ³ /h	
2.8	Tube side fluid inlet temperature	°C	
2.9	Tube side fluid outlet temperature	°C	
2.10	Tube side fouling resistance	h °C m ² /kcal	
2.11	LMTD	°C	
2.12	Maximum heat load	kcal/h	
2.13	Design heat duty	kcal/h	
2.14	Shell side design pressure	kg/cm ² (g)	
2.15	Tube side design pressure	kg/cm ² (g)	
2.16	Shell side design temperature	°C	
2.17	Tube side design temperature	°C	
2.18	Shell side test pressure	kg/cm ² (g)	

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

2.19	Tube side test pressure	kg/cm ² (g)	
2.20	Tube side fluid velocity	m/s	
2.21	Maximum shell side pressure drop	kg/cm ²	
2.22	Maximum tube side pressure drop	kg/cm ²	
3.0	CONSTRUCTIONAL FEATURES		
3.1	Tube type		U type / Straight / Straight – fin
3.2	No. of tube passes		
3.3	Tube OD x thick	mm x mm	
3.4	Shell OD x thick	mm x mm	
3.5	No. of tubes		
3.6	Effective surface area	m ²	
3.7	Type of joints between tube and tube sheet		Rolled / Welded
3.8	Shell side relief valve		Included / Not included

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	RRVUNL RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATA SHEET B 11 STG and their auxiliaries OIL COOLER HEAT EXCHANGERS		SHEET 4 OF 5
ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

3.9	Tube side relief valve		Included / Not included
3.10	Corrosion allowance on shell side	mm	
3.11	Corrosion allowance on tube side	mm	
3.12	Type of baffles		
3.13	Tube pitch	mm	
3.14	Type of pitch		Triangular / Square; Rotated / Non-rotated
4.0	MATERIALS OF CONSTRUCTION		
4.1	Shell		
4.2	Shell cover		
4.3	Channel		
4.4	Channel Cover		
4.5	Tube		
4.6	Tube Sheet		
4.7	Flanges		

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SPECIFICATION NO. TCE.5750A-H-500-001	TATA CONSULTING ENGINEERS LIMITED		VOLUME III
	RRVUNL RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATA SHEET B 11 STG and their auxiliaries OIL COOLER HEAT EXCHANGERS		SHEET 5 OF 5
ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

4.8	Gaskets		
4.9	Studs, Bolts & Nuts		
4.10	Nozzles		
4.11	Impingement plates		
4.12	Fin (If applicable)		
5.0	All start up spares required		Included / Not included
6.0	All essential spares as specified		Included / Not included
7.0	All special maintenance tools as required		Included / Not included
8.0	CODES AND STANDARDS		
	(Bidder to list out)		

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SPECIFICATION NO. TCE.5750A-H-500-001	TATA CONSULTING ENGINEERS LIMITED	VOLUME III
	RRVUNL RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATA SHEET B 12 STG and their auxiliaries FEED WATER CHEMICAL DOSING SYSTEM	SHEET 1 OF 2

ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	DESCRIPTION	AMMONIA DOSING SYSTEM	OXYGEN SYSTEM

1.1.0	No. of skids per unit		
1.2.0	PREPARATION TANK		If applicable (else, bidder to indicate)
1.2.1	No. of tanks per Skid		
1.2.2	Capacity		
1.2.3	Type		
1.2.4	Material of the tank		
1.2.5	Thickness		
1.2.6	Motorised Stirrer		
1.2.7	Breather with vent		
1.2.8	Type of agitator		
1.3.0	METERING TANK		If applicable (else, bidder to indicate)
1.3.1	No. of tanks per Skid		
1.3.2	Capacity		
1.3.3	Type		
1.3.4	Material of the tank		
1.3.5	Thickness		
1.3.6	Motorised Stirrer		
1.3.7	Low level switch		
1.3.8	Breather with vent		
1.3.9	Type of agitator		
1.3.10	Hand pump with flexible hose.		
1.4.0	METERING PUMP		If applicable (else, bidder to indicate)
1.4.1	Type of pump		
1.4.2	Mode of control		
1.4.3	No. of pumps motor assembly.		

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	RRVUNL RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATA SHEET B 12 STG and their auxiliaries FEED WATER CHEMICAL DOSING SYSTEM		SHEET 2 OF 2
ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	DESCRIPTION	AMMONIA DOSING SYSTEM	OXYGEN SYSTEM

1.4.4	Capacity (LPH)		
1.4.5	Discharge pressure (Kg/Cm ²)		
1.4.6	All Wetted parts of pumps.		
1.5.0	STRAINERS		
1.5.1	No. of strainers		
1.5.2	Type		
1.5.3	Material of screen		
1.5.4	Mesh Size		
1.6.0	PIPING		
1.6.1	Material		
1.6.2	Material code		
1.6.3	Diameter		
1.7.0	VALVES		
1.7.1	Body, Cover, Yoke & Trim Material		
1.7.2	Weld ends		
1.8.0	RATING		
1.8.1	Suction side		
1.8.2	Discharge side		

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	RRVUNL RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATA SHEET B 13 STG and their auxiliaries VARIABLE SPEED HYDRAULIC COUPLINGS		SHEET 1 OF 3
ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

1.1	Type		
1.2	Manufacturer		
1.3	Power transmission rating	kW	
1.4	Input motor speed	rpm	
1.5	Gear ratio		
1.6	Primary start-up speed		
1.7	Full load slip		
1.8	Secondary speed (maximum)		
1.9	Number of bearings / type		
1.10	<u>Performance</u>		
	(a)	Slip between impeller and runner at normal load	
	(b)	Maximum possible slip between impeller and runner at design ratings of drive	

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

		equipment.	
	(c)	Scoop tube minimum portion to start the unit	
1.11	Oil recommended		
1.12	Oil tank storage capacity		
1.13	Working oil cooler		
	(a)	Type	Duplex / Simplex
	(b)	Shell material	
	(c)	Channel material	
	(d)	Tube sheet material	
	(e)	Tube material	
1.14	Hydraulic coupling scoop tube actuator		
	(a) Make		
	(b) Type		

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

2.0	PERFORMANCE DATA AT BEST EFFICIENCY POINT		
	(100% TG MCR Operating condition)		
5.1	Power losses in hydraulic coupling / fluid drive	kW	
5.2	Overall efficiency of hydraulic coupling / fluid drive	%	
3.0	<u>MATERIALS OF CONSTRUCTION</u>		
3.1	Hydraulic coupling		
	(i)	Coupling wheels	
	(ii)	Coupling wheels casing	
	(iii)	Scoop tube	

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	RRVUNL RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATA SHEET B 14 STG and their auxiliaries RUBBER EXPANSION JOINT		SHEET 1 OF 2
ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

1.0	Expansion Joint Size	mm	
2.0	Pressure Drop through the Expansion Joint at Design Flow	bar	
3.0	Maximum Movements		
3.1	Axial Compression	mm	
3.2	Axial Elongation	mm	
3.3	Lateral Movement	mm	
3.4	Angular Deflection	mm	
3.5	Torsional Deflection	mm	
4.0	Materials of Construction		
4.1	As Per Specification and Data Sheet – A		YES / NO
5.0	Features of Construction		
5.1	Face to Face Dimension	mm	

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

5.2	Wall Thickness	mm	
5.2.1	Flange	mm	
5.2.2	Body	mm	
5.2.3	Arch	mm	
5.3	Steel Retaining Ring		
5.3.1	Thickness	mm	
5.3.2	Number of Segments		
5.4	Arch inner Diameter	mm	
5.5	Number of Control Units Per Expansion joint		

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	RRVUNL RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATA SHEET B 15 STG and their auxiliaries BUTTERFLY VALVES		SHEET 1 OF 4
ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

1.0	<u>SCOPE OF SUPPLY</u>		
1.1	Valve Size		
1.1.1	Nominal diameter	mm	
1.1.2	Internal diameter	mm	
1.2	Number of valves offered	No	
1.3	Companion flanges	Yes/No	
1.4	Valve supporting lugs supplied	Yes/No	
1.5	Lifting lugs provided	Yes/No	
1.6	Extension spindle provided	Yes/No	
1.7	Torque/limit switch mechanism supplied	Yes/No	
1.8	End limit switch provided	Yes/No	
1.9	Reduction gear unit supplied	Yes/No	
1.10	Valve position indicator provided	Yes/No	
1.11	Motor with actuator for valves above 200mm NB provided	Yes/No	

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	RRVUNL RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATA SHEET B 15 STG and their auxiliaries BUTTERFLY VALVES		SHEET 2 OF 4
ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

2.0	<u>TECHNICAL PARTICULARS</u>		
2.1	Valve operation time	Sec	
2.2	Flow	m ³ /hr	
2.3	Pressure		
2.3.1	Operating	kPa	
2.3.2	Maximum	kPa	
2.3.3	Design	kPa	
2.3.4	Maximum discharge differential	kPa	
2.4	Design temperature	°C	
2.5	Pressure drop at maximum flow when valve fully open	kPa	
2.7	Flange drilling standard		
2.8	Design pressure	kPa	
2.9	Body test pressure	kPa	
2.10	Disc test pressure	kPa	

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

2.11	Seat leakage test pressure	kPa	
2.13	Tolerance		
2.14	Valve end - Flanged/Water type		
2.15	Free straight length required upstream of valve/down stream valves	mm	
2.16	Weight of valve with accessories	kg	
2.17	Shipping dimensions	mm	
3.0	<u>MATERIALS OF CONSTRUCTION</u>	Materials Standard	
3.1	Body		
3.2	Disc		
3.3	Disc sealing		
3.4	Body seal ring		
3.5	Shaft		
3.6	Seal retaining ring		
3.7	Bearings		

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

3.8	Gear casing		
3.9	Gears		
3.10	Companion flanges		
3.11	Internal hardware		
3.12	External hardware		
4.0	<u>TESTS AND INSPECTION</u>		
4.1	Whether all the tests and inspection as specified are included?	Yes/No	

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	RRVUNL RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATA SHEET B 16 STG and their auxiliaries MISCELLANEOUS PUMPS		SHEET 1 OF 2
ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

1.	DESIGNATION		
2.	NUMBER OFFERED		
3.	DESIGN CAPACITY	m ³ /hr.	
4.	DIFFERENTIAL HEAD	mlc	
5.	SHUT-OFF HEAD	mlc	
6.	HYDROSTATIC TEST PRESSURE	kg/cm ² (g)	
7.	NUMBER OF STAGES		
8.	PUMP EFFICIENCY AT DUTY POINT	%	
9.	PUMP SPEED	RPM	
10.	PUMP BkW	kW	
11.	POWER INPUT TO DRIVER AT DUTY POINT	kW	
12.	NPSH REQUIRED	mlc	
13.	DRIVER EFFICIENCY	%	
14.	SUCTION NOZZLE		
15.	SIZE	mm	
16.	DISCHARGE NOZZLE		

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

17.	SIZE	mm	
18.	TYPE OF COUPLING		
19.	MINIMUM CAPACITY FOR CONTINUOUS OPERATION	m ³ /hr	
20.	EXTERNAL WATER REQUIREMENT FOR SEALING & COOLING		REQD / NOT REQD.
21.	WEIGHT OF BARE PUMP	kg	
22.	WEIGHT OF DRIVER	kg	
23.	WEIGHT OF COMMON BASE PLATE	kg	
24.	MOMENT OF INERTIA OF PUMP ROTOR	kg-m ²	
25	MOTOR RATING		
26	MATERIALS OF CONSTRUCTION- AS PER DATA SHEET -A		YES/NO

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	RRVUNL RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATA SHEET B 17 STG and their auxiliaries CONDENSATE POLISHING UNIT		SHEET 1 OF 5
ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

	Design code for tanks and vessels		
	Period of operation in Hydrogen cycle and in ammonia cycle.		
1.0	Deep Mixed Bed Units		
	(a) Total No.		
	(b) Type		
	(c) Capacity per stream	m ³ /h	
	(d) Design surface flow rate (e) Design Temperature (f) Design Pressure	m ³ /h m ² °C kg/sq.cm	
	a) Pressure drop (clogged condition) b) Pressure drop (clean condition)		
	c) Material of construction (shell & dished ends)		
	d) Air Blowers Type Material Duty Capacity & head		
1.1	External Regeneration Facility		
	(a) Resin Separation & Cation		

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

	Regeneration Vessel		
	(b) Anion Regeneration Unit		
	(c) Mixed Resin Storage Unit		
	Pressure drop (clogged condition)		
	Pressure drop (clean condition)		
	(d) Material of construction (shell & dished ends)		
	(e) Air Blowers		
	Type		
	Material		
	Duty		
	Capacity & head		
	(e1) Attrition loss of anion - %/ year		
	(e2) Attrition loss of cation - %/ year		
	(f) Resin Make up Hopper		
	(g) Alkali solution Preparation Tank		

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

	(h) Activated Carbon Filter		
	(i) DM regeneration pumps		
	(j) Alkali Measuring Tank		
	(k) Acid Measuring Tank		
	(l) Acid metering pumps		
	(m) Alkali Metering pumps		
	(n) Hot water tank (o) Bulk Acid Tank (Common for RO-DM & CPU) (p) Bulk Alkali Tank (Common for RO-DM & CPU) (q) Acid unloading pumps (r) Alkali Unloading Pumps (s) Neutralised Effluent Transfer Pumps		
1.3	Regeneration Equipment		
	a) Regenerant Chemicals		
	b) Acid & Caustic Dilution Stations		

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ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

	c) Materials of construction of chemical tanks		
1.4	Piping And Valves		
	Piping – CPU Inlet		
	Piping – CPU Outlet		
	CPU bypass piping		
	Resin Transfer piping		
	Backwash, Acid & Alkali Regeneration piping		
	Acid / Alkali Transfer piping		
	Instrument Air piping		
1.5	Resins		
	Cation Resin		
	Anion Resin		
	Inert Resin		
	Volumetric Ratio		
	Resin Quantity		

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SPECIFICATION NO. TCE.5750A-H-500-001		TATA CONSULTING ENGINEERS LIMITED		VOLUME
		RRVUNL RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATA SHEET B 17 STG and their auxiliaries CONDENSATE POLISHING UNIT		SHEET 5 OF 5
ENQUIRY/SPECIFICATION NO.:			BIDDER:	
SL. NO.	ITEM	UNIT		

<u>NOTES TO BIDDER</u> 1. ITEMS WHICH DEVIATE FROM THE SPECIFICATION SHOULD BE MARKED WITHIN ASTERISK (*) AND DETAILS TO BE GIVEN IN SCHEDULE OF DEVIATIONS. 2. THIS DATA SHEET SHALL BE FILLED UP COMPLETELY AND A COPY SHALL BE ENCLOSED WITH EACH COPY OF THE BID.	SIGNATURE OF BIDDER & DATE	

ISSUE
R1

SPECIFICATION NO. TCE.5750A-H-500-001	TATA CONSULTING ENGINEERS LIMITED		VOLUME III
	RRVUNL RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATA SHEET B 18 STG and their auxiliaries STRAINERS		SHEET 1 OF 4
ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

	DESIGN DATA			
1.0	Tag Number	Lube Oil	Condensate	Boiler Feed Pump Suction
2.0	Quantity Required			
3.0	Location			
4.0	Type			
5.0	Fluid			
6.0	Flow rate, kg/hr			
7.0	Operating pressure – Kg/cm2 (g)			
8.0	Operating temperature – 0C			
9.0	Design pressure – Kg/cm2 (g)			
10.0	Design temperature – 0C			
11.0	Fluid viscosity cP at Op. temp			
12.0	Fluid Sp. gravity at Op. temp.			
13.0	Max. permissible Pr. Drop at 50% clogging			
14.0	Screen / basket data			

NOTES TO BIDDER 1. ITEMS WHICH DEVIATE FROM THE SPECIFICATION SHOULD BE MARKED WITHIN ASTERISK (*) AND DETAILS TO BE GIVEN IN SCHEDULE OF DEVIATIONS. 2. THIS DATA SHEET SHALL BE FILLED UP COMPLETELY AND A COPY SHALL BE ENCLOSED WITH EACH COPY OF THE BID.	SIGNATURE OF BIDDER & DATE	
	ISSUE R1	

SPECIFICATION NO. TCE.5750A-H-500-001	TATA CONSULTING ENGINEERS LIMITED		VOLUME III
	RRVUNL RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATA SHEET B 18 STG and their auxiliaries STRAINERS		SHEET 2 OF 4
ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

	(i) CA of perforations			
	(ii) Min. Thickness – mm			
	(iii) Free straining area			
15.0	Steam jacket			
	(a) Inlet pr. Kg/cm2(g) Op. / Desn.			
	(b) Inlet temp. 0C Op. / Desn.			
16.0	End connections			
	(a) Size NB mm			
	(b) Type			
	(c) Details / Standards			
17.0	Cover			
	MATERIAL OF CONSTRUCTION			
18.0	(a) Body			
	(b) Cover			
	(c) Screen basket			
	(d) Bolts / Studs			

NOTES TO BIDDER 1. ITEMS WHICH DEVIATE FROM THE SPECIFICATION SHOULD BE MARKED WITHIN ASTERISK (*) AND DETAILS TO BE GIVEN IN SCHEDULE OF DEVIATIONS. 2. THIS DATA SHEET SHALL BE FILLED UP COMPLETELY AND A COPY SHALL BE ENCLOSED WITH EACH COPY OF THE BID.	SIGNATURE OF BIDDER & DATE	
	ISSUE R1	

SPECIFICATION NO. TCE.5750A-H-500-001	TATA CONSULTING ENGINEERS LIMITED		VOLUME III
	RRVUNL RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATA SHEET B 18 STG and their auxiliaries STRAINERS		SHEET 3 OF 4
ENQUIRY/SPECIFICATION NO.:			BIDDER:
SL. NO.	ITEM	UNIT	

	(e) Nuts			
	(f) Gaskets			
19.0	ACCESSORIES BY VENDOR			
	(a) For Bolts			
	(b) Diff. Pressure gauge			
	(c) Drain / Vent cock (Forged Steel)			
20.0	Hydro static test Pr. – Kg/cm ²			
	(a) Shell side			
	(b) Jacket side			
21.0	Vacuum test required			
22.0	Press. drop test required clean/50% clogged			

- Duplex Filter shall be provided with Valves with a single handle or interlink so as to operate simultaneously.
- External valve position indicator shall be provided to indicate strainer housing in use.
- Strainer parts shall be replaceable without removing strainer housing from the line.
- Strainer housing covers shall be provided with Davit arm.
- Provision for equalising the pressure in standby housing before switching over should be provided.

NOTES TO BIDDER 1. ITEMS WHICH DEVIATE FROM THE SPECIFICATION SHOULD BE MARKED WITHIN ASTERISK (*) AND DETAILS TO BE GIVEN IN SCHEDULE OF DEVIATIONS. 2. THIS DATA SHEET SHALL BE FILLED UP COMPLETELY AND A COPY SHALL BE ENCLOSED WITH EACH COPY OF THE BID.	SIGNATURE OF BIDDER & DATE	
	ISSUE R1	

SPECIFICATION NO. TCE.5750A-H-500-001		TATA CONSULTING ENGINEERS LIMITED		VOLUME III
		RRVUNL RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan DATA SHEET B 18 STG and their auxiliaries STRAINERS		SHEET 4 OF 4
ENQUIRY/SPECIFICATION NO.:			BIDDER:	
SL. NO.	ITEM	UNIT		

6. Acceptable leakage rates: NIL
7. Strainers shall be skid mounted.

<u>NOTES TO BIDDER</u> 1. ITEMS WHICH DEVIATE FROM THE SPECIFICATION SHOULD BE MARKED WITHIN ASTERISK (*) AND DETAILS TO BE GIVEN IN SCHEDULE OF DEVIATIONS. 2. THIS DATA SHEET SHALL BE FILLED UP COMPLETELY AND A COPY SHALL BE ENCLOSED WITH EACH COPY OF THE BID.	SIGNATURE OF BIDDER & DATE	
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SECTION D

SPEC NO.	TATA CONSULTING ENGINEERS LIMITED			VOLUME III B
TCE.5750A-H-500-001	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan			SHEET 1 OF 3
LIST OF CONTENTS				
<u>SECTION</u>	<u>SPECIFICATION NO</u>	<u>ISSUE NO.</u>	<u>TITLE</u>	<u>NO OF SHEETS</u>
D8	TCE M4-101-01	R3	SHELL AND TUBE HEAT EXCHANGER	11
		R3	DATA SHEET-C	1
D9	TCE.M4-102-01	R3	WELDED UNFIRED PRESSURE VESSEL	9
		R1	DATA SHEET-C	1
D10	TCE.M4-102-34 (Drawing)	R3	GUSSETS FOR NOZZLE 40 NB AND BELOW	1
D11	TCE.M4-102-43 (Drawing)	R3	EARTHING CLEAT	1
D12	TCE.M4-102-51 (Drawing)	R3	FABRICATION TOLERANCE FOR PRESSURE VESSELS	2
D13	TCE.M4-102-30-01 (Drawing)	R3	SUPPORTING SADDLE VESSEL OUTSIDE DIAMETER 219.1 TO 508	1
D14	TCE M4-102-30-02 (Drawing)	R3	SUPPORTING SADDLE VESSEL OUTSIDE DIAMETER 600 TO 900	1
D15	TCE.M4-102-30-03 (Drawing)	R3	SUPPORTING SADDLE VESSEL OUTSIDE DIAMETER 1000 TO 1200	1
D16	TCE.M4-102-30-04 (Drawing)	R3	SUPPORTING SADDLE VESSEL OUTSIDE DIAMETER 1300 TO 1900	1
D17	TCE M4-102-30-05 (Drawing)	R3	SUPPORTING SADDLE VESSEL OUTSIDE DIAMETER 2000 TO 2500	1
D18	TCE M4-102-30-06 (Drawing)	R3	SUPPORTING SADDLE VESSEL OUTSIDE DIAMETER 2600 TO 4000	1
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SPEC NO.	TATA CONSULTING ENGINEERS LIMITED			VOLUME III B
TCE.5750A-H-500-001	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan			SHEET 2 OF 3
LIST OF CONTENTS				
<u>SECTION</u>	<u>SPECIFICATION NO</u>	<u>ISSUE NO.</u>	<u>TITLE</u>	<u>NO OF SHEETS</u>
D19	TCE.M4-102-30-07 (Drawing)	R3	SUPPORTING SADDLE GENERAL NOTES	1
D20	TCE.M4-103-99	R3	VALVES AND SPECIALITIES	4
		R3	DATA SHEET-C	1
D21	TCE.M4-103-54	R3	CAST STEEL VALVES	6
		R3	DATA SHEET-C	1
D22	TCE.M4-103-55	R3	FORGED STEEL VALVES	4
		R3	DATA SHEET-C	1
D23	TCE. M4- 104-50- (Drawing)	R3	TYPICAL ARRANGEMENT FOR SLEEVES THROUGH FLOORS AND WALLS	1
D24	TCE. M4- 104-51 (Drawing)	R3	TYPICAL INSULATION DETAILS FOR FLANGED VALVES AND FLANGES	1
D25	TCE. M4- 104-52 (Drawing)	R3	TYPICAL INSULATION FOR BENDS	1
D26	TCE. M4- 104-53 (Drawing)	R4	TYPICAL INSULATIONS FOR HANGERS	1
D27	TCE. M4- 134-103	R7	DESIGN OF POWER PLANT PIPING	15
		R7	DATA SHEET-C	2
D28	TCE. M4- 134-02	R4	SUPPLY, SHOP FABRICATION AND TESTING OF POWER PLANT PIPING	17
D29	TCE. M4-105-01	R10	HORIZONTAL CENTRIFUGAL PUMPS	3
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SPEC NO.	TATA CONSULTING ENGINEERS LIMITED	VOLUME III B
TCE.5750A-H-500-001	RRVUNL, 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan LIST OF CONTENTS	SHEET 3 OF 3

<u>SECTION</u>	<u>SPECIFICATION NO</u>	<u>ISSUE NO.</u>	<u>TITLE</u>	<u>NO OF SHEETS</u>
		R10	DATA SHEET –C	1
D30	TCE.M4-113-54	R5	] ELECTRICAL OPERATED HOISTS AND TROLLEYS	4
		R4	DATA SHEET-C	1
D31	TCE. M4- 113-50	R2	CHAIN PULLEY BLOCK	2
		R1	DATA SHEET-C	1
D32	TCE.M4-405-01	R5	SUPPLY & FABRICATION OF STRUCTURAL STEEL	12
D33	TCE.M4-104-02	R9	THERMAL INSULATION FOR HOT SURFACES	14
		R1	DATA SHEET-C	1
D34	TCE.M4-134-03	R4	ERECTION AND TESTING OF POWER PLANT PIPING	14
		R4	DATA SHEET-C	1
D35	TCE.M4-134-04	R5	WELDING SPECIFICATION FOR PIPING SYSTEM	17
	TCE.M4-101-03	R6	STEAM GENERATION PRESSURE PARTS POWER PLANT SERVICE	9

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SPEC.NO. TCE.M4-101-01	TATA CONSULTING ENGINEERS LIMITED	SECTION: D8
	SHELL AND TUBE HEAT EXCHANGERS	SHEET 1 OF 11

1.0

SCOPE

This specification covers the general design, preparation of detailed fabrication drawings for review and approval, supply of materials, fabrication, stage-wise inspection, final inspection, testing, packing, forwarding, transportation and delivery at site of unfired shell and tube heat exchangers.

2.0

CODES AND STANDARDS

2.1

The design, materials, fabrication, inspection, testing and performance of shell and tube heat exchangers shall comply with all currently applicable design codes and standards, statutes, regulations and safety codes in the locality where the equipment is to be installed. The equipment shall also conform to the latest applicable Indian or equivalent standards. Other international standards are also acceptable, if these are established to be equal, or superior to the listed standards. Nothing in this specification shall be construed to relieve the VENDOR of this responsibility.

2.2

This specification covers shell and tube heat exchangers designed as per the standards of the Tubular Exchanger Manufacturers Association (TEMA).

2.3

If statutory approvals are specified in data sheet A, the VENDOR shall be responsible for obtaining all approvals on design, materials, stage-wise inspection, final inspection and testing of the heat exchanger.

3.0

MATERIALS

3.1

All materials used in the fabrication of heat exchangers shall be as specified in the data sheets. Equivalent materials are acceptable only when approved by the PURCHASER in writing.

3.2

All plates shall be ultrasonically tested as follows :

(a)

For nominal thickness 20 mm and higher when used for fabrication of dished ends

(b)

For nominal thickness 40 mm and higher when used for fabrication of shells

(c)

For nominal thickness 50 mm and higher when used for blind flanges

(d)

All thicknesses, when used for body flanges and tube sheets

3.3

The VENDOR shall ensure that code mandatory requirements of impact testing are met in accordance with the minimum design temperatures specified in the data sheets.

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R3

FILE NAME : M410101R3.DOC

TCE FORM NO. 329 R3

SPEC.NO. TCE.M4-101-01	TATA CONSULTING ENGINEERS LIMITED	SECTION: D8
	SHELL AND TUBE HEAT EXCHANGERS	SHEET 2 OF 11

3.4 Any non-pressure parts such as cleats, pads at support lugs or legs, wear plates at saddles and pads at pipe supports etc., welded directly on to the pressure parts, shall be of the same material as the pressure parts.

3.5 Reinforcement pads at nozzles and other load bearing locations shall be of the same material and nominal thickness as the pressure part.

3.6 ALLOY STEEL PROTECTIVE LINING AND CLADDING

3.6.1 Lining is defined as loose strip lining and bush lining. Cladding may be by weld deposit overlay or explosion bonding or roll bonding.

3.6.2 Clad plate or lining shall conform to the following requirements :

(a) Clad plate thickness shall be minimum 3 mm, exclusive of pass-partition groove depth. Wherever pass-partitions are specified cladding or lining shall be minimum 8 mm thick.

(b) Clad plate made either by the explosion bonding process or reduction roll bonding process is acceptable.

(c) Clad plate shall meet the ASME code requirements of SA 263,SA 264, SA 265 including bond test or AD - Merkblatter W-8.The shear bond test shall be executed as per SA 264, Figure 1.Ultrasonic inspection shall be carried out in accordance with SA 578, acceptance level S-6.

(d) For the purpose of ensuring that cladding thickness of reduction roll-bonded clad plates is not less than 3 mm, each plate shall be inspected at the mill using a "coating gauge".Plates shall be scanned on at least three edges and one across the width of the plate. Thickness shall be plotted at points not more than 600 mm apart. The VENDOR shall furnish a mill certificate, showing an outline of the plate and the points at which readings were taken together with the results.

(e) Instead of lining, weld deposit overlay may also be considered.

(f) At weld deposit overlay or clad-restoring welds, at least the same chemical composition shall be present at 3 mm depth, to be analysed by the welding procedure qualification in advance.

(g) Weld deposit overlay and clad-restoring welds shall be dye penetrant tested and crack-free.

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SPEC.NO. TCE.M4-101-01	TATA CONSULTING ENGINEERS LIMITED	SECTION: D8
	SHELL AND TUBE HEAT EXCHANGERS	SHEET 3 OF 11
(h) Weld deposit overlay and clad-restoring welds as a minimum, shall be qualified as per ASME section IX. 3.6.3 Alloy steel lining shall not be used when cladding is specified. Alloy steel lining, when specified, shall be so designed that the distance between attachments does not exceed 150 mm. 3.6.4 The minimum required thickness of pressure parts shall exclude cladding or lining. 3.6.5 Cladding or lining requirements discussed in this specification are using low and high alloy steels only. For cladding or lining using non-ferrous and other materials, when specified, the VENDOR shall furnish on his drawings all details, including Welding Procedure Specification (WPS), for review and approval. 4.0 <u>MINIMUM THICKNESS</u> 4.1 The thicknesses of pressure parts as shown in the data sheets or drawings are the minimum acceptable thicknesses after manufacture, even though the code may permit a lesser thickness. The minimum acceptable thickness includes specified corrosion allowance. 4.2 The VENDOR shall be responsible for proper selection of plate thickness considering the fabrication and forming allowances, mill under-tolerances etc., to meet the minimum thickness requirements as specified. 5.0 <u>SHELLS</u> Shell courses shall be of the largest possible dimensions to minimise the number of weld seams. 6.0 <u>HEADS AND REDUCING SECTIONS</u> 6.1 Heads shall be of 2:1 ellipsoidal or equivalent ellipsoidal type (crown radius $R = 0.9 D$, knuckle radius $r = 0.17 D$), unless specified otherwise, where D is the inside diameter of the shell. 6.2 Reducing sections or conical bottoms shall have a knuckle radius of $r = 0.06D$, unless specified otherwise. However, knuckle radius shall not be less than 50 mm. 6.3 Dished ends shall be seamless or 100 % radiographed when made from more than one piece.		
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SPEC.NO. TCE.M4-101-01	TATA CONSULTING ENGINEERS LIMITED	SECTION: D8
	SHELL AND TUBE HEAT EXCHANGERS	SHEET 4 OF 11
7.0 <u>NOZZLES AND MANHOLES</u> 4.3 Nozzles fabricated from plates are acceptable for sizes larger than 250 mm NB in case of carbon and low alloy steels and 150 mm NB in case of high alloy steels. However, this is to be done with prior approval and subject to all welds being 100% radiographed. 7.2 All nozzle sizes and quantities indicated in the data sheets are tentative and for bid purpose only. Final sizes and quantities are subject to confirmation during review of drawings. The BIDDER shall include and confirm in his BID, that changes, to the extent of one size lower or higher for each nozzle and quantities plus or minus one number for each size, are acceptable at no extra cost to the PURCHASER. 7.3 All nozzles with butt-welding end connections shall have edge preparation as per ANSI B 16.25 suitable for connected piping inside diameter. Such nozzles shall have 100 mm extra stub length with pipe caps for hydrotest purpose. 7.4 All nozzles of sizes 40 mm NB and below shall be gusseted as per the companion specification TCE.M4-102-34. 7.5 All openings in pressure parts shall be compensated for the area of opening as per code. Minimum width of pad shall be 50 mm. 7.6 All load bearing areas in pressure parts shall be verified for buckling and local stresses. Adequate reinforcement shall be provided. 7.7 Nozzle and manhole necks shall be flush with the inside surface unless specified otherwise. Inside edges of manholes shall be smooth and rounded-off with a radius of 3 mm. 8.0 <u>FLANGES</u> 8.1 Unless specified otherwise, all nozzles shall be provided with rated flanges only, from considerations of interchangeability, as per the dimensional standards indicated in the data sheets. 8.2 Bolt holes shall straddle the main exchanger axes, unless specified otherwise. 8.3 All flanges on nozzles shall be of forged construction with integral hubs. Plate or plate type forged flanges are not acceptable in place of forged flanges with integral hubs. ISSUE R3		

SPEC.NO. TCE.M4-101-01	TATA CONSULTING ENGINEERS LIMITED	SECTION: D8
	SHELL AND TUBE HEAT EXCHANGERS	SHEET 5 OF 11
8.4 All slip-on type flanges of sizes larger than 50 mm NB and girth flanges shall be provided with adequate venting arrangement during welding. 8.5 Girth flanges, if made out of multiple plates, shall be a maximum of three segments. All welds shall be 100 % radiographed. Pre-heating and postweld heat treatment shall be carried out as per code. 8.6 Companion flanges specified with alloy steel liner shall be supplied with 100 mm long alloy steel stub ends with butt-welding edge preparation to suit connected pipe thickness. 8.7 When companion flanges are of welding neck type, the same shall be to suit bore of connected pipe. However, this information shall be provided by the PURCHASER, during review of drawings. 8.8 Blind flanges and covers intended for inspection or access openings shall be provided with adequate arrangement to facilitate opening and closing without undue effort . 8.9 Unless specified otherwise, seating surfaces for non-metallic gaskets shall have stock or serrated finish. For other types of gaskets, the type of finish shall be furnished by the VENDOR on the drawings for review and approval. 8.10 When flanges specified are of tongue and groove or male and female type, groove or female face shall be on the nozzle flanges and tongue or male face on the companion flanges. 9.0 <u>TUBES</u> 9.1 All tubes shall be seamless, unless specified otherwise. 9.2 When welded tubes are specified, the same shall be tested with eddy current method besides other test requirements. 9.3 All tubes shall be formed from a single length without circumferential welds. 9.4 The VENDOR shall check the adequacy of tube gauge for external pressure. 10.0 <u>TUBE BUNDLES</u> 10.1 The tube bundle, after taking out the floating head cover and the backing device, shall be removable through the inlet channel end. 10.2 The tube bundle shall be capable of being rotated, through 180 degrees about the longitudinal axis without bending.		
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SPEC.NO. TCE.M4-101-01	TATA CONSULTING ENGINEERS LIMITED	SECTION: D8
	SHELL AND TUBE HEAT EXCHANGERS	SHEET 6 OF 11
10.3 When straight tube channel type construction is used, all tubes shall be accessible for inside cleaning, rolling and replacement from both ends of the exchanger. 10.4 On vertical removable bundle units with channel down, stationary tube sheet shall be provided with at least four collar bolts or other means approved by the PURCHASER, to hold the tube bundle with channel removed. 10.5 Guide devices to ensure alignment and to facilitate assembly shall be provided for floating head covers, internal bellows, flanges, channel covers and stationary tube sheets having grooved partitions. 10.6 Sliding bars or rails shall be provided to facilitate pulling the removable tube bundles. 10.7 Vertical exchangers shall be provided with four sliding bars or rails equally spaced around the circumference of the bundle. 10.8 When mechanical cleaning is required on shell side (tube layout of square pitch patterns), the sliding bars or rails shall not obstruct the tube lanes. 10.9 Kettle-type exchangers (TEMA - type K) shall be provided with sliding rails continuously welded to the shell. Bundles shall be provided with suitable means to be secured in place during shipment and erection. 10.10 Annular clearances between tubes and shell shall be kept to minimise by-passing for efficient heat transfer. If the clearance exceeds 20 mm, suitable longitudinal sealing strips shall be provided. 10.11 <u>U-TUBES</u> 10.11.1 All tubes shall be seamless, unless specified otherwise. 10.11.2 Tubes shall be cold bent. 10.11.3 Each U tube shall be formed from a single length. Thinning shall meet the stipulations as per TEMA. 11.0 <u>EXPANSION BELLOWS</u> 11.1 Expansion bellow shall preferably be made from a single piece. 11.2 When made from more than one piece, all seams shall be 100% radiographed.		
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SPEC.NO. TCE.M4-101-01	TATA CONSULTING ENGINEERS LIMITED	SECTION: D8
	SHELL AND TUBE HEAT EXCHANGERS	SHEET 7 OF 11
11.3 When carbon steel is specified as the expansion bellow material, the outer diameter of cylindrical portion of bellow shall be flush with outer diameter of the shell. 11.4 All exchangers fitted with expansion bellows shall be provided with restraining bars to protect the bellows assembly during handling and transportation. These bars shall be painted yellow. 11.5 Expansion bellows without internal sleeve shall be installed between two transverse baffles. 11.6 Only a single ply construction shall be provided for expansion bellows, unless specified otherwise. 11.7 Expansion bellows shall preferably be located near the supports. 12.0 <u>GASKETS</u> 12.1 All gaskets with or without internal web segments shall be made in one piece. 12.2 All spiral-wound gaskets shall be provided with outer centering ring and inner ring, unless specified otherwise. 13.0 <u>PASS PARTITION PLATES</u> 13.1 Pass partition plates shall be tightly welded in place. 13.2 Adequate weep holes shall be provided in the pass partition plates. 14.0 <u>BAFFLES AND SUPPORT PLATES</u> 14.1 Baffles shall be provided with adequate bottom notches for shell draining. 14.2 All removable tube bundles shall be provided with a full baffle or support plate for support at the free end. Also, a central opening, of area equal to percentage cut in the baffle, shall be provided in the full baffle. However, this opening requirement is not applicable for kettle-type of exchangers. 15.0 <u>WEIR PLATES</u> Weir plates for kettle-type exchangers shall have a minimum thickness of 10 mm and 6 mm for carbon steel and stainless steel materials respectively. In no case shall the thickness be less than two times the specified corrosion allowance on shell side. 16.0 <u>IMPINGEMENT PLATES</u>		
		ISSUE R3

SPEC.NO. TCE.M4-101-01	TATA CONSULTING ENGINEERS LIMITED	SECTION: D8
	SHELL AND TUBE HEAT EXCHANGERS	SHEET 8 OF 11
16.1 The impingement plate shall be square or rectangle in shape having double the area of the inlet nozzle. It shall have a minimum thickness of 10 mm and 6 mm for carbon steel and stainless steel materials respectively and shall be located on the tube bundle and not in the nozzle. 16.2 Perforated impingement plates are not acceptable. 17.0 <u>VENT AND DRAIN CONNECTIONS</u> All high and low points on shell side and tube side of an exchanger shall be provided with 20 mm NB flanged connections covered with blind flange, unless specified otherwise. 18.0 <u>PRESSURE GAUGE CONNECTIONS</u> All flanged nozzles 50 mm NB or larger shall be provided with 20 mm NB flanged connection covered with blind flange, unless specified otherwise. 19.0 <u>THERMOMETER CONNECTIONS</u> All flanged nozzles 100 mm NB or larger shall be provided with one 25 mm NB flanged connection covered with blind flange, unless specified otherwise. 20.0 <u>JACK SCREWS</u> 20.1 Jack screws of proper size and number shall be provided for breaking the channel cover joint, shell cover joint and floating head cover joint. 20.2 The jack screws shall be of the same material as the bolting. 21.0 <u>HOLDING LUGS AND EYE BOLTS</u> Suitable holding lugs and forged steel eye bolts shall be provided for channel and shell cover, tube sheets and floating head cover for assembly and dismantling the unit. 22.0 <u>DOWEL PINS</u> Dowel pins shall be provided to prevent misassembly of floating head cover, channel, channel cover having grooved partitions and stationary tube sheet to shell flange.		
	ISSUE R3	

SPEC.NO. TCE.M4-101-01	TATA CONSULTING ENGINEERS LIMITED	SECTION: D8
	SHELL AND TUBE HEAT EXCHANGERS	SHEET 9 OF 11
23.0 <u>TEST RIG / TEST FLANGE</u> 23.1 At least one set of test rigs and/or test flanges shall be supplied in case of heat exchangers with removable tube bundle for each size and each type. 23.2 In the case of stacked units, number of sets to be supplied shall be equal to number of shells in a stack. 24.0 <u>STACKED UNITS</u> 24.1 For stacked units, the VENDOR shall develop and furnish the required details for accommodating expansion. 24.2 The VENDOR shall check and ensure that the local stresses at support and intermediate nozzles (assuming exchanger in corroded condition) are within the allowable limits. 24.3 Intermediate nozzles between units shall have raised face flanges for ease of assembly. 24.4 Bolting in flanges of mating connections between stacked exchangers shall be removable without moving the exchangers. 24.5 Intermediate supports shall be installed during fabrication and the entire stack shall be erected at the manufacturer's works and checked for accuracy of nozzle location and alignment. 24.6 A set of shim plates with a total thickness of 15 mm shall be provided for final adjustments at site. 25.0 <u>MISCELLANEOUS</u> 25.1 The BIDDER shall include two (2) numbers stainless steel name plates in his scope. This requirement is exclusive of manufacturer's name plate. The details on name plate shall be furnished during review of drawings. 25.2 Lifting lugs shall be provided for all heat exchangers. Details are subject to review and approval. 25.3 Earthing cleats as per companion specification TCE.M4-102-43 shall be provided at the approved locations. ISSUE R3		

SPEC.NO. TCE.M4-101-01	TATA CONSULTING ENGINEERS LIMITED	SECTION: D8
	SHELL AND TUBE HEAT EXCHANGERS	SHEET 10 OF 11
25.4 All pads at nozzles, supports etc. shall be provided with a tell-tale hole at the bottom-most location, which shall be tested with air at 1.0 kg/cm² (g) and checked with soap solution for leakage. Such tell-tale holes shall be plugged after satisfactory testing. 25.5 For insulated or fire proofed heat exchangers, the insulation or fire proofing supports as per enclosed companion specification shall be provided by the VENDOR. 25.6 Where materials are “free issue” as indicated in the enquiry specification or data sheet, the BIDDER shall furnish along with the technical BID, a firm Bill of Materials (BOM) of all “free issue” items and also indicate cutting and wastage allowances both accountable and unaccountable. 26.0 <u>ANCHOR BOLTS</u> Anchor bolts are not included in the scope of supply of the VENDOR, unless specified otherwise in the data sheets. 27.0 <u>FABRICATION</u> 27.1 All welders, WPS and Procedure Qualification Records (PQR) shall meet the requirements of the specified code irrespective of pressure service or non-pressure service. 27.2 Before welding , edges shall be checked in order to ascertain the absence of flaking, irregularities or serious defects. 27.3 Stainless steel and high alloy steel fabrication shall have independent set of tools, grinding wheels and wire brushes etc. 27.4 Welding shall be executed by qualified welders. 27.5 Butt-welds shall have full penetration. Single sided welds shall be chipped back to sound metal and rewelded from the other side. Wherever chipping is not possible, root run shall be by TIG. Backing strip shall not be used without prior approval. 27.6 Openings, reinforcing pads and attachments shall clear longitudinal and circumferential weld seams. 27.7 Circumferential welds shall be situated 100 mm above or below the support rings and packing support rings meant for supporting internals, if specified.		
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SPEC.NO. TCE.M4-101-01	TATA CONSULTING ENGINEERS LIMITED	SECTION: D8
	SHELL AND TUBE HEAT EXCHANGERS	SHEET 11 OF 11
27.8 Circumferential and longitudinal weld seams shall clear saddles and support lugs. Longitudinal seams, in case of horizontal heat exchangers, shall be at least 150 mm above saddle wear plate. 27.9 Nozzle and reinforcement pads, where applicable, shall be set-in type and attached to the heat exchanger by full penetration welds. 27.10 All welds shall be deburred, free from undercuts, overlap ridges and valleys. 27.11 No welding shall be carried out after stress relieving and/or postweld heat treatment. All flange faces shall be suitably protected against oxidation during heat treatment. 28.0 <u>PAINTING</u> All carbon steel exteriors shall be descaled, edges deburred and wire brushed. Subsequently, all such surfaces shall be painted with two coats of red oxide primer. 29.0 <u>ESSENTIAL AND RECOMMENDED SPARES</u> 29.1 The BIDDER shall include following essential spares in his scope of supply : (a) Two (2) gaskets as spares for each nozzle (b) Three (3) gaskets as spares for body flanges (c) 10% spare fasteners of each size and length. However, the minimum quantity shall be four (4) for each size and length. 29.2 In addition to essential spares as indicated in para 29.1, the BIDDER may recommend additional spares considered necessary by him, for three (3) year trouble-free operation. 29.3 The BIDDER shall include essential spares as indicated in para 29.1 and recommended spares as considered necessary by him, in TCE.M4-993-01 "Schedule of Essential and Recommended Spares". Total value of such spares shall not be included in the quoted price for supply of equipment. This value shall be considered for the purpose of BID evaluation.		
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SPEC.NO. TCE.M4-101-01	TCE CONSULTING ENGINEERS LIMITED	SECTION: D8
	TITLE SHELL AND TUBE HEAT EXCHANGERS	SHEET 1 OF 1

DATA SHEET C

**DATA TO BE FURNISHED BY THE VENDOR AFTER THE
ISSUE OF PURCHASE ORDER**

1. Schedule of complete design calculations, drawings and documents to be submitted along with submission dates
2. Quality Assurance Plan (QAP)
3. Complete design calculations
4. General arrangement drawing indicating overall dimensions, complete design data, general notes, BOM, specifications of each of the pressure and non-pressure parts, tube bundle assembly, tube sheet details, tube layouts and related details, nozzle schedule with nozzle tag number, service, size, nozzle wall thickness, complete end connection details, nozzle elevations, locations, and orientation, support details, locations and orientation etc. Drawing shall also include removal space for tube bundle, wherever applicable. Tube bundle weight, operating weight, erection weight and weight filled with water shall also be indicated.
5. Detailed fabrication drawing for each part and welding details
6. Welding procedure

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SPEC.NO. TCE.M4-102-01	TATA CONSULTING ENGINEERS LIMITED WELDED UNFIRED PRESSURE VESSELS	SECTION: D9 SHEET 1 OF 9
1.0 <u>SCOPE</u> This specification covers the general design, preparation of detailed fabrication drawings for review and approval, supply of materials, fabrication, stage-wise inspection, final inspection, testing, packing, forwarding, transportation and delivery at site of welded unfired pressure vessels. 2.0 <u>CODES AND STANDARDS</u> 2.1 The design, materials, fabrication, inspection, testing and performance of welded unfired pressure vessels shall comply with all currently applicable design codes and standards, statutes, regulations and safety codes in the locality where the equipment is to be installed. The equipment shall also conform to the latest applicable Indian or equivalent standards. Other international standards are also acceptable, if these are established to be equal, or superior to the listed standards. Nothing in this specification shall be construed to relieve the VENDOR of this responsibility. 2.2 If statutory approvals are specified in data sheet A, the VENDOR shall be responsible for obtaining all approvals on design, materials, stage-wise inspection, final inspection and testing of the vessel. 3.0 <u>MATERIALS</u> 3.1 All materials used in the fabrication of pressure vessels shall be as specified in the data sheets. Equivalent materials are acceptable only when approved by the PURCHASER in writing. 3.2 All plates shall be ultrasonically tested as follows : (a) For nominal thickness 20 mm and higher when used for fabrication of dished ends (b) For nominal thickness 40 mm and higher when used for fabrication of shells (c) For nominal thickness 50 mm and higher when used for blind flanges (d) All thicknesses, when used for body flanges 3.3 The VENDOR shall ensure that code mandatory requirements of impact testing are met in accordance with the minimum design temperatures specified in the data sheets. ISSUE R3		

SPEC.NO. TCE.M4-102-01	TATA CONSULTING ENGINEERS LIMITED	SECTION: D9
	WELDED UNFIRED PRESSURE VESSELS	SHEET 2 OF 9
3.4 Any non-pressure parts such as cleats, pads at support lugs or legs, wear plates at saddles and pads at pipe supports etc., welded directly on to the pressure parts, shall be of the same material as the pressure parts. 3.5 Reinforcement pads at nozzles and other load bearing locations shall be of the same material and nominal thickness as the pressure part. 3.6 Material for skirt in case of alloy steel vessels and columns shall be the same as that of pressure part at least for a minimum length of 500 mm from bottom tan-line. 3.7 <u>ALLOY STEEL PROTECTIVE LINING AND CLADDING</u> 3.7.1 Lining is defined as loose strip lining and bush lining. Cladding may be by weld deposit overlay or explosion bonding or roll bonding. 3.7.2 Clad plate or lining shall conform to the following requirements : (a) Clad plate thickness shall be minimum 3 mm, unless specified otherwise. (b) Clad plate made either by the explosion bonding process or reduction roll bonding process is acceptable. (c) Clad plate shall meet the ASME code requirements of SA263, SA264, SA265 including bond test or AD-Merkblatter W-8. The shear bond test shall be executed as per SA264, Figure 1. Ultrasonic inspection shall be carried out in accordance with SA 578, acceptance level S-6. (d) For the purpose of ensuring that cladding thickness of reduction roll-bonded clad plates is not less than 3 mm, each plate shall be inspected at the mill using a "coating gauge". Plates shall be scanned on at least three edges and one across the width of the plate. Thickness shall be plotted at points not more than 600 mm apart. The VENDOR shall furnish a mill certificate, showing an outline of the plate and the points at which readings were taken together with the results. (e) Instead of lining, weld deposit overlay may also be considered. (f) At weld deposit overlay or clad-restoring welds, at least the same chemical composition shall be present at 3 mm depth, to be analysed by the welding procedure qualification in advance. (g) Weld deposit overlay and clad-restoring welds shall be dye penetrant tested and crack-free.		
	ISSUE R3	

SPEC.NO. TCE.M4-102-01	TATA CONSULTING ENGINEERS LIMITED WELDED UNFIRED PRESSURE VESSELS	SECTION: D9 SHEET 3 OF 9
(h) Weld deposit overlay and clad-restoring welds as a minimum, shall be qualified as per ASME Section IX. 3.7.3 Alloy steel lining shall not be used when cladding is specified. Alloy steel lining, when specified, shall be so designed that the distance between attachments does not exceed 150 mm. 3.7.4 The minimum required thickness of pressure parts shall exclude cladding or lining. 3.7.5 Cladding or lining requirements discussed in this specification are using low and high alloy steels only. For cladding or lining using non-ferrous and other materials, when specified, the VENDOR shall furnish on his drawings all details, including Welding Procedure Specification (WPS), for review and approval. 4.0 <u>MINIMUM THICKNESS</u> 4.1 The thicknesses of the pressure parts as shown in the data sheets or drawings are the minimum acceptable thicknesses after manufacture, even though the code may permit a lesser thickness. The minimum acceptable thickness includes specified corrosion allowance. 4.2 The VENDOR shall be responsible for proper selection of plate thickness considering the fabrication and forming allowances, mill under-tolerances etc., to meet the minimum thickness requirements as specified. 5.0 <u>SHELLS</u> Shell courses shall be of the largest possible dimensions to minimise the number of weld seams. 6.0 <u>HEADS AND REDUCING SECTIONS</u> 6.1 Heads shall be of 2:1 ellipsoidal or equivalent ellipsoidal type (crown radius $R = 0.9D$, knuckle radius $r = 0.17D$), unless specified otherwise, where D is the inside diameter of the shell. 6.2 Reducing sections or conical bottoms shall have a knuckle radius of $r = 0.06D$, unless specified otherwise. However, knuckle radius shall not be less than 50 mm. ISSUE R3		

SPEC.NO. TCE.M4-102-01	TATA CONSULTING ENGINEERS LIMITED	SECTION: D9
	WELDED UNFIRED PRESSURE VESSELS	SHEET 4 OF 9

6.3

Dished ends shall be seamless or 100% radiographed when made from more than one piece.

7.0

AGITATOR ASSEMBLY

7.1

Agitator assembly shall be complete with drive motor, mechanical seal with seal housing, bearings, gear box, agitator shaft with impellers, foot-step bearing with support, rigid coupling between agitator shaft and gear box output shaft with spool piece, flexible couplings between gear box and drive motor, suitable base plate and supporting structure for agitator drive arrangement and necessary fasteners etc. so as to make it complete in all respects.

7.2

Drive motor and gear box shall be mounted on a common base frame and duly coupled and aligned through flexible couplings.

7.3

Agitator shaft and gear box output shaft shall be coupled through a rigid coupling with split ring locking arrangement in order to ensure that agitator shaft does not fall into the vessel during operation.

7.4

Agitator, shaft and impeller assembly shall be statically and dynamically balanced.

7.5

The VENDOR shall obtain necessary approvals from the seal manufacturer regarding arrangement of assembly and application of API cooling plan etc. for the mechanical seal.

7.6

The gear box shall be rated for heavy duty agitator service, continuously working for 24 hours a day and shall be suitable to withstand static and dynamic loads and bending moment on the gear box due to agitator shaft.

7.7

Drive motor and gear box unit shall be provided with a suitable lifting eye hook.

7.8

There shall be no oil spillage from gear box on to the vessel.

7.9

Base frame shall be provided with suitable lifting lugs suitably designed for lifting complete agitator assembly.

8.0

NOZZLES AND MANHOLES

8.1

Nozzles fabricated from plates are acceptable for sizes larger than 250 mm NB in case of carbon and low alloy steels and 150 mm NB in case of high alloy

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SPEC.NO. TCE.M4-102-01	TATA CONSULTING ENGINEERS LIMITED	SECTION: D9
	WELDED UNFIRED PRESSURE VESSELS	SHEET 5 OF 9

steels. However, this is to be done with prior approval and subject to all welds being 100% radiographed.

8.2 All nozzle sizes and quantities indicated in the data sheets are tentative and for bid purpose only.Final sizes and quantities are subject to confirmation during review of drawings.The BIDDER shall include and confirm in his BID, that changes, to the extent of one size lower or higher for each nozzle and quantities plus or minus one number for each size, are acceptable at no extra cost to the PURCHASER.

8.3 All nozzles with butt-welding end connections shall have edge preparation as per ANSI B16.25 suitable for connected piping inside diameter. Such nozzles shall have 100 mm extra stub length with pipe caps for hydrotest purpose.

8.4 All nozzles of sizes 40 mm NB and below shall be gusseted as per the companion specification TCE.M4-102-34.

8.5 All openings in pressure parts shall be compensated for the area of opening as per code. Minimum width of pad shall be 50 mm.

8.6 All load bearing areas in pressure parts shall be verified for buckling and local stresses.Adequate reinforcement shall be provided.

8.7 Nozzle and manhole necks shall be flush with the inside surface of vessel, unless specified otherwise. Inside edges of manholes shall be smooth and rounded-off with a radius of 3 mm.

9.0 **FLANGES**

9.1 Unless specified otherwise, all nozzles shall be provided with rated flanges only, from consideration of interchangeability, as per the dimensional standards indicated in the data sheets.

9.2 Bolt holes shall straddle the main vessel axes, unless specified otherwise.

9.3 All flanges on nozzles shall be of forged construction with integral hubs. Plate or plate type forged flanges are not acceptable in place of forged flanges with integral hubs.

9.4 All slip-on type flanges of sizes larger than 50 mm NB and girth flanges shall be provided with adequate venting arrangement during welding.

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SPEC.NO. TCE.M4-102-01	TATA CONSULTING ENGINEERS LIMITED	SECTION: D9
	WELDED UNFIRED PRESSURE VESSELS	SHEET 6 OF 9
9.5 Girth flanges, if made out of multiple plates, shall be a maximum of three segments. All welds shall be 100% radiographed. Pre-heating and postweld heat treatment shall be carried out as per code. 9.6 Companion flanges specified with alloy steel liner shall be supplied with 100 mm long alloy steel stub ends with butt-welding edge preparation to suit connected pipe thickness. 9.7 When companion flanges are of welding neck type, the same shall be to suit bore of connected pipe. However, this information shall be provided by the PURCHASER, during review of drawings. 9.8 Blind flanges and covers intended for inspection or access openings shall be provided with adequate arrangement to facilitate opening and closing without undue effort. 9.9 Unless specified otherwise, seating surfaces for non-metallic gaskets shall have stock or serrated finish. For other types of gaskets, the type of finish shall be furnished by the VENDOR on the drawings for review and approval. 9.10 When flanges specified are of tongue and groove or male and female type, groove or female face shall be on the nozzle flanges and tongue or male face on the companion flanges. 10.0 <u>SUPPORTS</u> 10.1 All skirt supports shall have at least one access opening and adequate vent holes at the top of skirt. 10.2 Skirt shall be provided with adequate holding and climbing rungs inside, above and below the skirt opening. Details shall be furnished by the VENDOR on the drawings for review and approval. 11.0 <u>MISCELLANEOUS</u> 11.1 The sizing of vessel internals shall be such that all removable parts can be removed through manholes. 11.2 Wherever applicable and unless specified otherwise in data sheets all support rings, bolting bar for internals such as trays, tower packings, downcomers etc. shall be in the scope of the VENDOR.		
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SPEC.NO. TCE.M4-102-01	TATA CONSULTING ENGINEERS LIMITED	SECTION: D9
	WELDED UNFIRED PRESSURE VESSELS	SHEET 7 OF 9
11.3 Internal baffles, tray support beams of other internals spanning a chord or diameter of the vessel shall be provided with a means for allowing differential expansion between the part and the vessel shell. 11.4 Unless specified otherwise, baffles or weir plates shall not be welded directly to the shell or dished end of the vessel. These shall be bolted to the support attachments which are welded to the shell or dished end. 11.5 The BIDDER shall include two (2) numbers stainless steel name plates in his scope. This requirement is exclusive of manufacturer's name plate. The details on name plate shall be furnished during review of drawings. 11.6 Lifting lugs shall be provided for all vessels. Details are subject to review and approval. 11.7 Earthing cleats as per companion specification TCE.M4-102-43 shall be provided at the approved locations. 11.8 All pads at nozzles, supports etc. shall be provided with a tell-tale hole at the bottom-most location, which shall be tested with air at 1.0 kg/cm²(g) and checked with soap solution for leakage. Such tell-tale holes shall be plugged after satisfactory testing. 11.9 For insulated or fire proofed vessels, insulation or fire proofing supports as per enclosed companion specification shall be provided by the VENDOR. 11.10 Wherever platforms and ladders are specified in the data sheets, necessary supports shall be provided by the VENDOR as per details which shall be made available during review of drawings. 11.11 Where materials are "free issue" as indicated in the enquiry specification or data sheet, the BIDDER shall furnish along with the technical BID, a firm Bill of Materials (BOM) of all "free issue" items and also indicate cutting and wastage allowances both accountable and unaccountable. 12.0 <u>ANCHOR BOLTS</u> Anchor bolts are not included in the scope of supply of the VENDOR, unless specified otherwise in the data sheets. 13.0 <u>FABRICATION</u> 13.1 All welders, WPS and Procedure Qualification Records (PQR) shall meet the		
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SPEC.NO. TCE.M4-102-01	TATA CONSULTING ENGINEERS LIMITED	SECTION: D9
	WELDED UNFIRED PRESSURE VESSELS	SHEET 8 OF 9
requirements of the specified code irrespective of pressure service or non-pressure service. 13.2 Before welding, edges shall be checked in order to ascertain the absence of flaking, irregularities or serious defects. 13.3 Stainless steel and high alloy steel fabrication shall have independent set of tools, grinding wheels and wire brushes etc. 13.4 Welding shall be executed by qualified welders. 13.5 Butt-welds shall have full penetration. Single sided welds shall be chipped back to sound metal and rewelded from the other side. Wherever chipping is not possible, root run shall be by TIG. Backing strip shall not be used without prior approval. 13.6 Openings, reinforcing pads and attachments shall clear longitudinal and circumferential weld seams. 13.7 Circumferential welds shall be situated 100 mm above or below the support rings and packing support rings meant for supporting internals, if specified. 13.8 Circumferential and longitudinal weld seams shall clear saddles and support lugs. Longitudinal seams, in case of horizontal vessels, shall be at least 150 mm above saddle wear plate. 13.9 Nozzle and reinforcement pads, where applicable, shall be set-in type and attached to the vessel by full penetration welds. 13.10 Skirt to vessel heads joints shall have continuous flat-faced weld matching with outer diameter of the vessel. The width of the weld shall be equal to skirt thickness and height of weld shall be twice the width. 13.11 All welds shall be deburred, free from under cuts, overlap ridges and valleys. 13.12 No welding shall be carried out after stress relieving and/or postweld heat treatment. All flange faces shall be suitably protected against oxidation during heat treatment. 14.0 <u>FIELD ERECTION</u> 14.1 Where size or shape of vessel makes it impossible to ship it in one piece for erection by others, the VENDOR shall ship largest shop fabricated sections		
	ISSUE R3	

SPEC.NO. TCE.M4-102-01	TATA CONSULTING ENGINEERS LIMITED WELDED UNFIRED PRESSURE VESSELS	SECTION: D9 SHEET 9 OF 9
	suitable for shipment and ease of handling for field erection and assembly. Fabrication and erection shall be completed at the site by the VENDOR. 14.2 All pieces shall be shop fit-up into sections and each sections shall be fit to adjacent section and all pieces shall be match marked. 14.3 The width of permissible gap during fit-up shall be in accordance with approved drawings and welding procedures and shall generally be 3 mm maximum with a tolerance of plus 0.8 mm to minus 0.0 mm. 14.4 Flame cut edges shall be ground by the VENDOR as required to remove slag, detrimental discoloration and non-uniformity of edges. 14.4 All radiographic requirements for welds completed in shop shall be made by the VENDOR before the parts of section leave the shop. 15.0 <u>PAINTING</u> All carbon steel exteriors shall be descaled, edges deburred and wire brushed. Subsequently, all such surfaces shall be painted with two coats of red oxide primer. 16.0 <u>ESSENTIAL AND RECOMMENDED SPARES</u> 16.1 The BIDDER shall include following essential spares in his scope of supply : (a) Two (2) gaskets as spares for each nozzle (b) Three (3) gaskets as spares for body flanges (c) 10% spare fasteners of each size and length. However, the minimum quantity shall be four (4) for each size and length. 16.2 In addition to essential spares as indicated in para 16.1, the BIDDER may recommend additional spares considered necessary by him, for three (3) year trouble-free operation. 16.3 The BIDDER shall include essential spares as indicated in para 16.1 and recommended spares as considered necessary by him, in TCE.M4-993-01 "Schedule of Essential and Recommended Spares". Total value of such spares shall not be included in the quoted price for supply of equipment. This value shall be considered for the purpose of BID evaluation.	
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SPEC.NO. TCE.M4-102-01	TATA CONSULTING ENGINEERS LIMITED	SECTION: D9
	WELDED UNFIRED PRESSURE VESSELS	SHEET 1 OF 1

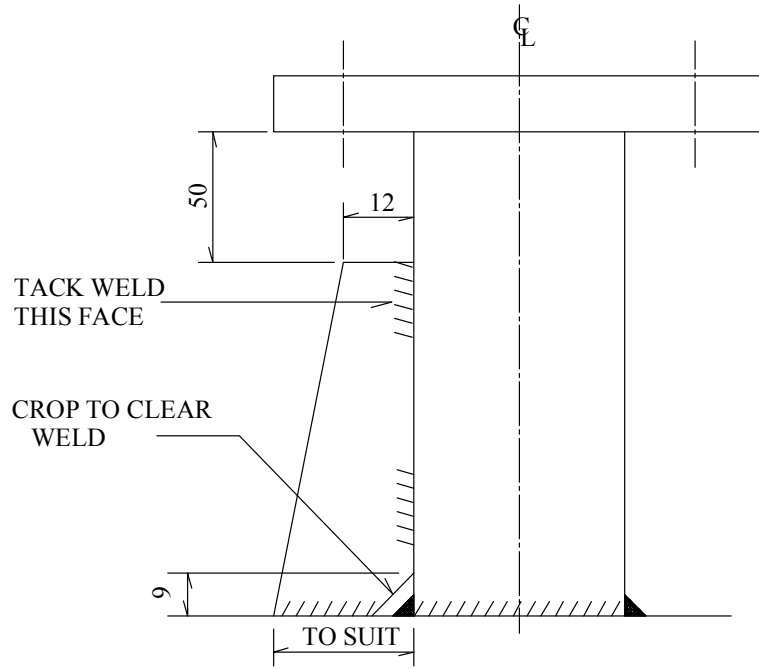
DATA SHEET C

**DATA TO BE FURNISHED BY THE VENDOR AFTER THE
ISSUE OF PURCHASE ORDER**

1. Schedule of complete design calculations, drawings and documents to be submitted along with submission dates
2. Quality Assurance Plan (QAP)
3. Complete design calculations
4. General arrangement drawing indicating overall dimensions, complete design data, general notes, BOM, specifications of each of the pressure and non-pressure parts, nozzle schedule with nozzle tag number, service, size, nozzle wall thickness, complete end connection details, nozzle elevations, locations, and orientation, support details, locations and orientation etc. Operating weight, erection weight and weight filled with water shall be indicated.
5. Detailed fabrication drawing for each part and welding details
6. Details of internals
7. Details of external cleats and structurals
8. Welding procedure

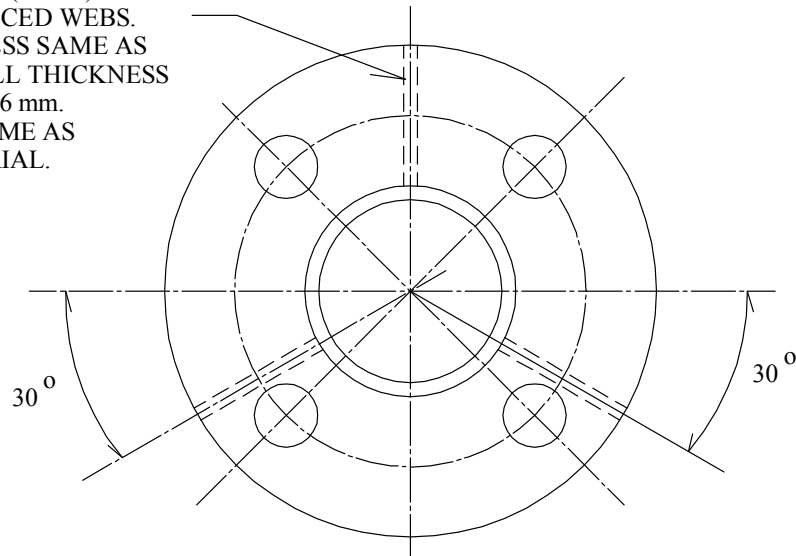
ISSUE R1

SPEC. NO. TCE.M4-102-34	TATA CONSULTING ENGINEERS LIMITED		SECTION: D10
	TITLE	GUSSETS FOR NOZZLES 40 mm NB AND BELOW	SHEET 1 OF 1



ELEVATION

3 TO 6 mm THK.(MAX.)
EQUALLY SPACED WEBS.
WEB THICKNESS SAME AS
SHELL IF SHELL THICKNESS
IS LESS THAN 6 mm.
MATERIAL SAME AS
SHELL MATERIAL.



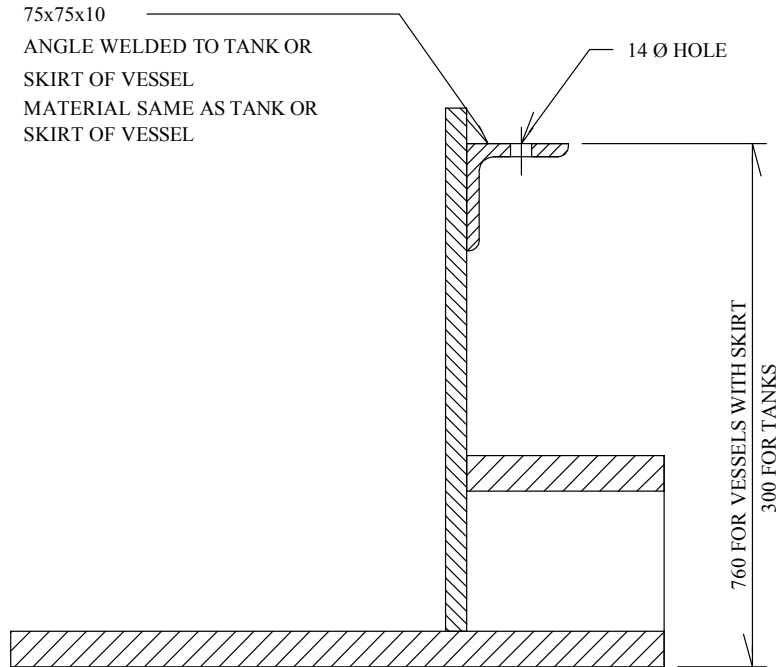
PLAN

NOTES

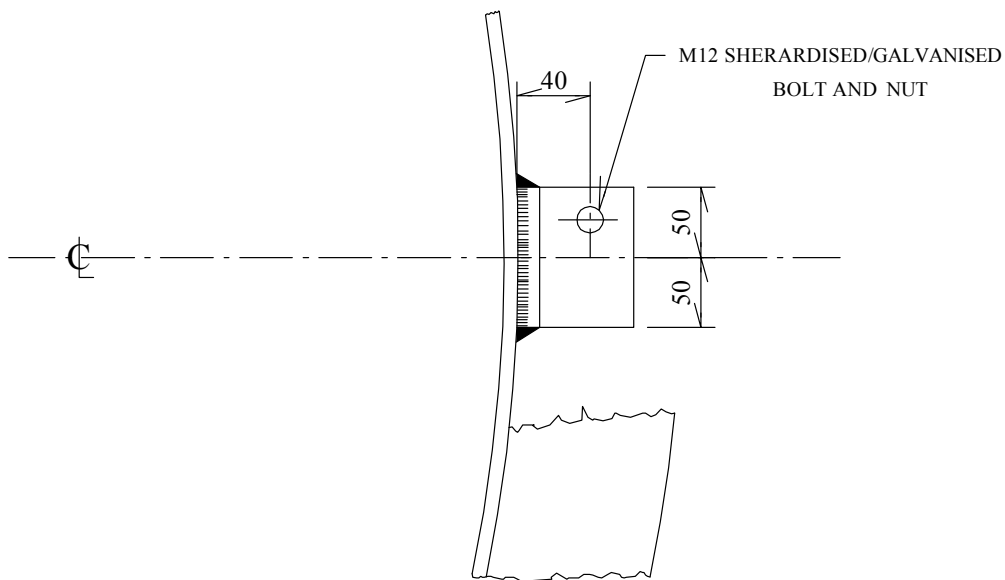
1. ALL DIMENSIONS AND SIZES ARE IN mm.

ISSUE
R3

SPEC. NO. TCE.M4-102-43	TATA CONSULTING ENGINEERS LIMITED EARTHING CLEAT	SECTION: D11 SHEET 1 OF 1



SECTIONAL ELEVATION



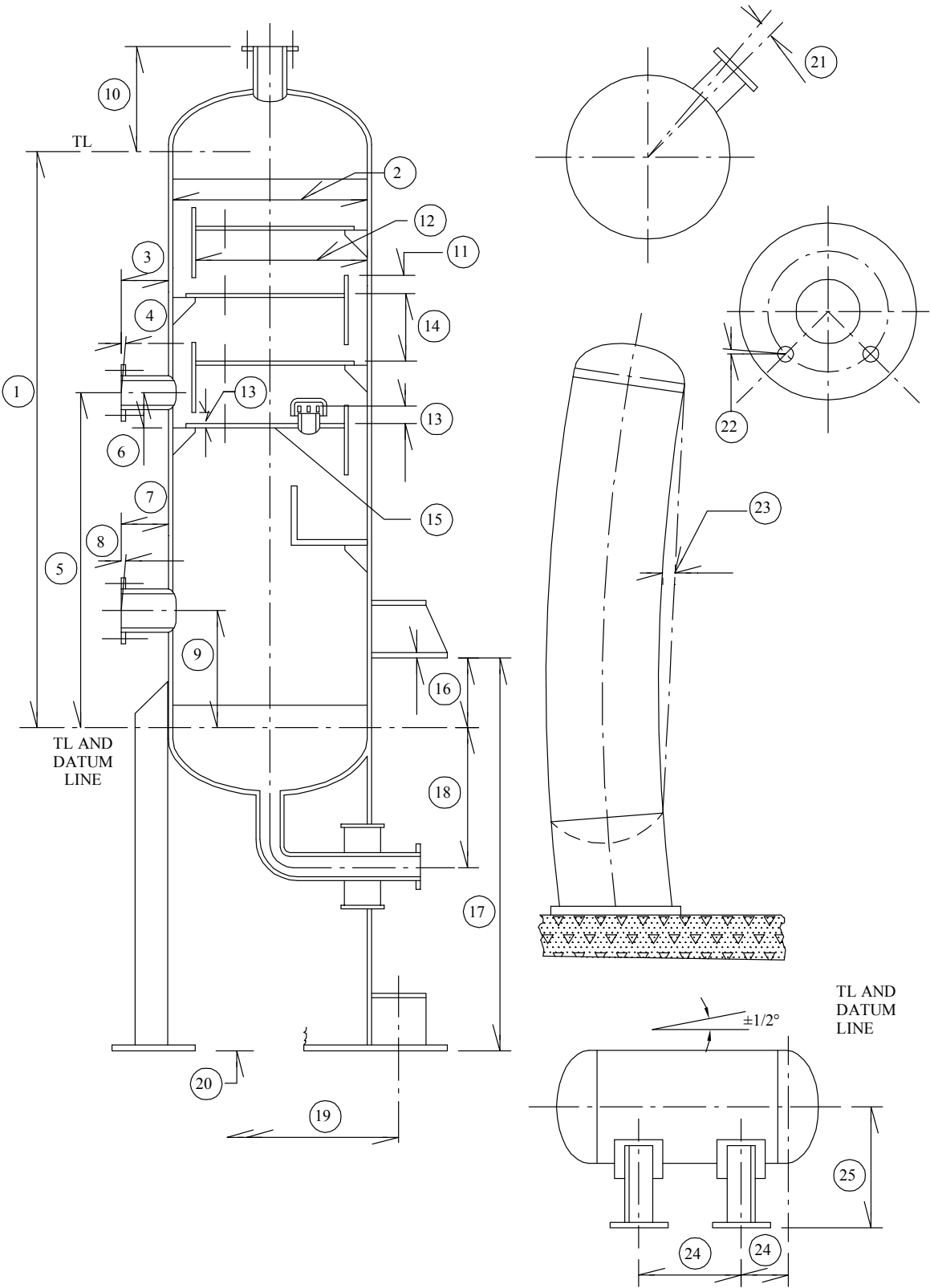
PLAN

NOTES

1. ALL DIMENSIONS AND SIZES ARE IN mm.
2. THIS IS A TYPICAL DETAIL FOR TANK OR VESSEL WITH SKIRT. CLEAT MAY BE WELDED TO LUG, LEG OR SADDLE SUPPORT FOR LUG, LEG OR SADDLE SUPPORTED VESSELS.

ISSUE
R3

SPEC. NO. TCE.M4-102-51	TATA CONSULTING ENGINEERS LIMITED TITLE FABRICATION TOLERANCES FOR PRESSURE VESSELS	SECTION: D12 SHEET 1 OF 2



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SPEC. NO. TCE.M4-102-51	TATA CONSULTING ENGINEERS LIMITED	SECTION: D12
	TITLE FABRICATION TOLERANCES FOR PRESSURE VESSELS	SHEET 2 OF 2

- ① DISTANCE BETWEEN TANGENT LINES $\pm 1.5/m$ OR 12 WHICHEVER IS SMALLER.

SHELL ID	TOLERANCES
ID < 1200	$\pm 0.5\%$ OF ID, max. ± 5
1200 < ID < 2100	± 5
2100 < ID < 5000	± 6.5
ID ≥ 5000	± 8

- ② AVERAGE ID TOLERANCE

- ③ FACE OF NOZZLE TO OUTSIDE SHELL OF VESSEL ± 5
- ④ ALIGNMENT OF FLANGE FACE OF NOZZLE SHALL BE WITHIN 0.5° OF SPECIFIED PLANE.
- ⑤ LOCATION OF SHELL NOZZLE FROM DATUM LINE SHALL BE ± 6
- ⑥ LOCATION OF SHELL NOZZLE FROM TRAY SUPPORTING RING SHALL BE ± 3
- ⑦ FACE OF MANHOLE TO OUTSIDE SHELL OF VESSEL ± 12
- ⑧ ALIGNMENT OF FLANGE FACE OF MANHOLE SHALL BE WITHIN 1° OF SPECIFIED PLANE.
- ⑨ LOCATION OF MANHOLE FROM DATUM LINE SHALL BE ± 12
- ⑩ FACE OF NOZZLES ON DISHED ENDS SHALL BE WITHIN ± 6 FROM TANGENT LINE.
- ⑪ HEIGHT OF WEIR ABOVE TRAY PLATE ± 1.5
- ⑫ INSIDE OF TOWER TO DOWNCOMER +0 AND (-)3
- ⑬ HEIGHT OF TOP OF BUBBLE CAP SLOTS ABOVE TRAY ± 1.5 ; BOTTOM OF DOWNCOMER ABOVE TRAY SUPPORT RING ± 1.5
- ⑭ DISTANCE BETWEEN ADJACENT SUPPORT RINGS ± 3

- ⑮ TRAY SUPPORT RING OUT-OF-LEVEL OVER ANY DIAMETER

VESSEL DIAMETER	TOLERANCE
ID < 1200	3
1200 < ID < 2100	4.5
ID > 2100	5.0

- ⑯ FOR BRACKET SUPPORTS LOCATED ABOVE DATUM LINE TOLERANCE +5
- ⑰ BOTTOM OF VESSEL SUPPORT TO DATUM LINE -5
- ⑱ LOCATION OF BOTTOM NOZZLE FROM DATUM LINE SHALL BE ± 6

- ⑲ BOLT CIRCLE DIAMETER TOLERANCE

SHELL DIAMETER	TOLERANCE
ID < 2100	± 3
ID ≥ 2100	± 6

- ⑳ BASE PLATE OUT OF LEVEL OVER ANY DIAMETER

VESSEL DIAMETER	TOLERANCE
ID < 1200	± 3
1200 < ID < 2100	± 5
ID ≥ 2100	± 7

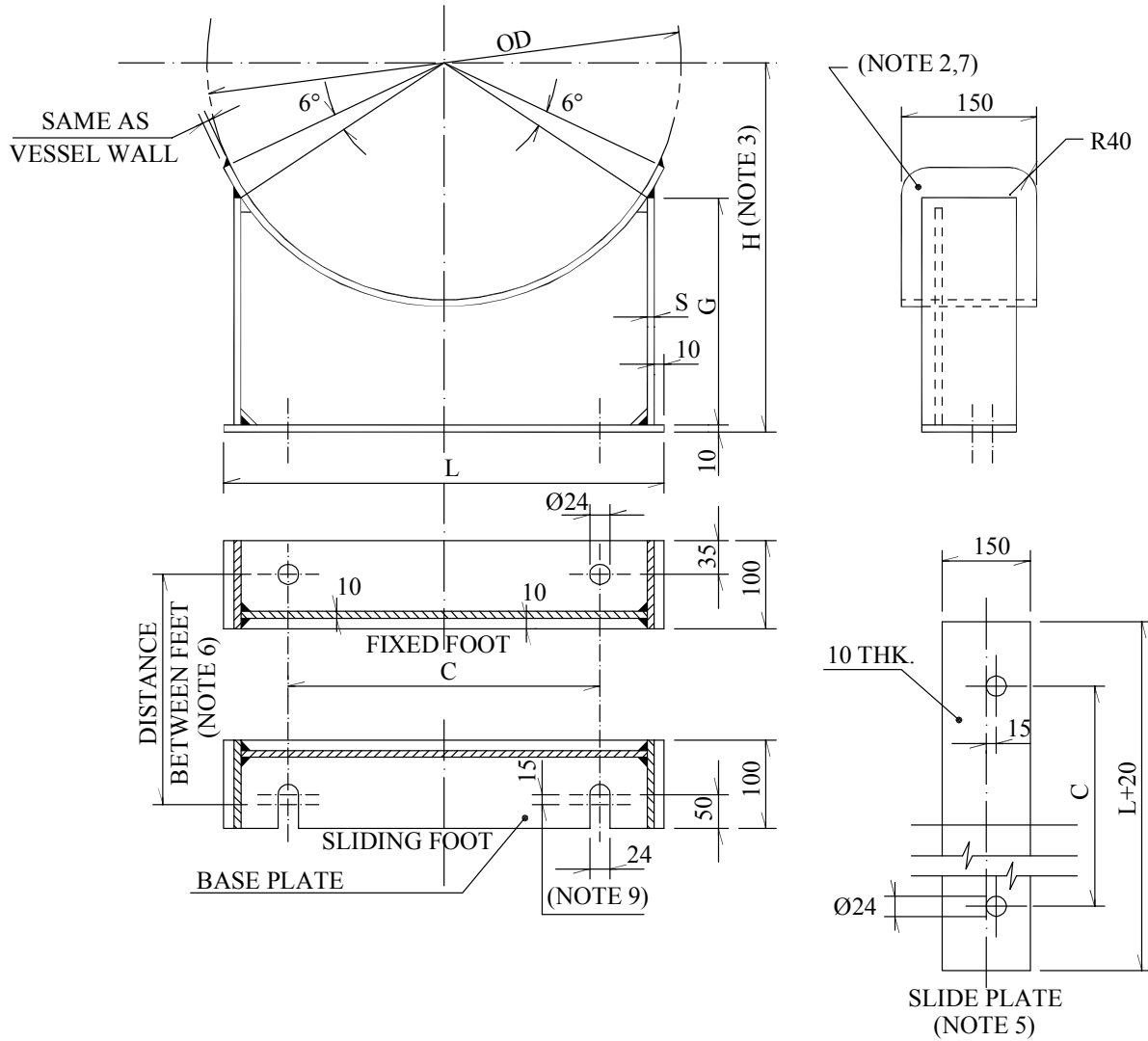
- ㉑ DEVIATION OF NOZZLE ORIENTATION $\pm 1/2^\circ$
- ㉒ ROTATION OF FLANGES FROM THE INDICATED POSITION MEASURED AS SHOWN 1.5(max.)
- ㉓ ALIGNMENT OF CYLINDRICAL SHELL SECTIONS SHALL BE TRUE AND STRAIGHT WITHIN 7 mm / 6 METER OF HEIGHT FROM THE DATUM LINE BUT SHALL NOT EXCEED 20 mm
- ㉔ TOLERANCE BETWEEN BOLT SUPPORT/SUPPORT AND TANGENT LINE ± 3
- ㉕ BOTTOM OF VESSEL SUPPORT TO CENTRE LINE +0 AND (-)5

NOTES

- ALL DIMENSIONS AND SIZES IN mm.
- OTHER FABRICATION TOLERANCES SHALL BE AS PER SPECIFIED DESIGN CODE/STANDARDS.

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SPEC. NO. TCE.M4-102-30-01	TATA CONSULTING ENGINEERS LIMITED	SECTION: D13
	TITLE SADDLE SUPPORTS VESSEL OUTSIDE DIAMETER 219.1 TO 508 mm	SHEET 1 OF 1

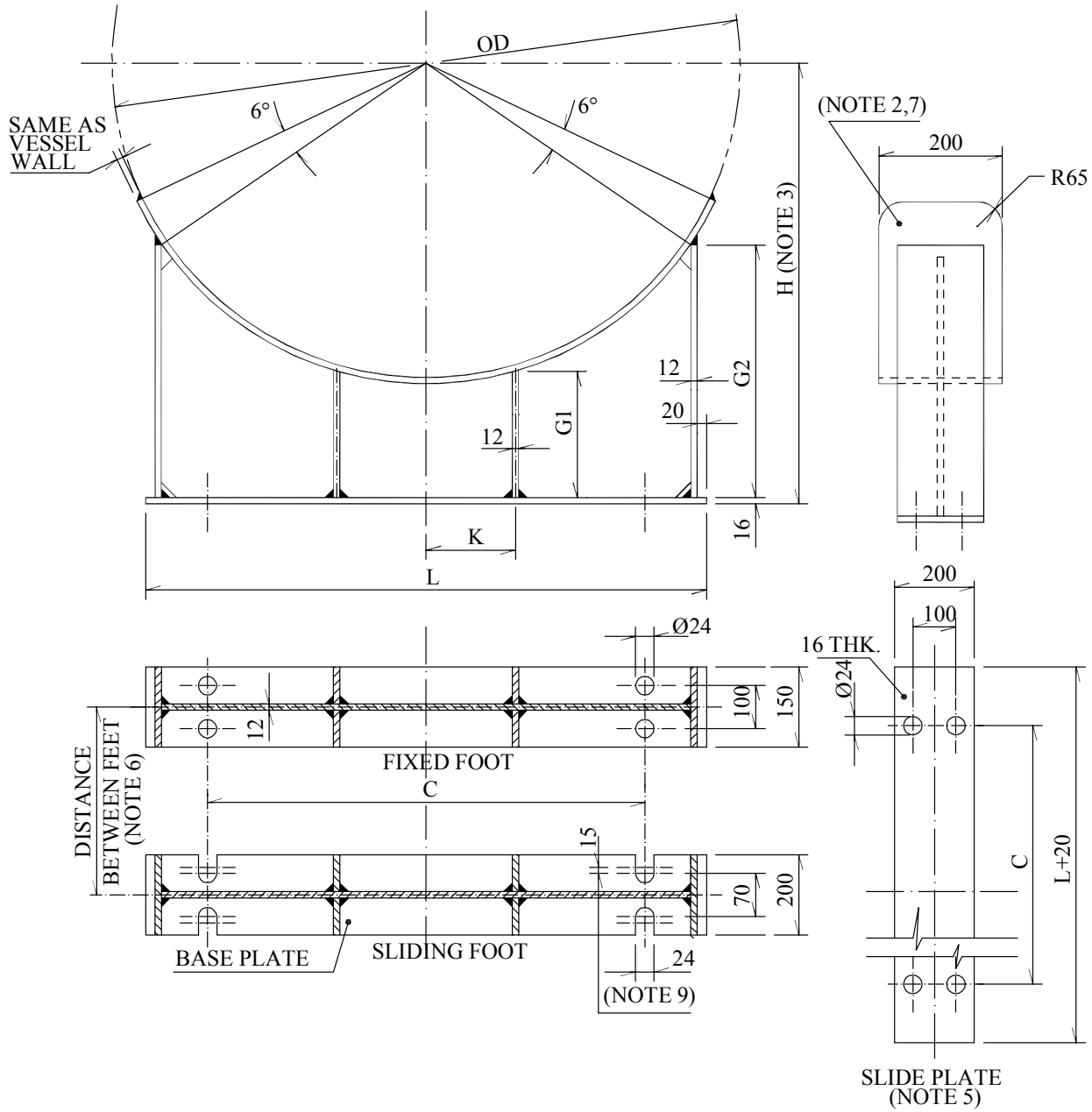


OD	H	L	C	G	S	WEIGHT kg.(NOTE 4)	
						SUPPORTING SADDLE	SLIDING PLATE
219.1	400	210	100	310	6	11.0	2.6
273	450	260	140	348		12.0	3.2
323.9		300	180	332		13.0	3.7
355.6	500	330	220	376		15.0	4.1
406.4		390	270	371	8	16.0	4.7
457		420	300	398		18.0	5.1
508		480	360	394	10	29.0	5.8

FOR NOTES REFER TCE.M4-102-30-07.

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SPEC. NO. TCE.M4-102-30-03	TATA CONSULTING ENGINEERS LIMITED	SECTION: D15
	TITLE SADDLE SUPPORTS VESSEL OUTSIDE DIAMETER 901 TO 1200 mm	SHEET 1 OF 1

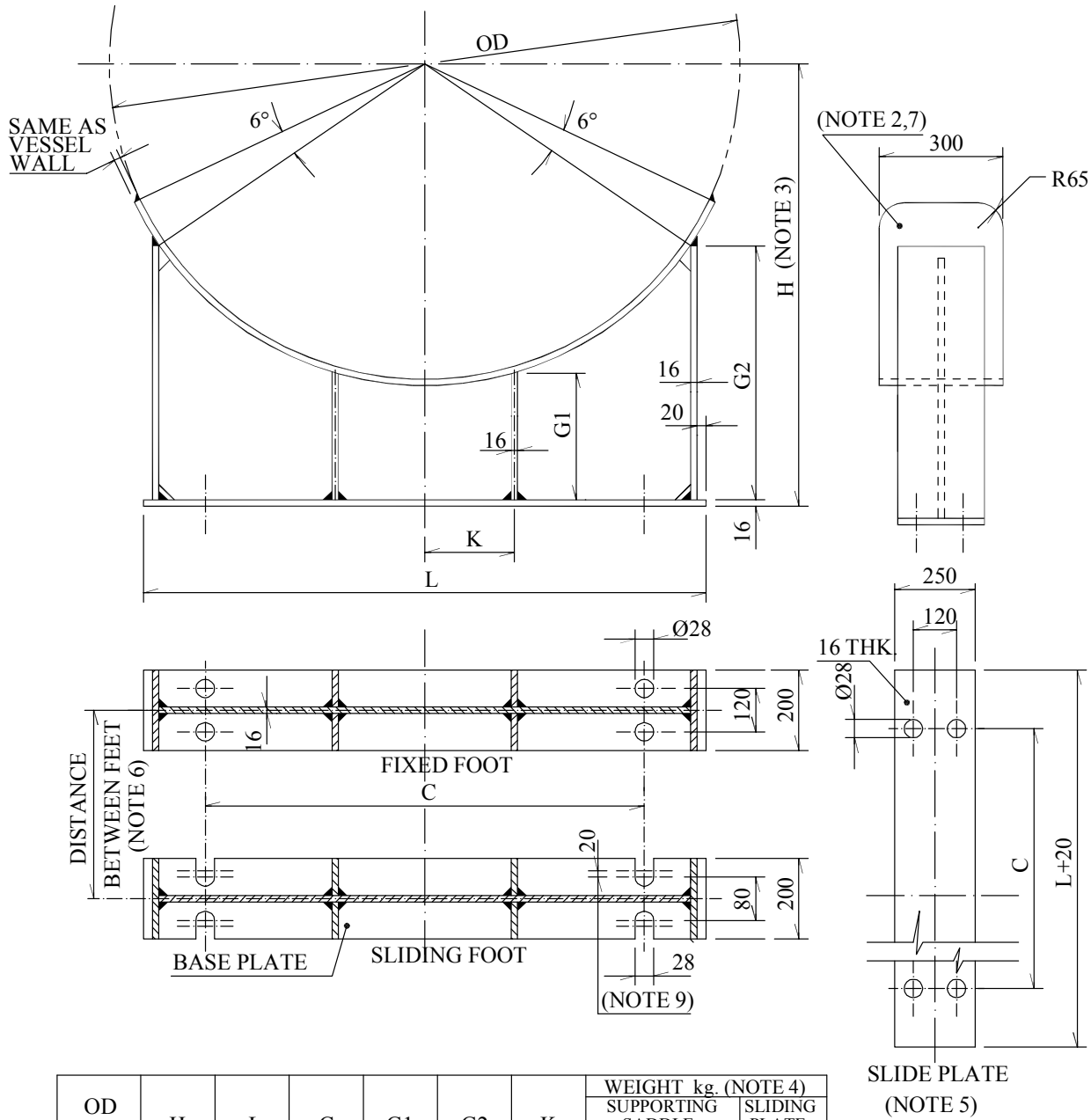


OD	H	L	C	G1	G2	K	WEIGHT kg. (NOTE 4)	
							SUPPORTING SADDLE	SLIDING PLATE
1000	800	900	700	294	492	140	88.0	17.2
1100	850	990	790	296	519	155	96.0	19.0
1200	900	1080	880	298	547	170	104.0	20.6

FOR NOTES REFER TCE.M4-102-30-07.

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SPEC. NO. TCE.M4-102-30-04	TATA CONSULTING ENGINEERS LIMITED	SECTION: D16
	TITLE SADDLE SUPPORTS VESSEL DIAMETER 1201 TO 1900 mm	SHEET 1 OF 1



FOR NOTES REFER TCE.M4-102-30-07.

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SPEC. NO. TCE.M4-102-30-07	TATA CONSULTING ENGINEERS LIMITED	SECTION: D19
	TITLE SADDLE SUPPORTS	SHEET 1 OF 1

NOTES

1. ALL DIMENSIONS AND SIZES ARE IN mm.
2. THE WEAR PLATE MATERIAL SHALL BE SAME AS VESSEL MATERIAL.
3. NOZZLE SHALL BE SET BACK APPROX. 50mm FROM THE EDGE OF THE SADDLE PLATE. WHERE NECESSARY DIMENSION H SHALL BE INCREASED ACCORDINGLY.
4. WEIGHTS GIVEN ARE FOR ONE SADDLE OF STEEL MATERIAL.
5. THE SLIDE PLATE SHALL BE SUPPLIED WITH THE VESSEL.
6. FOR LOCATION OF SADDLES AND DISTANCE BETWEEN FEET REFER DATA SHEET 'A' FOR VESSEL.
7. SUITABLE VENT HOLE WITH PLUG SHALL BE PROVIDED AT A SUITABLE LOCATION ON WEAR PLATE.
8. FOR INTERMEDIATE VESSEL DIAMETERS FOLLOW SADDLE DETAILS APPLICABLE FOR NEXT HIGHER VESSEL OD.
9. THIS DIMENSION SHALL BE INCREASED TO THE LINEAR EXPANSION OF THE SHELL BETWEEN THE TWO SADDLE SUPPORTS, IF THE CALCULATED LINEAR EXPANSION IS MORE THAN THE INDICATED DIMENSION.
10. SADDLE DETAILS ARE APPLICABLE FOR INSULATED AND NON-INSULATED VESSELS.
11. FOR SADDLE DETAILS REFER TCE.M4-102-30-01 TO 06 AS APPLICABLE.

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SPEC.NO. TCE.M4-103-99	TATA CONSULTING ENGINEERS LIMITED TITLE VALVES AND SPECIALITIES GENERAL REQUIREMENTS	SECTION: D SHEET 1 OF 4

1.0

SCOPE

The following paragraphs describe general requirements for valves and specialties. Only the applicable paragraphs for the type of valve or speciality are to be considered along with data sheet-A. These apply unless specified otherwise in data sheet-A.

2.0

CODES AND STANDARDS

Valves and specialties shall be generally as per the following standards:

2.1

ANSI B16.1

:

Cast Iron Valve Ratings

2.2

ASME B16.34

:

Ratings of Valves-Flanged, Threaded and Welding Ends

2.3

API 594

:

Wafer and Wafer - Lug Check Valves

2.4

API 600

:

Steel Flanged and Butt Welding End Gate Valves

2.5

API 602

:

Steel Gate Valves, Threaded and Socket Welding Ends

2.6

API 609

:

Butterfly Valves

2.7

BS 1414

:

Steel Gate Valves, Flanged and Butt Welding Ends

2.8

BS 1868

:

Steel Check Valves, Flanged and Butt Welding Ends

2.9

BS 1873

:

Steel Globe Valves, Flanged and Butt Welding Ends

2.10

BS 5156

:

Diaphragm Valves

2.11

BS 5351

:

Steel Ball Valves

2.12

BS 5352

:

Steel Gate, Globe and Check Valves, 50 mm and Smaller

2.13

IS 778

:

Bronze Valves

2.14

MSS-SP 67

:

Butterfly Valves

3.0

GEAR OPERATORS

Gear operators shall be provided on the following basis:

3.1

GATE AND GLOBE VALVES

Up to and including ANSI 300 class

-

350 mm and larger

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SPEC.NO. TCE.M4-103-99	TATA CONSULTING ENGINEERS LIMITED TITLE VALVES AND SPECIALITIES GENERAL REQUIREMENTS	SECTION: D SHEET 2 OF 4
3.2	600 class and higher - 200 mm and larger <u>OTHER VALVES</u> Plug and ball - 150 mm and larger Butterfly - 200 mm and larger 3.3 Gear operators shall be suitable for a differential pressure corresponding to the maximum valve rating at room temperature. 3.4 All gear operators shall be of the enclosed type. <u>INTEGRAL BYPASS</u> 4.1 Gate valves shall be provided with integral bypass valve, as per MSS-SP 45, as follows: Classes 150 and 300 - 350 mm and larger Class 600 and higher - 200 mm and larger 4.2 Type of bypass valve shall generally be the same as the main valve. Bypass pipe shall be at least schedule 80 and material of construction of bypass valve and pipe shall be compatible with the main valve. <u>VALVE STEMS</u> Valve stems shall be of wrought materials. Castings are not acceptable. <u>BACKSEAT</u> All gate, globe and piston valves shall be provided with back seating arrangement to facilitate replacement of gland packing with the valve in service. <u>CHECK VALVES</u> Check valves of sizes 350 mm and larger shall be provided with features to prevent slamming and hammering. These can be in the form of springs or external dash pot. <u>HARDNESS</u> 13% chromium steel seat surfaces shall have a minimum hardness of 250 BHN and a differential hardness of 50 BHN.	ISSUE R3

SPEC.NO.	TATA CONSULTING ENGINEERS LIMITED		SECTION: D
TCE.M4-103-99	TITLE	VALVES AND SPECIALITIES GENERAL REQUIREMENTS	SHEET 3 OF 4

9.0

NAME PLATES

The details on name plates shall be as per MSS-SP 25.

10.0

TAG PLATES

Tag plates shall be of stainless steel type 304 or aluminium.

11.0

TESTING

Strength and leak tests shall be as per any of the standards MSS-SP-61, API 598 or BS EN 12266-1 and 2 at the test pressures indicated in data sheet-A. Stainless steel valves shall be tested using potable water.

12.0

NDT REQUIREMENTS

12.1

All cast steel valves shall be subject to radiography in all accessible areas, as defined in ASME B16.34, on the following basis:

(a)

Class 600 and higher

-

All sizes

(b)

Class 300

-

Sizes 450 mm and larger

(c)

Class 150

-

Sizes 600 mm and larger

12.2

All cast steel valves of class 600 and higher shall also be subject to magnetic particle or liquid penetrant examination as per ASME B16.34.

12.3

All cast steel valves of class 300 shall have radiography quality castings irrespective of size.

12.4

Acceptable levels of defects shall be as per ASME B16.34.

13.0

FACE-TO-FACE OR END-TO-END DIMENSIONS

13.1

Face-to-face dimensions of flanged-end valves and end-to-end dimensions of butt welding-end valves shall be as per ASME B16.10.

13.2

For valves not covered by ASME B16.10, the dimensions shall be as per applicable valve standards.

14.0

PREPARATION FOR DESPATCH

14.1

COATING

All carbon steel and cast iron exposed surfaces shall be given one coat of primer and two coats of aluminium finish paint after release has been given for painting and

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SPEC.NO.	TATA CONSULTING ENGINEERS LIMITED		SECTION: D
TCE.M4-103-99	TITLE	VALVES AND SPECIALITIES GENERAL REQUIREMENTS	SHEET 4 OF 4

before despatch. Machined surfaces shall be coated with an easily removable rust protective except that this is not applicable for austenitic stainless steel components.

14.2 END PROTECTION

After completion of the requirements of para 14.1, body end ports, flange faces and welding ends shall be covered with suitable close fitting protectors to protect the machined ends and prevent ingress of dirt and moisture.

14.3 DISC

The disc shall be closed before despatch except in the case of soft-seated valves where the disc shall be backed off to relieve the pressure on the seal.

14.4 PACKING

Valves and specialities shall be so packed as to minimise the possibility of damage during storage or transit. The packing shall be suitable for tropical conditions.

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SPEC.NO.	TATA CONSULTING ENGINEERS LIMITED	SECTION: D
TCE.M4-103-99	TITLE VALVES AND SPECIALITIES GENERAL REQUIREMENTS	SHEET 1 OF 1

DATA SHEET-C

DATA TO BE FURNISHED BY THE VENDOR AFTER THE

ISSUE OF PURCHASE ORDER

1.0

List of drawings and documents to be submitted for review, approval or information with scheduled submission dates.

2.0

Quality Assurance Plan (QAP)

3.0

Drawings showing outline dimensions, clearance dimensions for disassembly, weight, part numbers, materials of construction, test pressures, statutory and any special requirements, sizes, tag numbers and quantities. All information covered in data sheets A and B shall be incorporated in this drawing. The PURCHASER'S identifying tag numbers shall be shown on each drawing or on a sheet attached to the drawing with proper cross-references.

4.0

Operation and maintenance manuals

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R3

SPEC.NO. TCE.M4-103-54	TATA CONSULTING ENGINEERS LIMITED	SECTION: D
	CAST STEEL VALVES	SHEET 1 OF 6

1.0 **SCOPE**

This specification covers the design, material, construction features, manufacture, inspection and testing at the VENDOR's/his SUB-VENDOR's Works and delivery to Site of cast steel gate, globe including angle and Y-type and check valves generally for sizes NB65 and larger.

2.0 **CODES AND STANDARDS**

2.1 The design, material, construction, manufacture, inspection, testing and performance of valves shall comply with all currently applicable statutes, regulations and safety codes in the locality where the valves will be installed. Valves shall also conform to the latest editions of applicable codes and standards as specified in various clauses of this specification. Nothing in this specification shall be construed to relieve the VENDOR from this responsibility.

2.2 Various codes and standards referred in this specification shall form an integral part of this specification. In the event of conflict between this specification and the codes and standards, the same shall be brought to the attention of the CONSULTANT for resolution.

3.0 **DESIGN AND CONSTRUCTION FEATURES**

3.1 The following design and construction features of valves shall be minimum acceptable unless otherwise specified in Data Sheet-A and/or Section-C.

3.1.1 All gate and globe valves shall be of rising stem, outside screw and yoke type. The design of valves shall ensure a streamlined passage and gate valves shall have low pressure drop. The seats and discs shall be easily renewable and/or shall be suitable for easy refacing and grinding. Valve discs shall be of such design as to keep the seats tight when the valve body is subjected to pressure, temperature variations and piping stresses. Gate valves shall close in both flow directions.

3.1.2 All globe valves shall be capable of being closed against pressure.

3.1.3 All valves end details shall be as specified in Data Sheet-A. In the case of all end-welded valves, the stub ends of the valves shall project from the valve body a sufficient amount to ensure that the welding process will not distort the valve body and internal parts.

3.1.4 Valves for regulating duties shall be of the globe type with tapered plug type disc.

3.1.5 Hardness of seating surfaces shall be a minimum of 350 BHN and a minimum differential hardness of 50 BHN shall be provided between seats to prevent galling. This is not applicable for stellited seats.

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SPEC.NO. TCE.M4-103-54	TATA CONSULTING ENGINEERS LIMITED	SECTION: D
	CAST STEEL VALVES	SHEET 2 OF 6

- 3.1.6 Check valves of sizes 400 mm NB and larger shall have dash pot arrangement.
- 3.1.7 All gate and globe valves shall have back-seating arrangement to facilitate easy replacement of packing with the valve in service.
- 3.1.8 All valves shall be so designed that the hand-wheel moves in a clockwise direction to close the valve. The face of the hand-wheel shall be clearly marked with the words 'OPEN' and 'CLOSE' and an arrow to indicate the direction for opening. All hand-wheels shall be fitted with name plate.
- 3.1.9 Piston lift check valves shall have accurately guided pistons so that the pistons are cushioned in their cylinders as they move up.
- 3.2 All gate, globe, Y-type and angle valves intended for manual operation and falling under the following categories shall be equipped with a gear operator for ease of operation and to ensure fast and tight closure:

ANSI PRESSURE RATING	VALVE SIZES FOR WHICH GEAR OPERATOR IS REQUIRED
----- Class 300 and below	----- 350 mm and larger
Class 600 and above	200 mm and larger

- 3.3 All gate valves falling in the following categories shall be provided with integral bypass valve. Bypass size shall conform to MSS-SP-45 as a minimum standard unless otherwise specified in Data Sheet-A. The bypass valve shall be hand operated unless otherwise specified in Data Sheet-A. Pipe for bypass shall be at least Schedule 80 seamless and of a material of the same nominal chemical composition and physical properties as that used for the main line. Orientation of bypass arrangement shall be subject to the approval of PURCHASER/ENGINEER.

ANSI PRESSURE RATING	VALVE SIZES FOR WHICH BYPASS IS REQUIRED
----- Class 600 and over	----- 200 mm and larger
Class 300 & 150	350 mm and larger

- 3.4 All gate valves of ANSI pressure rating class 150 and 300 shall have solid or flexible wedge and ANSI pressure rating class 600 and above shall have flexible or parallel slide type of wedge.

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SPEC.NO. TCE.M4-103-54	TATA CONSULTING ENGINEERS LIMITED CAST STEEL VALVES	SECTION: D SHEET 3 OF 6
3.5 Valves with flexible wedge shall have provision for relieving the pressure in the neck of the valve when the valve is in the closed position. 3.6 All valves of ANSI pressure rating upto class 600 shall have bolted bonnet construction and class 900 and above shall have bonnet construction of the pressure seal type. Pressure seal valves shall have stainless steel inlay in the gasket area and silver-plated gaskets or other acceptable proven features. 3.7 All carbon steel valves of ANSI pressure rating upto class 150 and 300 shall have stainless steel trim (13% Cr) unless otherwise specified in Data Sheet-A and ANSI pressure rating class 600 and above shall have stellited trim. 3.8 All alloy steel valves shall have stellited seats. 3.9 All valves of ANSI pressure rating upto class 900 and higher shall have yoke with anti-friction bearing arrangement. 3.10 Valves that are to be kept in full 'OPEN'/'CLOSE' position shall be provided with a non-detachable locking arrangement. The locking arrangement provided shall be subject to approval by the PURCHASER. 3.11 As specified in Data Sheet-A, valves operating under vacuum conditions shall have glands with water sealing. The inlet and outlet connections shall be NB 15mm. The VENDOR shall indicate the maximum and minimum sealing water pressure and the required flow rate. 3.12 Motor operators shall be designed to close the valve within the time shown in Data Sheet-A. For details of motor operator, refer companion specifications TCE.M4-203-01 and TCE.M4-203-06. 3.13 Y-globe valves shall have flow area designed for minimum turbulence and pressure drop. 3.14 Stop check valves shall have full floating and accurately guided discs. 3.15 When chain wheels are specified for valves, they shall be constructed to give good traction for the chain. Roller guides shall be provided to hold the chain to a greater part of the circumference of the wheel, to increase traction and to prevent the chain from jumping off the wheel. 3.16 Extension stems where specified, shall be of extra strong pipe with suitable coupling, fastened by locknuts and set screws. Floor stands shall be of sturdy construction and shall be at least one metre high from the floor. They shall be provided with chromium-plated scales and valve movement indicators. Where lateral and/ or vertical movements of valve are indicated in Data Sheet-A, the floor stand and extension spindle shall be		
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SPEC.NO. TCE.M4-103-54	TATA CONSULTING ENGINEERS LIMITED	SECTION: D
	CAST STEEL VALVES	SHEET 4 OF 6

designed to permit these movements. Adequate greasing facilities shall be provided for all pedestals and extended operating spindle attachments.

3.17 Flow direction shall be clearly embossed on the valve body for globe and check valves.

3.18 Wherever special class valves as per ANSI B16.34 "Steel Valves" are specified in Data Sheet-A, all requirements of ANSI B16.34 for this class of valves shall be met in addition to the requirements given in this specification.

4.0 **WELDING REQUIREMENTS**

All welding procedure qualifications and welder performance qualifications shall be in accordance with Section-IX of the ASME Boiler and Pressure Vessel Code. Hard facing operations require procedure qualification.

5.0 **CLEANING**

Prior to factory inspection, all manufacturing waste, such as metal chips and filings, welding rods and stubs, rags, debris and all other foreign matter shall be removed from the interior of each valve. All mill scale, rust, oil, grease, chalk, crayon, paint marks and other deleterious material shall be removed from the interior and exterior surfaces. At the time of shipment, valves shall be clean inside and outside.

6.0 **INSPECTION AND TESTS**

6.1 Inspection & tests shall be as per TCE.M4-185-17 and TCE.M4-185-01.

6.2 Defect Removal and Repair in Castings

6.2.1 Defects in excess of acceptance standards shall be removed by suitable means. If removal of surface defects does not result in reduction in wall thickness below 5% of intended thickness of metal at that location, the area shall be blended smoothly into the surrounding surface. Where defect removal results in a wall thickness below the above, resultant cavity may be repaired by welding. The procedure and operator shall be qualified as per applicable standards. Major weld repairs shall be stress relieved or heat treated in accordance with ASME Section VIII Division I-UCS 56.

6.2.2 The required area shall be re-examined and the acceptance standards shall be as in the original examination.

6.2.3 Weld repairs made as a result of radiographic examination shall be radiographed after welding. Repairing a particular area more than 2 times is not permitted and the component shall be rejected. The acceptance

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SPEC.NO. TCE.M4-103-54	TATA CONSULTING ENGINEERS LIMITED	SECTION: D
	CAST STEEL VALVES	SHEET 5 OF 6

standards for welds shall be as per ASME Boiler and Pressure Vessel Code, Section VIII, Division I, UW - 51.

6.2.4 Prior approval shall be obtained from the PURCHASER/ ENGINEER before taking up major weld repairs (major weld repair - when depth of repair exceeds 20% of thickness or 1 inch whichever is smaller). Mapping of major weld repairs is also required.

6.3 All valves shall be tested hydrostatically for strength, tightness of seats and tightness of backseating at the pressures indicated in Data Sheet-A, in accordance with MSS-SP 61, "Hydrostatic Testing of Steel Valves". Water used for hydrostatic testing of valves with stainless steel components shall not have chloride content exceeding 20 ppm. Clean potable water may be used for testing of all other valves.

6.4 All valves except check valves shall be tested for seat tightness by air at a pressure of 6 bar (g) on both sides of seat.

6.5 All check valves shall also be hydrotested at 25% of the seat hydro test pressure.

6.6 All valves shall be checked for correctness in respect of specified end details as per applicable standards.

7.0 **PAINTING AND CORROSION PROTECTION**

Unless otherwise specified in Data Sheet-A/Section-C, two coats of primer of thickness 35 microns for each coat shall be applied to all steel and cast iron exposed surfaces as required to prevent corrosion, after release has been given for painting and before despatch. The use of grease or oil, other than light grade mineral oil, for corrosion protection is prohibited. Bores of all valves shall be covered, immediately after testing, draining and drying with suitable plastic end covers to avoid ingress of foreign materials.

8.0 **DRAWINGS**

The BIDDER shall furnish, along with his Bid, drawings giving outline dimensions, clearance dimensions for disassembly and weight of valve with actuator.

9.0 **NAME PLATES**

All valves shall have permanent stainless steel name plates indicating details as per MSS SP-25 "Standard Marking Systems for Valves, Fittings, Flanges and Unions". Also for all carbon steel valves of ANSI

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SPEC.NO. TCE.M4-103-54	TATA CONSULTING ENGINEERS LIMITED CAST STEEL VALVES	SECTION: D SHEET 6 OF 6

pressure rating class 600 and above, the pressure containing castings shall be marked with melt identification number. In addition, they shall have a permanent stainless steel tag fixed on the valve body indicating the PURCHASER's valve tag number and service.

10.0 **DATA SHEETS**

As specified in Data Sheet-A/Section-C, the BIDDER shall submit details about valves.

11.0 **INFORMATION TO BE FURNISHED AFTER THE AWARD OF CONTRACT**

The VENDOR shall furnish all the information as called for in Data Sheet-C.

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SPEC.NO. TCE.M4-103-54	TATA CONSULTING ENGINEERS LIMITED CAST STEEL VALVES	SECTION: D SHEET 1 OF 1

DATA SHEET - C

DATA TO BE FURNISHED BY THE VENDOR
AFTER THE AWARD OF CONTRACT

The VENDOR shall submit, in the manner and within the time set forth in the Purchase Order/Letter of Intent the following :

- 1.0 Drawings showing Purchase Order number, outline dimensions, clearance dimensions for disassembly and weight (valve and actuator). The VENDOR's drawings identified by character, number and date, when reviewed by the PURCHASER, will be considered a part of this specification. The PURCHASER's identifying tag numbers shall be shown on each drawing or on a sheet attached and referenced to the drawing.
- 2.0 Quality plans as per the format enclosed in TCE.M4-185-01, covering also the inspection requirements as indicated in this specification, as minimum.
- 3.0 Operation and maintenance instruction manuals.
- 4.0 Test Certificates/reports for :
 - a) Physical and chemical analysis and metallurgical tests for all components of valves.
 - b) Hydrostatic and pneumatic tests.
 - c) Non-destructive tests.
- 5.0 Test certificates as required by statutory regulations.
- 6.0 If specified in Data Sheet-A/Section-C, the details of all valves and valve list as per enclosed formats.

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SPEC.NO. TCE.M4-103-55	TATA CONSULTING ENGINEERS LIMITED	SECTION: D22
	FORGED STEEL VALVES	SHEET 1 OF 4

1.0

SCOPE

This specification covers the design, material, construction features, manufacture, inspection and testing at the VENDOR's/his SUB-VENDOR's Works and delivery to Site of forged steel valves comprising gate, globe including angle and Y-type, needle and check valves generally for sizes NB 50 and smaller.

2.0

CODES AND STANDARDS

2.1 The design, material, construction, manufacture, inspection, testing and performance of valves shall comply with all currently applicable statutes, regulations and safety codes in the locality where the valves will be installed. The Valves shall also conform to the latest editions of applicable codes and standards as specified in various clauses of this specification. Nothing in this specification shall be construed to relieve the VENDOR of this responsibility.

2.2 Various codes & standards referred in this specification shall form an integral part of this specification. In the event of conflict between this specification and the codes and standards, the same shall be brought to the attention of the CONSULTANT for resolution.

3.0

DESIGN AND CONSTRUCTION FEATURES

3.1 The following design and construction features of valves shall be minimum acceptable unless otherwise specified in Data Sheet-A and/or Section-C.

3.1.1 All gate and globe valves shall be of rising stem, outside screw and yoke type. The design of valves shall ensure a streamlined passage and low pressure drop. The seats and discs shall be easily renewable and/or shall be suitable for easy refacing and grinding. Valve discs shall be of such design as to keep the seats tight when the valve body is subjected to pressure, temperature variations and piping stresses. Gate valves shall close in both directions.

3.1.2 In the case of all end-welded valves, the stub ends of the valves shall project from the valve body a sufficient amount to ensure that the welding process will not distort the valve body and internal parts.

3.1.3 Valves for regulating duties shall be of the globe type with tapered plug type disc.

3.1.4 Hardness of seating surfaces shall be a minimum of 350 BHN and a minimum differential hardness of 50 BHN shall be provided between seats to prevent galling. This is not applicable for stellited seats.

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SPEC.NO. TCE.M4-103-55	TATA CONSULTING ENGINEERS LIMITED FORGED STEEL VALVES	SECTION: D22 SHEET 2 OF 4
3.1.5 All gate and globe valves shall have back-seating arrangement to facilitate easy replacement of packing with the valve in service. 3.1.6 All valves shall be so designed that the hand-wheel moves in a clockwise direction to close the valve. The face of the hand-wheel shall be clearly marked with the words 'OPEN' and 'CLOSE' and an arrow to indicate the direction for opening. All hand-wheels shall be fitted with name plate. 3.1.7 Forged steel needle and Y-type valves shall have extra long thread chambers and a plug type disc which shall be resistant to wear and foreign matter. The stuffing box shall be adequately deep and shall be fitted with a high grade packing. Stems shall have fine pitch threads to permit fine adjustment. The discs and seats shall be cone shaped. 3.2 All valves of ANSI pressure rating upto class 600 shall have bolted bonnet construction and class 900 and above shall have bonnet construction of integral or welded type. 3.3 All carbon steel valves of ANSI pressure rating class 600 and 800 shall have stainless steel trim (13% Cr.) unless otherwise specified in Data Sheet-A and ANSI pressure rating exceeding class 800 shall have stellited trim. 3.4 All alloy steel valves shall have stellited seats. 3.5 Valves that are to be kept in full 'OPEN'/'CLOSE' position shall be provided with a non-detachable locking arrangement. The locking arrangement provided shall be as per standard practice and shall be subject to approval by the PURCHASER/ENGINEER. 3.6 As specified in Data Sheet-A, valves operating under vacuum conditions shall have special glands designed for such conditions. 3.7 Motor operators shall be designed to close the valve within the time shown in Data Sheet-A. For details of motor operator, refer companion specifications TCE.M4-203-01 and TCE.M4-203-06. 3.8 Wherever extension stems are specified, these shall be of extra strong pipe with suitable coupling, fastened by locknuts and set screws. Floor stands shall be of sturdy construction and shall be at least one metre high from the floor. They shall be provided with chromium-plated scales and valve movement indicators. Where lateral and/ or vertical movements of valve are indicated in Data Sheet-A, the floor stand and extension spindle shall be designed to permit these movements. Adequate greasing facilities shall be provided for all pedestals and extended operating spindle attachments.		
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SPEC.NO. TCE.M4-103-55	TATA CONSULTING ENGINEERS LIMITED FORGED STEEL VALVES	SECTION: D22 SHEET 3 OF 4
3.9 Flow direction shall be clearly embossed on the valve body for globe and check valves. 4.0 <u>WELDING REQUIREMENTS</u> All welding procedure qualifications and welder performance qualifications shall be in accordance with Section-IX of the ASME Boiler and Pressure Vessel Code. Hard facing operations require procedure qualification. 5.0 <u>CLEANING</u> Prior to factory inspection, all manufacturing waste, such as metal chips and filings, rags, debris, welding rod stubs, and all other foreign matter shall be removed from the interior of each valve. All mill scale, rust, oil, grease, chalk, crayon, paint marks and other deleterious material shall be removed from the interior and exterior surfaces. At the time of shipment, valves shall be clean inside and outside. 6.0 <u>INSPECTION AND TESTS</u> 6.1 Inspection & tests shall be as per TCE.M4-185-18 and TCE.M4-185-01. 6.2 All valves shall be checked for correctness in respect of socket dimensions as per standard. 6.3 All valves shall be tested hydrostatically for strength, tightness of seats and tightness of backseating at the pressures indicated in Data Sheet-A . Water used for hydrostatic testing of valves with stainless steel components shall not have chloride content exceeding 20 ppm. Clean potable water may be used for testing of all other valves. 6.4 All valves shall be tested for seat tightness by air at a pressure of 6 bar (g) except for check valves. 6.5 All check valves shall also be hydrotested at 25% of the seat hydro test pressure. 7.0 <u>PAINTING AND CORROSION PROTECTION</u> Unless otherwise specified in Data Sheet-A/Section-C, two coats of primer of thickness 35 microns for each coat shall be applied to all steel and cast iron exposed surfaces as required to prevent corrosion, after release has been given for painting and before despatch. All parts shall be adequately protected for rust prevention. The use of grease or oil, other than light grade mineral oil, for corrosion protection is prohibited. Bores of		
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SPEC.NO. TCE.M4-103-55	TATA CONSULTING ENGINEERS LIMITED FORGED STEEL VALVES	SECTION: D22 SHEET 4 OF 4

all valves shall be covered, immediately after testing, draining and drying with suitable plastic end covers to avoid ingress of foreign materials.

8.0 **DRAWINGS**

The BIDDER shall furnish, along with his Bid, dimensioned outline and cross sectional drawings.

9.0 **NAME PLATES**

All valves shall have permanent stainless steel name plates indicating details as per MSS SP-25 "Standard Marking Systems for Valves, Fittings, Flanges and Unions". In addition, they shall have a permanent stainless steel tag fixed on the valve body indicating the PURCHASER's valve tag number .

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SPEC.NO. TCE.M4-103-55	TATA CONSULTING ENGINEERS LIMITED TITLE FORGED STEEL VALVES	SECTION: D SHEET 1 OF 1

DATA SHEET C

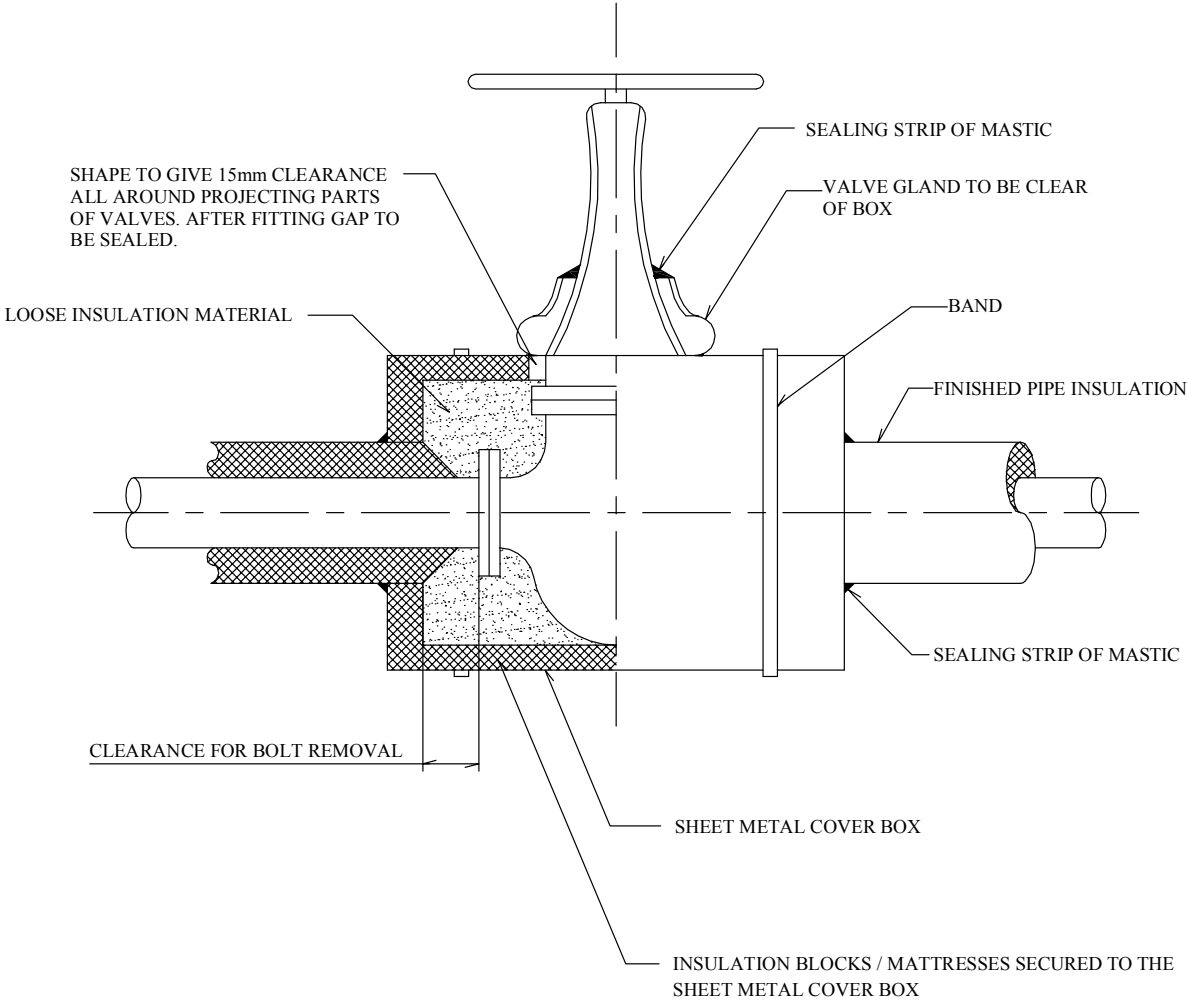
DATA TO BE FURNISHED BY THE VENDOR AFTER THE AWARD OF CONTRACT

The VENDOR shall submit, in the manner and within the time set forth in the Purchase Order/Letter of Intent the following :

- 1.0 Drawings showing Purchase Order number, outline dimensions, clearance dimensions for disassembly and weight (valve and actuator). The VENDOR's drawings identified by character, number and date, when reviewed by the PURCHASER, will be considered a part of this specification. The PURCHASER's identifying tag numbers shall be shown on each drawing or on a sheet attached and referenced to the drawing.
- 2.0 Quality plans as per the format enclosed in TCE.M4-185-01, covering also the inspection requirements as indicated in this specification, as minimum.
- 3.0 Operation and maintenance instruction manuals.
- 4.0 If specified in Data Sheet-A/Section-C, the details of all valves and valve list as per Purchaser's formats.

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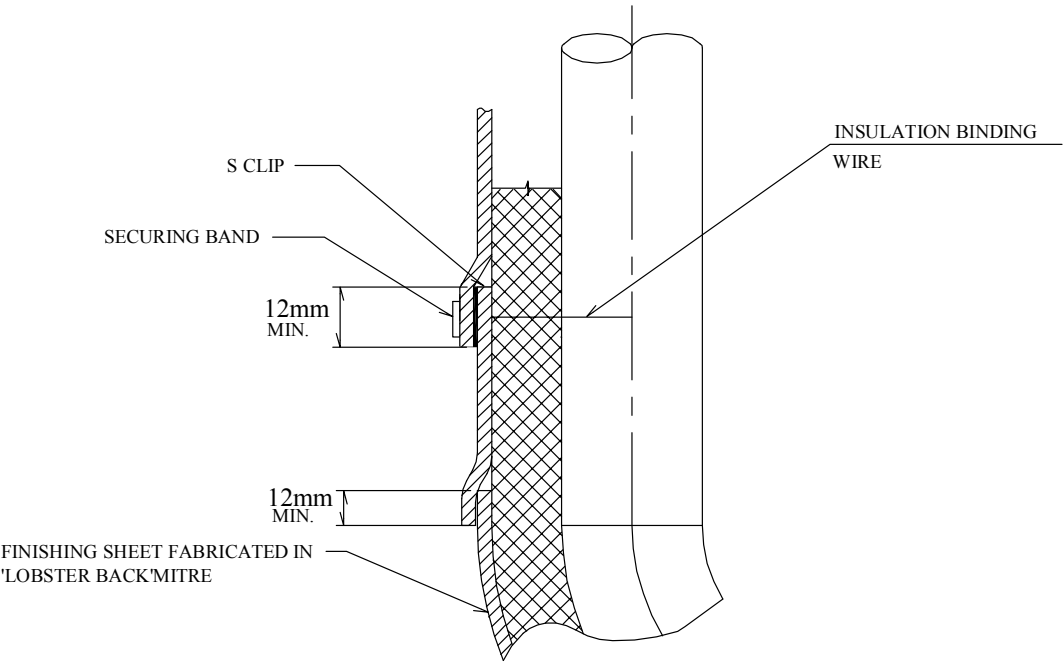
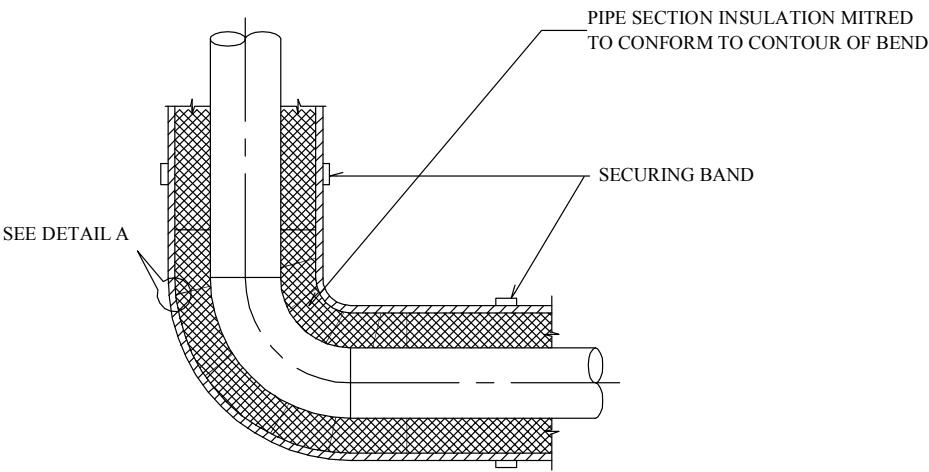
SPEC. NO. TCE.M4-104-51	TATA CONSULTING ENGINEERS LIMITED TITLE HOT AND COLD INSULATION FLANGED VALVES AND FLANGES	SECTION: D24 SHEET 1 OF 1



NOTES

- 1. FOR DETAILS OF MATERIALS AND APPLICATION OF INSULATION REFER TCE.M4-104-02 FOR HOT INSULATION AND TCE.M4-104-03 FOR COLD INSULATION.

SPEC. NO. TCE.M4-104-52	TATA CONSULTING ENGINEERS LIMITED	SECTION: D25
	TITLE HOT AND COLD INSULATION BENDS WITH METAL FINISHING SHEET	SHEET 1 OF 1

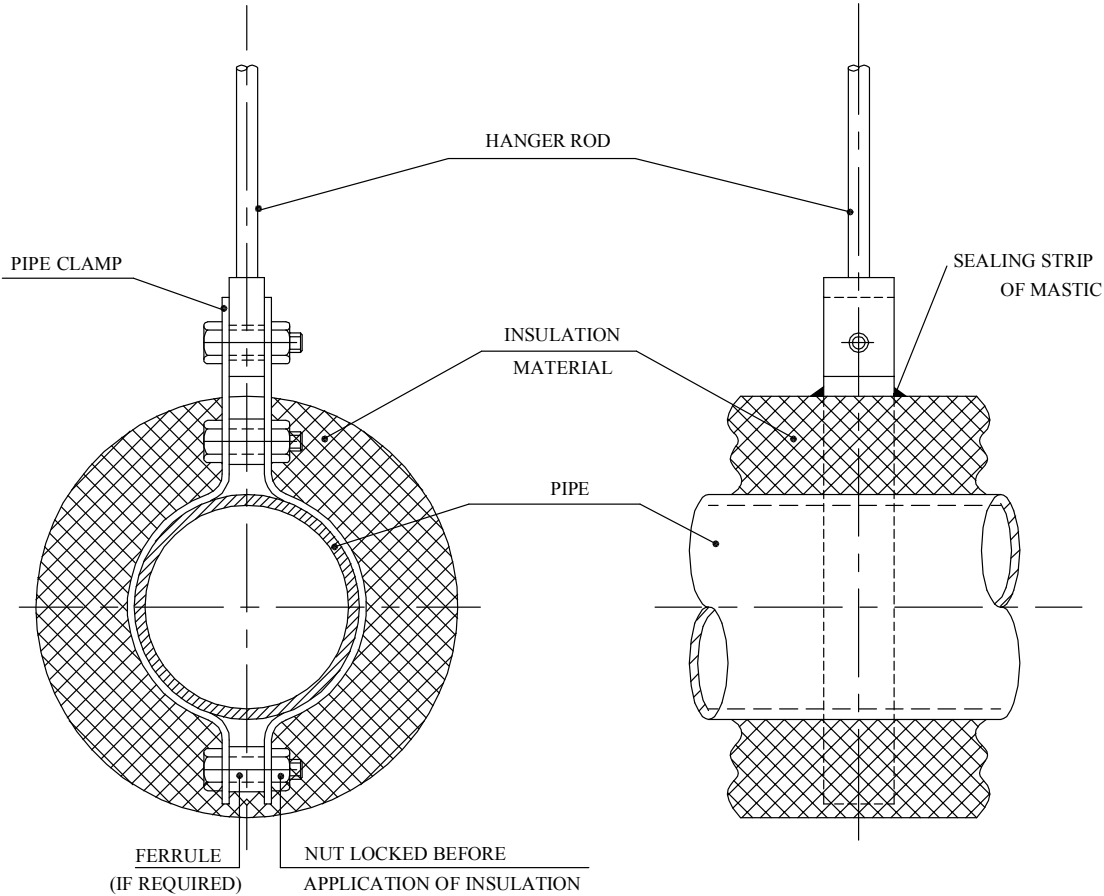


DETAIL A

NOTES

- FOR DETAILS OF MATERIALS AND APPLICATION OF INSULATION REFER TCE.M4-104-02 FOR HOT INSULATION AND TCE.M4-104-03 FOR COLD INSULATION.

SPEC. NO. TCE.M4-104-53	TATA CONSULTING ENGINEERS LIMITED		SECTION: D26
	TITLE	HOT INSULATION HANGERS FOR HORIZONTAL PIPE	SHEET 1 OF 1



NOTES

1. FOR DETAILS OF MATERIALS AND APPLICATION OF INSULATION REFER TCE.M4-104-02.



TEMPERATURE RANGE	SPAN FOR EXPANSION JOINT
BELOW 200° C	5.4 METRES
200 TO 300°C	3.6 METRES
301 TO 400°C	2.7 METRES
ABOVE 400°C	1.8 METRES

1. FOR DETAILS OF MATERIALS AND APPLICATION OF INSULATION REFER TCE.M4-104-02.

SPEC.NO.	TATA CONSULTING ENGINEERS LIMITED	SECTION : D
TCE.M4-134-103	DESIGN OF POWER PLANT PIPING	SHEET 1 OF 15
1.0	<u>SCOPE</u> This specification covers the minimum technical requirements and essential particulars for the design of the piping systems included in the VENDOR's scope as identified in the drawings and documents forming a part of this specification. The VENDOR/CONTRACTOR shall demonstrate that the piping meets the specification and the applicable codes.	
2.0	<u>CODES AND STANDARDS</u>	
2.1	The design of pipes, pipe assemblies, pipe fittings, flanges and components, valves and specialities and any other pressure retaining part in a piping system shall be carried out in accordance with the applicable power piping code.	
2.2	The design of the piping systems shall also meet the statutory requirements of the countries of manufacture and installation of the piping systems. In case the piping systems are manufactured and / or installed in India, the design shall meet the requirements of the Indian Boiler Regulations (IBR) for system under the purview of IBR.	
2.3	Notwithstanding the recommendations and stipulations of the codes and standards mentioned above, the requirement of this specification and associated Data sheets shall be deemed minimum and shall be complied with fully.	
2.4	All codes and standards referred shall be the latest version on the date of offer made by the Bidder unless otherwise indicated.	
2.5	Nothing in this specification shall be construed to relieve the Vendor/Contractor of his responsibilities as above.	
3.0	<u>BASIC DESIGN CRITERIA</u>	
3.1	Piping shall be designed adequately to meet the system requirements of flow, pressure drop, etc., under all operating modes of the plant, both normal and abnormal. Planned and forced outages of equipment or systems shall be taken into account and it shall be ensured that realisation of maximum feasible plant performance in terms of output and efficiency is not hampered by inadequacies in piping design.	
3.2	It shall also be ensured that, under no circumstances, including mal-operation or failure of an equipment or system, the safety of the plant, equipment or personnel is endangered by inadequate design of piping.	
3.3	Piping systems shall also be designed and conceived in such a manner as to maximise plant or equipment availability. Provision of ring headers, sectionalising valves, isolating valves, block valves, bypass, etc., are examples	
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TCE.M4-134-103	DESIGN OF POWER PLANT PIPING		SHEET 2 OF 15

illustrating this concept and it is the responsibility of VENDOR/CONTRACTOR to ensure provision of such facilities, at no extra cost to the PURCHASER, as deemed necessary regardless of whether the same have been identified in contract documents and drawings or not.

4.0 **LINE SIZING**

4.1 Sizes of piping shall be selected such that the velocity of fluid in pipes does not exceed the following limits under conditions of maximum possible volumetric flow.

STEAM

Superheated steam	75 m/s
Saturated steam / Exhaust steam	40 m/s.
Wet steam	30 m/s.

WATER

Pump suction	1.5 m/s.
Pump delivery	3.0 m/s
Boiler feed pump discharge	6.0 m/s.
City water	1.5 m/s.

OIL

Heavy oil (Heated)	2 m/s.
Light oil	2 m/s.

GASES

Compressed air	15 m/s.
Natural gas	30 m/s.

4.2 Lower values of velocities than those stated above shall be used to determine line size if dictated by considerations of pressure drop, NPSH, surges, water hammer, etc.

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4.3	The design flows considered in line sizing shall not be less than the rated capacities of equipment to which the piping is connected such as pumps, blowers, compressors turbines, boilers, etc., rated capacity of control valve, flow limiting orifices, etc., or, the system heat and / or mass balance diagrams.	
4.4	The selection of line size shall take into account likely increase in pressure drop with the ageing of the pipe due to increase in pipe roughness, encrustation of pipe with scale, dirt, foreign matter, etc.. A suitable allowance shall be made towards this expected increase in pressure drop and the same shall be subject to the approval of PURCHASER/ENGINEER.	
4.5	While sizing pump suction lines, NPSH requirements of pumps shall be fully met under all conditions of operation including trip-out of an operating pump and failure of the standby pump to come on line.	
4.6	Wherever strainer pressure drops are considered, the same shall be for the 50% clogged condition of the strainers. Pressure drops across equipment shall correspond to unclean condition of the equipment.	
4.7	Sizes of boiler feed pump suction piping shall be selected to meet the NPSH requirements of the pumps under transient conditions prevailing on turbine trip out and simultaneous loss of steam supply to feed water tank.	
4.8	Cascade drain piping systems of feed water heaters shall also be designed to handle the additional flows that are likely to occur due to tube rupture in the heaters besides other operating conditions stipulated elsewhere. The minimum additional flow to be considered shall be either 10 percent of tube side flow at Maximum Continuous Rating (MCR) conditions or the flow that can result from the complete rupture of one tube with two open ends, whichever is greater.	
4.9	All overflows shall be designed for a capacity not less than the maximum possible difference between inlet and outlet flows under all operating conditions normal and abnormal, including mal-operation.	
5.0	<u>MATERIALS</u>	
5.1	The material specifications of piping of various systems shall be as specified in Data sheet – A.	
5.2	Bidders may offer, if they so desire, alternate materials equal or superior to those specified. However, no credit would be given to offers containing materials superior to those specified. The responsibility for establishing equality or superiority of the alternate materials offered to those specified rests entirely with the Bidder, the PURCHASER/ENGINEER reserves the right to reject such alternate materials and insist upon those specified.	
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TCE.M4-134-103	DESIGN OF POWER PLANT PIPING	SHEET 4 OF 15
5.3	Bidders shall note that equality or superiority of the materials offered by them vis-à-vis those specified would be judged not only based on a comparison of the material standards but also on the ease of fabrication, shop and field welding, heat treatment, service record and any other characteristics considered important by the ENGINEER.	
5.4	Bidders shall indicate, in their offer, reasons for their wishing to deviate from the materials specified.	
6.0	<u>DESIGN PRESSURES</u>	
6.1	The minimum design pressures of piping systems shall be as indicated in Data Sheet – A attached to this specification. In the event of this information not being available in the Data sheets, the following shall be construed to be the minimum requirements for design pressures.	
6.2	<u>MAIN STEAM LINE</u>	
6.2.1	The main steam line beyond the steam stop valve shall be designed for the design pressure of boiler, i.e. not less than the highest pressure at which any safety valve is to be set to lift, except that, for piping which are operating under thermal creep and the total capacity of the safety valve on the superheater is not less than 20% of the evaporative capacity of the boiler, the lowest pressure at which any superheater safety valve is set to lift.	
6.2.2	When there is no superheater, the design pressure of the piping shall be the design pressure of the boiler.	
6.2.3	In case of a forced flow steam generator, the design pressure shall be as indicated in data sheet – A.	
6.3	<u>REHEAT STEAM LINES</u>	
6.3.1	In reheat systems which are not operating under thermal creep, the design pressure shall be the highest pressure at which any safety valve on the reheat system is set to lift. When no safety valves are mounted at the reheater inlet, the design pressure of the reheater inlet piping shall be the highest pressure at which any reheater outlet safety valve is set to lift, increased to take account of the pressure drop through the reheater corresponding to the most severe condition of operation.	
6.3.2	In reheat systems which are operating under creep, the design pressure shall be the lowest pressure to which any safety valve on the reheat system is set to lift.	
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6.4	<u>EXHAUST STEAM LINES</u>	
	All uncontrolled extraction steam lines of turbine shall be designed for 1.1 times the maximum possible working pressure on the lines.	
6.5	<u>FEED WATER PIPELINE</u>	
6.5.1	The feed water piping beyond the discharge nozzles of the feed water pumps, shall be designed for the pump discharge pressure under no-flow condition for a fluid temperature of 15 deg. C.	
6.5.2	In the event of there being a likelihood of the speed of the prime mover exceeding the rated speed by more than 10%, the design pressure shall be increased by the effect of the excess in overspeed over 10%.	
6.5.3	<u>Feed water booster pump suction line.</u>	
	The design pressure shall be not less than the sum of the highest set pressure of safety valves on the deaerator / feed water tank and the pressure due to static head of the water in the suction line calculated for a fluid temperature of 15°C.	
6.5.4	<u>Feed water booster pump discharge line.</u>	
	The design pressure shall not be less than the sum of the design pressure as calculated for the suction line of the booster pump and the differential head of the booster pump for the no-flow condition with a fluid temperature of 15 deg. C.	
6.6	<u>PROVISION OF SAFETY AND RELIEF VALVES</u>	
6.6.1	Piping downstream of pressure reducing devices such as control valves, orifices, etc., shall be designed for the same pressures as applicable for piping upstream of the devices unless the downstream piping systems are adequately protected by safety or relief valves as under :	
6.6.2	In order to take cognisance of the provision of safety or relief valves, the combined relieving capacity of all safety or relief valves provided to protect a system shall equal or exceed the maximum possible mass flow that the system may be expected to handle under all normal or abnormal conditions of operation. In the case of safety valves located downstream of a control valve for example, the combined relieving capacity of the safety valves shall equal or exceed the estimated flow through the control valve when the valve is wide open with maximum upstream pressure and all downstream valves closed.	
6.6.3	When safety and / or relief valves have been provided as above, the design pressure of the piping system protected by the safety valves shall not be less than 1.1 times the highest set pressure of any safety valve. The lowest set pressure of	
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any safety valve shall not be less than 1.1 times the maximum expected working pressure of the system.		
6.7	<u>PUMP DISCHARGE LINES</u>	
The discharge piping of all pumps other than the boiler feed pumps and boiler feed booster pumps shall be designed for a pressure not less than 1.1 times the pump discharge pressure under no-flow conditions for a working fluid temperature of 15⁰C.		
6.8	The design pressure of all branch piping including drain, vent and instrument impulse piping up to the last roof valve shall be the same as that of the main line.	
6.9	In general, piping shall be designed for the maximum possible pressure attainable under the most arduous operating condition including pressure surges. However, the design pressure of any piping system shall not be less than 10 kg/cm²g.	
7.0	<u>DESIGN TEMPERATURES</u>	
7.1	The design temperatures shall be as indicated in the Data Sheets – A.	
7.2	Where no value is indicated in the Data sheets, the same shall be as per the recommendations of applicable codes.	
8.0	<u>WALL THICKNESS</u>	
8.1	The calculation of wall thickness required for piping subject to internal and / or external pressure shall be based on the formulae and recommendations given in the applicable codes. Adequate allowances shall be made towards thinning due to bending, weakening at branch connections, threading, commercial tolerances on pipe wall thickness, corrosion and erosion, etc., and the same shall be subject to approval by the ENGINEER.	
8.2	A minimum corrosion / erosion allowance of 1 mm, shall be considered while selecting wall thickness of pipes for all systems. Additional allowances would be required in the case of piping handling corrosive and / or erosive media and in case of piping located in a corrosive environment.	
8.3	Pipe handling flashing liquids, as in case of feed heater drain lines, shall be selected with extra wall thickness to combat erosion.	
8.4	Much greater wall thickness than called for by strength calculations would be required in order to minimise noise and vibration at certain locations such as downstream sections of high pressure reducing valves. The thickness and lengths of such sections shall be as specified by the ENGINEER.	
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8.5 Unless otherwise indicated in Data sheets – A, piping shall be designed for a maximum equivalent full temperature cycles of 7000 occurring over the design life of the piping system.

8.6 In case of carbon steel materials, (primarily for water & air services) the nominal wall thickness of no piping shall be less than the minimum acceptable values given below. For rolled and welded pipes thickness shall be 8 mm from NB 500 to NB 800, 10 mm from NB 850 to NB 1000, 12 mm from NB 1050 to NB 1200.

NB mm (in)	15 (1/2)	20 (3/4)	25 (1)	32 (1-1/4)	40 (1-1/2)	50 (2)	65 (2-1/2)	80 (3)	100 (4)	125 (5)
Min. Nominal Thickness mm	3.25	3.25	4.05	4.05	4.05	4.5	4.5	4.85	5.4	5.4
Nb mm (in)	150 (6)	200 (8)	250 (10)	300 (12)	350 (14)	400 (16)	450 (18)			
Min. Nominal Thickness mm	5.4	6.35	6.35	6.35	7.1	7.1	7.1			

Minimum thickness for other services (steam, feed water, condensate, fuel oil system etc.,) shall be as per standard schedule of ASME B 36.10.

9.0 **FLEXIBILITY ANALYSIS**

9.1 Formal flexibility analysis calculations shall be carried out in case of piping subject to restrained thermal expansions or contractions. The following piping systems shall be analysed.

9.1.1 Pipelines with a maximum operating temperature equal to or greater than 150 deg. C.

9.1.2 Regardless of the operating temperatures, all piping connected to sensitive rotating equipment such as turbines, feed pumps etc., for which limiting values of pipe reaction have been specified by the equipment manufacturer.

9.1.3 Any other pipeline which in the opinion of the ENGINEER requires a formal analysis even for the lines less than 150 deg.C

9.2 **OBJECTIVES OF FLEXIBILITY ANALYSIS**

The flexibility analysis calculation carried out shall meet the following basic objectives.

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9.2.1	To ensure that the stresses in the piping system are within the permissible values as given in the applicable codes under operating conditions, hot or cold.	
9.2.2	To ensure that the forces and moments exerted by the piping on connected equipment are within the maximum allowable values stipulated by the supplier of equipment under any operating condition, either hot or cold.	
9.2.3	To ensure that the forces and moments at the various restraints and anchors in the piping system are within limits acceptable to the ENGINEER under any operating conditions either hot or cold.	
9.2.4	To calculate the deflections and rotations of the piping at various salient points and to ensure availability of adequate space for the same.	
9.2.5	To arrive at a rational basis for the selection and design of hanger and support system for the piping.	
9.3	<u>METHOD OF ANALYSIS</u> Wherever formal analysis is called for, comprehensive analytical methods employing the use of modern electronic computers shall be adopted and these methods shall be comparable to the state of the art. The software used for analysis shall be validated with bench mark problems. In particular, the following requirements shall be met.	
9.3.1	Piping systems shall be treated as a whole between anchor points.	
9.3.2	Linear and rotational behaviour of connecting equipment and intermediate attachments shall be taken into account.	
9.3.3	All linear and rotational restraints shall be taken into account.	
9.3.4	The restraining effect of hangers and supports shall be taken into account. Thus, the CONTRACTOR shall include, in his flexibility analysis calculations, all piping beyond his terminal points upto the next available anchor in each branch in order to treat the system as a whole for purposes of flexibility analysis.	
9.3.5	Flexibility characteristics and stress intensification factors for bends, and other items branches shall be utilised. Flange correction factor and bend stress intensification shall be used where applicable.	
9.3.6	All components in a piping system which have heavy wall section and do not contribute to the flexibility of the piping system shall be considered as rigid elements (for example, valves).	
9.3.7	The effect of the dead weight of the piping system shall be taken into account.	
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9.3.8	Piping systems shall be analysed for all possible temperature distributions arising from various modes of operation, normal and abnormal, including possible mal-operation and the objectives of the analysis shall be met for each mode of operation.	
9.4	In the case of equipment to which several pipelines are connected each of which is analysed independently, it would be necessary to ensure that the combined values of the forces and moments exerted by each pipeline on the equipment for all possible modes of operation are also within acceptable limits as specified by the equipment manufacturer. The method of combining the values of forces and moments shall be as specified by the equipment manufacturer.	
9.5	<u>COLD SPRINGING</u>	
9.5.1	Cold springing of piping may be carried out when the operating temperatures are high and the net thermal expansions are large, provided that the same is acceptable to the equipment manufacturer. Cold springing of piping systems with relatively small thermal expansions as in case of boiler feed pump suction and discharge piping, is not permitted. CONTRACTOR shall obtain specific approval from ENGINEER in the event he proposes to carry out cold springing of any piping system.	
9.5.2	If the cold springing is carried out, it is recommended that the cold spring factor lies between 0.5 and 0.85.	
10.0	<u>SURGE ANALYSIS</u>	
10.1	If it is deemed necessary by the PURCHASER / ENGINEER, a surge analysis shall be carried out by the CONTRACTOR to evaluate the effect of sudden closure of valves that are hydraulically or pneumatically actuated. The pressure rise in the piping, additional thrusts and moments created at the terminal ends and intermediate restraints, additional stresses to which the piping is subjected and the deflection and rotation that the piping is subjected to due to the impact and / or surge shall be computed.	
10.2	The additional stresses, forces and moments created shall be studied in conjunction with the corresponding values computed by the flexibility analysis and the combined values shall be held within permissible limits specified by the equipment manufacturer and / or codes.	
10.3	The deflection and rotations of the pipe at the locations of the power actuated valves causing the impact and surge shall be within the limits specified by the valve manufacturer. In the event of these limits being exceeded, the CONTRACTOR shall introduce shock absorbers at suitable locations to hold the deflection and rotations within permissible limits. These shock absorbers shall	
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TCE.M4-134-103	DESIGN OF POWER PLANT PIPING	SHEET 10 OF 15
not offer any resistance to the movements and rotations of the piping caused by the thermal expansion as computed by flexibility analysis studies. 10.4 The details of the shock absorbers, mode of their connection to piping and structures and the loads transferred to the structures shall be furnished to PURCHASER/ENGINEER for review and approval. 10.5 The CONTRACTOR shall also submit to the PURCHASER/ENGINEER, a write-up outlining the procedure adopted by him for carrying out the surge analysis to the PURCHASER / ENGINEER for prior approval. 11.0 <u>LAYOUT AND DETAILING</u> 11.1 Contractor shall prepare composite drawings floor/elevation - wise on AUTOCAD which shall cover the following details : (a) Piping layout (NB 65 and above). (b) Hanger location (c) Valve spindle Orientation. (d) Equipment with maintenance details (e) Cable tray and ventilation ducts. (f) All main and internal columns, vertical bracings and other civil details. (g) Individual drawings shall be prepared only after approval of the composite drawings. Composite drawings shall be drawn to scale 1:50 scale. The CONTRACTOR shall also furnish floppy of the composite drawings. 11.2 All pipes of sizes greater than NB 50 mm are considered as shop fabricated piping and detailed piping layout drawings shall be to scale and shall be prepared as plan and sections and shall contain the following minimum details. 11.2.1 Fully dimensional layout with locating dimensions referred to plant axes and co-ordinates. 11.2.2 Details of all stub connections and other welded attachments as required for anchors, restraints, hangers, supports, etc., and all details to meet IBR requirements. 11.2.3 Slope, drains and vents.		
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11.2.4	Edge preparation details of weld ends.	
11.2.5	Mounting and orientation of valves and specialities and maintenance space requirements.	
11.2.6	Location and tag nos., of hangers, supports, restraints, anchors, etc.	
11.2.7	Locations and magnitudes of cold cuts, if any.	
11.2.8	Pipe sizes, materials, design parameters, shop and field test requirements.	
11.2.9	Insulation details.	
11.2.10	Tolerances if any.	
11.2.11	Any specific requirements on shop fabrication and / or field erection.	
11.2.12	Any other details considered necessary by the ENGINEER.	
11.3	Pipes of sizes of NB 50 mm and smaller are regarded as field -routed. The CONTRACTOR shall however indicate any specific requirements he may have in regard to the routing of these pipes.	
11.4	Detailed bills of material shall be prepared for all piping systems. In case of shop - fabricated piping, the bill of materials shall correspond to the layout drawing prepared. In the case of field - run piping, these shall be estimated quantities, with adequate surplus materials for wastage and contingencies.	
11.5	While routing piping, the following requirements shall be taken into account :	
11.5.1	All piping shall be routed so as to avoid interference with other pipes and their hangers and supports, electrical cable trays, ventilation ducting, structural members, equipment, etc. Adequate clearances shall be ensured with respect to the above to accommodate insulation and pipe movements. After the award of the contract, adequate number of prints of the PURCHASER's / ENGINEER's structural, general arrangement and such other drawings as may be required to finalise the piping layout will be furnished to the VENDOR / CONTRACTOR for his reference and use.	
11.5.2	All piping shall be grouped where practicable and shall be routed to present a neat appearance.	
11.5.3	The piping shall be arranged to provide clearance for the removal of equipment requiring maintenance and for easy access to valves and other piping accessories.	
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TCE.M4-134-103	DESIGN OF POWER PLANT PIPING	SHEET 12 OF 15
11.5.4	Piping shall be generally be routed above ground but where specifically indicated / approved by the ENGINEER, the pipes may be arranged in trenches or buried. Pipes at working temperatures above the ambient shall however not be buried. Buried piping shall be coated and wrapped as per TCE.M4-134-102	
11.5.5	Overhead piping shall have a minimum vertical clearance of 2.3 metres above walkways and working areas and 6 metres above roadways unless otherwise approved by the ENGINEER.	
11.5.6	Drains shall be provided at all low points and vents at all high points as per actual layout regardless of whether the same have been shown in the flow diagrams or not. Pipes shall be sloped towards the drain points. Besides at low points, tell-tale drains shall be provided at all other locations as necessary to remove on-line valves & specialities from piping for repair or replacement (e.g on either side of control valves). Where spray water is introduced into steam piping, at a suitable location downstream, drain pots shall be envisaged along with motor - operated drain valves and high and low level switches. The drain valves shall be interlocked with the level switches for automatic operation. All start-up drains on main steam, cold reheat, hot reheat and HP-LP bypass piping shall be furnished with motor-operated regulating valves. All other drains on steam piping systems shall be trapped and all trap stations shall be provided with isolating, bypass and free-blow valves. When drains are headered, each drain shall be provided with a non-return valve. Only drains from lines at identical operating pressures may be headered. Drains from all steam and hot water lines and equipment other than tell-tale drains shall be led into suitable flash tanks which in turn shall be drained and vented to condenser and/or atmosphere as directed by the PURCHASER/ENGINEER. All cold water drains shall be led down to the nearest floor drain. All vents shall be led into conveniently located anti-flash funnels which shall be drained into the nearest floor drain.	
11.5.7	Provision shall be made while preparing piping layout to accept control valves, flow measuring elements and any other online speciality or equipment supplied by others. Sufficient upstream and downstream lengths shall be provided for flow measuring devices, control valves, desuperheaters and other specialities as required by the suppliers.	
11.5.8	At all the screwed valves and screwed connections on equipment, unions or flanges shall be provided to facilitate disassembly. Likewise, unions/flanges shall also be provided at suitable points on straight length of screwed piping.	
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11.5.9	All local instruments shall be so located on piping as to render them observable from the nearest available platforms/floors.	
11.5.10	At all points where pipes pass through concrete floors or brick or other walls, suitable floor collars or wall boxes shall be provided by OTHERS. The VENDORS / CONTRACTOR shall design and furnish the details of the floor collars to the ENGINEER / PURCHASER.	
11.5.11	In the case of flanged piping, boxes shall be large enough to permit the passage of the flange.	
11.6	<u>HANGERS AND SUPPORTS</u>	
11.6.1	All piping supports, guides, anchors, turnbuckles, and hangers, spring hangers, rollers, with incidental structural subframing shall be designed, by the VENDOR/CONTRACTOR.	
11.6.2	The VENDOR/CONTRACTOR's supports, spring hangers, guides, anchors and rollers shall utilise the PURCHASER's existing steel in so far as this can be done. Where additional steel is required for the attachment of hangers, it shall be designed by the VENDOR/CONTRACTOR.	
11.6.3	The hangers and supports shall be spaced in accordance with standard engineering practice as outlined in applicable codes and standards. Their locations shall also be so chosen as to avoid unduly heavy loads being transferred to the PURCHASER's structures. The location of hangers and supports is be subjected to approval by the PURCHASER/ENGINEER.	
11.6.4	If severe vibration of piping is encountered in systems over which the VENDOR/CONTRACTOR has control, or if the piping system is to be subjected to shock loading, hangers shall be supplemented by vibration control equipment and/or snubbers of an approved design.	
11.6.5	At locations where lateral or axial movement is expected, the hangers shall be provided with suitable linkages to permit swing. All hangers shall be designed to be vertical in the cold position unless otherwise stipulated by the ENGINEER.	
11.6.6	In order to minimise any horizontal force components of the dead weight or any binding of the pin or rocker joints used on the hangers, hanger rods should be as long as possible. In critical piping systems, the length of the hanger assembly capable of swinging shall not be less than 20 times the maximum expected pipe movement in the horizontal plane at the hanger location.	
11.6.7	The CONTRACTOR shall furnish embedded part details covering type, size, location, design load, material specification and detailed drawings of the part (If	
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necessary). He shall furnish the embedded part list and details to the PURCHASER when called for. 11.6.8 When medium or heavy brackets are bolted to walls, back plates of adequate size and thickness shall be furnished to distribute the load against the wall. Where the use of a back plate is not practical, the brackets shall be fastened to the wall in an approved manner. However, the attachment of support brackets to brick walls shall be avoided as far as possible and where this is not possible, details of the attachment shall be furnished to the ENGINEER for his approval. 11.6.9 In case the PURCHASER is carrying out the building structural steel design, the CONTRACTOR shall furnish the following details : (a) Intensity of piping load to be considered in all areas. (b) Location of the hanger with load. (To mark this PURCHASER/ENGINEER would furnish floor framing drawing or floppy. CONTRACTOR shall indicate location of these on floor framing drawings and return the floppy to PURCHASER/ENGINEER). 11.7 <u>FITTINGS AND FLANGES</u> 11.7.1 Branch connections in piping shall as far as practicable be made by the use of wrought or forged seamless fittings such as tees, laterals and crosses. Small stubs as may be required for instrument, drain and vent connection may be provided in the form of weldolet fittings or forged couplings. Pipe to pipe branch connections are acceptable only in the event of non-availability of fittings. Such connections shall be reinforced as required. 11.7.2 Mitred bends may be adopted for piping systems upto a design pressure of 10 kg/cm²g only. Mitre angle shall not exceed 22.5 degrees. 11.7.3 Slip-on type of flanges shall be used only upto a maximum pressure rating of ANSI class 300 in the case of non-steam systems and 150 class in the case of steam systems. In case of higher pressure ratings, welding neck type of flanges shall be employed. 11.8 <u>DIMENSIONAL STANDARDS</u> 11.8.1 Uniform dimensional standards for all piping components shall be employed to ensure compatibility with one another. 11.8.2 Nominal pipe sizes and pipe outside diameters shall generally be as per ASME B36.10. In case of deviation, the CONTRACTOR shall bring it to the specific attention of the ENGINEER for prior approval stating reasons for the deviation.		
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11.9	<u>INSTRUMENT CONNECTIONS</u>	
11.9.1	Unless otherwise called for by the PURCHASER, all thermowell stubs shall have an internal threading to M33 x 2.	
11.9.2	All stubs for pressure or flow measurement for piping with a maximum working pressure equal to or above 62 barg or with a maximum working temperature equal to or above 425 ⁰ C shall be NB 25 mm and double root valves shall be used.	
11.9.3	Stubs for pressure or flow measurement on pipelines with a maximum working pressure less than 62 bar(g) or with a maximum working temperature less than 425 ⁰ C shall be NB 15 mm size and single root valves shall be used.	
11.9.4	Pressure measurement stubs on fuel oil lines shall be of NB 25 mm size.	
11.10	<u>DRAIN AND VENT CONNECTIONS</u>	
11.10.1	Vent and drain connections on pipelines shall be atleast of NB 25 mm size.	
11.10.2	For pressure as defined in clause 11.9.2, double isolating valves shall be used on drain and vent lines. For pressure and temperature conditions as defined in clause 11.9.3, single isolating valves are considered adequate.	
12.0	For drawings and documents to be submitted by the CONTRACTOR after the award of the CONTRACT, refer Data sheet – C attached to this specification.	
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DATA SHEET-C

INFORMATION TO BE FURNISHED BY THE VENDOR AFTER THE AWARD OF CONTRACT

The VENDOR shall submit, in the manner and within the time set forth in the purchase order/letter of intent, the following:

- 1.0 DESIGN CALCULATIONS FOR THE FOLLOWING:
 - (a) Line sizes
 - (b) Pipe wall thickness calculations
 - (c) Branch reinforcement calculations
 - (d) Results of the flexibility analysis.
 - (e) Hanger loads, selection and related details.
 - (f) Results of surge analysis (Where applicable).
 - (g) Code compliance calculations.
- 2.0 Necessary piping layout and/or isometric drawings for submission to statutory authorities/IBR.
- 3.0 Composite piping layout drawings. This shall indicate the piping layout engineered by the VENDOR as well as other piping layouts which are used by him to check for interferences. This shall also indicate the hanger locations.
- 4.0 Floppy of Purchaser's drawing (where applicable) with locations of hangers and supports marked therein. The VENDOR/CONTRACTOR shall be responsible for maintaining arrangement, dimensions etc., in accordance with the ENGINEER's approved drawings.
- 5.0 Results of the flexibility analysis: The results shall indicate for each system and each mode of operation on the following:
 - 5.1 Ranges of hot and cold values of forces and moments exerted by the piping on each nozzle of connected equipment.
 - 5.2 Summation of above values at all nozzles of a particular equipment as per the procedure to be outlined by the PURCHASER/ENGINEER.

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1.0

SCOPE

This specification covers the technical requirements and essential particulars for the design (as applicable), supply, shop fabrication, inspection, testing, cleaning, commissioning assistance and protection of the piping systems as covered in the tender specification documents and drawings. The CONTRACTOR shall demonstrate that the piping satisfies the requirements of the specification and applicable codes. To the extent design and engineering of piping systems are specified to be in the CONTRACTOR scope in Section C of the tender documents and hereunder, all references to the PURCHASER drawings and documents in the subsequent clauses of this section shall be understood to imply the CONTRACTOR's drawings and documents.

2.0

CODES AND STANDARDS

2.1

All piping systems including subcontracted items shall comply with all currently applicable statutes, regulations and safety codes in the locality where the system will be installed. The piping shall also conform to the latest editions of the codes and standards listed under Clause 2.2 below. Nothing in this specification shall be constructed to relieve the CONTRACTOR of this responsibility.

2.2

The system and work under this contract shall conform to the following standards/codes:

- (a) Indian Boiler Regulations
- (b) Indian Regulations of Inspector of Explosives
- (c) ASME Code 'Power Piping' - ASME B 31.1 and all other associated ANSI/ASME standards.
- (d) Manufacturer's Standardisation Society (MSS), USA, Standard Practices.
- (e) American Society for Testing and Materials (ASTM) Specifications.
- (f) Pipe Fabrication Institute (PFI), USA, Standards

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2.3

In case of conflict between the codes and standards referred to herein and the requirements of this specification, the more stringent requirement shall govern.

3.0

SCOPE OF WORK

3.1

The scope of supply of the CONTRACTOR under this contract shall be as defined in Section C of this specification. For all the piping systems included in this scope of supply, the CONTRACTOR shall supply all materials except those items specifically excluded from his scope in Section C, and render the piping systems complete as applicable. The CONTRACTOR's scope of supply shall include but not be limited to the following:

- (a) Pipes, tubes, headers, manifolds, etc.
- (b) Bends, elbows, returns, tees, laterals, crosses, reducers, caps and closures, full and half couplings, plugs, sleeves and saddles, stubs and bosses, unions and other similar fittings.
- (c) Flanges
- (d) Gaskets and fasteners
- (e) Complete assemblies of hangers, supports, anchors, guides, restraints, snubbers, shock absorbers, etc., including welded attachments, springs and spring gauges, beam clamps, clips, shoes, rollers, trapezes, trunnions, etc.
- (f) Auxiliary steel, concrete foundations, pedestals, etc., as required for hangers, supports, guides, restraints, anchors, snubbers, shock absorbers, etc.
- (g) All materials as required for providing anti-corrosive treatment to buried pipes
- (h) All paints, varnishes, primers, thinners and other painting materials.
- (i) Weather hoods for bare pipes crossing ceilings and walls.

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3.2 Unless otherwise specified in Section C, the CONTRACTOR's scope of supply includes all instrument impulse piping and fittings upto the last root valve. In the case of temperature measurement points, the CONTRACTOR's scope includes supply of thermowell stubs. 3.3 The CONTRACTOR shall supply all necessary drains and vents including anti flash funnels as required for the safe and effective draining/venting of the piping systems. It must be noted that the flow diagrams may not indicate all the drains and vents that would be required. As stated elsewhere, it is the CONTRACTOR's responsibility to identify the requirements of drains and vents whether the same have been shown in the flow diagrams or not and supply the necessary pipe work, fittings, hangers, supports, etc. The drains and vents indicated on the flow diagrams shall however be regarded as minimum requirements. The drains and vents shall be led upto the nearest floor drain in case of cold water systems and upto the flash tank in case of steam and hot water systems, as directed by the PURCHASER. 3.4 In the case of pipes laid in trenches or on pipe racks, the CONTRACTOR shall supply necessary steel members, cross beams and other supporting accessories such as stools, saddles, base plates, clamps, U-bolts, angles, clips, etc. 3.5 All concrete pedestals and foundations other than those specifically indicated as excluded from the CONTRACTOR's scope in Section C shall be supplied by the CONTRACTOR. 3.6 Wherever uninsulated pipes cross walls or roofs, the necessary weather hoods shall be designed, fabricated and supplied by the CONTRACTOR as directed by the PURCHASER. 3.7 The CONTRACTOR shall design, fabricate and supply all hangers and supports, anchors, guides, restraints, etc., including necessary welded attachments and auxiliary steel based on data furnished by the PURCHASER/ENGINEER. The data to be furnished by the PURCHASER / ENGINEER would be from the systems point of view and would typically include the overall configuration of the support system, operating and design loads, cold to hot movements of pipe, desired hanger/support spring constant, type of spring support, viz., constant load type or variable load type, etc. It is the CONTRACTOR's responsibility to design, engineer and select the individual components of the hangers, supports, restraints, guides or anchors based on the				
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PURCHASER's data and in accordance with the requirements of this specification. 3.8 The loads indicated in the PURCHASER's hanger/support sketches do not include the weights of hanger components such as clamps, turnbuckles, trapezes, spring cage assemblies, etc. The weights of these components shall be considered by the CONTRACTOR in the design and settings of hangers and supports under advice to the PURCHASER/ENGINEER. 3.9 The CONTRACTOR shall perform necessary internal machining of pipes for installing orifices, flow nozzles, straightening vanes, etc. 3.10 At all intersection joints, it is the CONTRACTOR's responsibility to design and provide suitable reinforcements as per the applicable codes and standards taking into account the pressure, temperature and dead weight loads. 3.11 Welding, nondestructive examination of welded joints and repair of weld defect areas shall conform to TCE specification no. TCE.M4-134-04. 3.12 The CONTRACTOR shall prepare fabrication isometric drawings and bills of material for piping NB 65 mm and larger based on the PURCHASER's piping drawings except for Low Pressure (LP) piping systems such as water and air. The PURCHASER/ ENGINEER will review, prior to release for fabrication, all piping isometric drawings. The PURCHASER/ENGINEER may request changes, if the PURCHASER/ENGINEER's stress analysis or other considerations require it. As the CONTRACTOR is responsible for the design and adequacy of hanger components, no comments or approval may be given by the PURCHASER/ENGINEER except in those instances where it may appear that the CONTRACTOR's work does not meet the standard desired by the PURCHASER/ ENGINEER. In such cases, the CONTRACTOR shall be guided by the PURCHASER / ENGINEER's comments and the CONTRACTOR shall comply to the requirements at no extra cost. 3.13 The CONTRACTOR's fabrication drawings shall take into account the requirements of this specification as also all applicable codes and standards including statutory regulations such as the Indian Boiler Regulations. The CONTRACTOR's fabrication drawings shall carry all details of fabrication, welding, etc., as may be required for obtaining				
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necessary statutory clearances. It is the CONTRACTOR's responsibility to obtain all such clearances, and fabrication shall commence only after the necessary clearances have been obtained from the appropriate authorities. All expenses incurred in obtaining these clearances shall be to the CONTRACTOR's account.

4.0 MATERIALS AND WALL THICKNESS

4.1 All piping materials to be supplied by the CONTRACTOR shall be in accordance with the PURCHASER's piping material specification and/or piping bill of materials.

4.2 The BIDDERS may offer if they so desire, alternate materials equal or superior to those specified. However, no credit would be given to offers containing materials superior to those specified. The responsibility for establishing equality or superiority of the alternate materials offered to those specified rests entirely with the BIDDER. The PURCHASER / ENGINEER reserves the right to reject such alternate materials and insist upon only those specified.

4.3 The BIDDERS shall note that equality or superiority of the materials offered by them vis-a-vis those specified would be judged not only based on a comparison of the material standards but also on the ease of fabrication, shop and field welding, heat treatment, service record and any other characteristic considered important by the ENGINEER.

4.4 BIDDERS shall indicate in their offer, reasons and justification for their wishing to deviate from the materials specified.

4.5 Materials inferior to those specified will not be acceptable.

4.6 Where bending and forming allowances are excluded from the wall thicknesses specified in the specification documents, the specified wall thicknesses shall be increased in accordance with the CONTRACTOR's standards to allow for the manufacturing process for bends and fittings. In no case shall the wall thicknesses of fittings be less than those specified for straight pipes.

4.7 For steam piping systems, all materials shall be procured directly from the manufacturers. Materials procured from traders and stockists are not acceptable. For LP piping systems, these can be procured from reputed and approved traders or stockists.

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4.8 All materials procured shall be new and specifically for the subject contract.

4.9 All materials shall be certified by proper material test certificates. All material test certificates shall carry proper identification number or other acceptable references to enable identification of the certificate with the material it purports to certify. The heat number shall also be indicated on the material certified.

5.0 **FABRICATION**

5.1 Unless otherwise specified in Section C, all steam piping systems of size NB 65 mm and larger shall be supplied fully prefabricated at works as per the piping drawings. All piping, NB 50 mm size and smaller, shall be supplied in straight lengths, with the pipe ends cut square to the axis.

5.2 Unless otherwise specified in piping drawings or piping materials specification data sheets, all pipeline joints shall have welded construction. Butt-welded joints shall be used for pipes NB 65 mm and larger. Socket welded joints shall be used for pipes NB 50 mm and smaller. The use of companion flanges to connect two pieces of pipe or the use of odd or short pieces of pipes in making up long runs is prohibited, except as noted on the PURCHASER's piping drawings.

5.3 Where welded pipes or fittings are used, longitudinal welds in adjoining sections shall be staggered by minimum of 90° during fabrication. All piping shall be fabricated true to lines and elevations as indicated in the piping drawings.

5.4 Neither butt nor branch joints shall be closer than twice the pipe diameter to any other joint in the same pipeline except where 'weldolet' type fittings are used, in which case the branch weld will be made to the 'weldolet'.

5.5 The number of joints for field welding shall be kept as a minimum as practicable and limited to accessible circumferential butt welds.

5.6 All pipe bends shall have a bend radius of five nominal pipe diameters unless otherwise specified in the PURCHASER's piping drawings. The pipe bends shall be true to angle and radius and shall maintain a true

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circular cross section of pipe without deformity or undue stretching. Crimping of pipes to form bends is not acceptable. 5.7 All pipe flanges and contact surfaces shall be concentric with the axis of the piping. All flanges and fittings shall be accurately machined and drilled true to template. 5.8 All threads on piping components shall be taper pipe threads as per applicable standards. Threaded connections for insertion type fluid temperature sensing and sampling devices shall be seal welded when the service temperature exceeds 495°C or the service pressure exceeds 103.5 bar (g). The threads shall be entirely covered by the seal weld and only qualified welders shall carry out such seal welding. 5.9 The CONTRACTOR shall cut the pipe short for cold spring for all hot lines in accordance with the data furnished by the PURCHASER. In addition to the cut for cold spring, a length of pipe must be cut to attain slope when the line is in the cold or hot position. The additional cut must not add to the cold spring in the system. In order not to add to the cold spring, the pipe must be detailed and fabricated so that the affected horizontal runs will be sloped to the proper angle when installed in the field before the final weld is made. At the point of closure, the two pipe ends should be separated by the required amount of cold spring only. 5.10 All welded attachments such as lugs, shoes, trunnions, etc., as required for supporting, restraining or anchoring a pipe shall be welded to the pipe at works and stress relieved as required. All welded attachments and thermocouple pads shall be of the same material as the parent pipeline and shall be subjected to the same fabrication and welding procedures as the associated piping. 5.11 All welds between dissimilar materials shall be carried out at works. Field welding of joints involving dissimilar materials shall be avoided. 5.12 The first circumferential weld joint after a pipe bend shall as far as possible be after a minimum straight length of two times the pipe diameter or 500 mm whichever is less. 5.13 All pipelines shall be pitched to low point(s) where drainage is indicated on the PURCHASER's drawings. The pitch shall be sufficient to prevent pockets of moisture collecting at low points between supports.				
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5.14 The CONTRACTOR shall fabricate the pipe assemblies in such a way as to avoid any difficulty during field erection.

5.15 All branch connections shall be realised through the use of tees, crosses and laterals to the extent such standards fittings are available as per ANSI standards. Where intersection welds are employed due to non-availability of a standard fitting, they shall be of suitable structural adequacy by virtue of intrinsic weld connection, reinforcing pads or rings or materials inherent in the branch. It is the CONTRACTOR's responsibility to provide reinforcement, wherever necessary for branch connections.

5.16 The CONTRACTOR shall machine welding ends of all pipes, bends and fittings, to make sound welds. The welding rod shall be compatible with the parent material.

5.17 The CONTRACTOR shall be responsible for determining the proper bending procedure, including bending temperature, as well as the heat treatment or stress relieving procedures to produce the desired end product.

5.18 Cold bending may be performed on carbon steel, carbon molybdenum and chromium molybdenum steel pipes with chromium content less than 1 % in a stress relieved, normalised and tempered or fully annealed condition. Bending performed at temperatures below 900°C shall be considered "cold bending".

5.19 Only hot bending at 900°C to 1200°C shall be performed on chromium - molybdenum steel regardless of its heat treatment by full annealing. The pipes shall be filled with free running, sulphur free silica sand or other dry solid inert material, firmly tapped for the hot bending operations. Optical pyrometry or other approved methods shall be used for temperature control of these operations.

5.20 Oxyacetylene torches shall not be used for heating purposes during bending operations.

5.21 Carbon steel, carbon molybdenum and chromium molybdenum piping shall be bent hot if cold bends, free of cracks or buckles, cannot be made.

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5.22 Bends in seam welded pipes shall be oriented so that the seam is positioned along the neutral axis. 5.23 All materials that have been bent, forged or formed shall be subsequently heat treated in a furnace as described below: (a) Hot bent, forged or formed carbon steel piping require no subsequent heat treatment. (b) Hot bent, forged or formed ferritic alloy steel piping shall receive a stress relieving treatment, a full anneal or a normalise and temper treatment. (c) Cold bent, forged or formed carbon steel and ferritic alloy piping shall be stress relieved after bending when: i. Carbon steel pipe wall thickness equals or exceeds 19 mm. ii. Ferritic alloy steel pipe wall thickness equals or exceeds 13mm or when the nominal pipe size is 100 mm or larger. 5.24 Cold bending of carbon and ferritic alloy steel pipe in sizes and wall thicknesses less than specified in para 5.23(c) may be used without a postheat treatment, if it is demonstrated that the mechanical and metallurgical properties are not impaired by omission of such post heat treatment. 5.25 Ferritic piping materials upto and including 2.25 Cr - 1 Mo that have been bent, forged, formed or welded may have the final heat treatment delayed until a full furnace charge is available. 5.26 The preferred method of heat treatment is full annealing for the low chromium molybdenum steels. The full annealing heat treatment shall be carried out in a temperature-controlled furnace capable of accommodating the assembly with adequate supports and contact thermocouples. The PURCHASER/ENGINEER shall reserve the right to select the alternative heat treatment, viz., normalising and tempering. 5.27 Liquid quenching for heat treatment is not permitted. The preferred method of heat treatment for the chromium molybdenum steel is full		
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annealing. Following are the recommended heat treatments in the order of preference:

- (a) Full annealing chromium molybdenum steels, 1 Cr 1/2 Mo to 3 Cr 1 Mo inclusive. Full annealing shall be accomplished by heating in a heat treatment furnace to a metal temperature of 900°C+14°C and holding at that temperature for a period equal to one hour per 25 mm of wall thickness of the thickest section but in any case not less than one hour. The material shall then be allowed to cool in the furnace at a rate of 30°C per hour to a metal temperature of 600°C. The material shall then be removed from the furnace and cooled in still air in a building having a room temperature of not less than 10°C.
- (b) Normalising and tempering chromium molybdenum steels, 1 Cr 1/2 Mo to 3 Cr 1 Mo inclusive. Normalising shall be accomplished by heating in a heat treatment furnace to a metal temperature of 900°C to 960°C and holding at that temperature for a period equal to one hour per 25 mm of wall thickness of the thickest section but in any case not less than one hour. The material shall then be allowed to cool in still air to a metal temperature of 315°C or below. The air temperature shall not be lower than 10°C. Tempering shall be accomplished by reheating in a heat treatment furnace to a metal temperature of 630°C to 750°C depending on the alloy range and holding at that temperature for a period equal to one hour per 25 mm of wall thickness of the thickest section but in any case not less than one hour. The material shall then be cooled to 315°C in the furnace at a controlled rate not to exceed 110°C per hour. At 315°C, the material may be removed from the furnace.

5.28 Stress relieving treatment for carbon steel shall be accomplished by heating in a heat-treatment furnace to a metal temperature of 635°C to 675°C and holding at that temperature for a period equal to one hour per 25 mm of wall thickness of the thickest section but in any case not less than one hour. The material shall then be cooled in the furnace until the metal temperature drops to 315°C. or below, and then air cooled in a draft free area where the air temperature is not below 10°C.

5.29 Stress relieving treatment for C - 1/2 Mo and 1/2 Cr 1/2 Mo steels shall be accomplished by heating in a heat treatment furnace to a metal temperature as follows:

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Carbon 1/2 Molybdenum steel 650°C 675°C

1/2 Chromium1/2 Molybdenum steel 690°C 729°C

The temperature shall be held for a period equal to one hour per 25 mm of wall thickness of the thickest section but in any case not less than one hour. The material shall then be cooled in the furnace until the metal temperature drops to 315°C or below, then air cooled in a draft free area where the air temperature is not below 10°C.

5.30 When pipe must be threaded before bending, forging or heat treating, all exposed thread surfaces should be protected during heat treatment with high temperature silicone paint.

6.0 **CLEANING OF PIPING**

6.1 All hot bent, forge formed, fabricated and straight sections of piping shall be chemically cleaned, pickled or wire brushed and purged with an air blast or shot / grit blast to remove all sand and scale from the inner surface. The inside and outside of all pipes shall be free of sand, loosely adhering scale, dirt and other foreign matter. The method of cleaning shall not leave any material on the inner or outer surfaces that will affect the serviceability of the pipe.

6.2 During manufacturing and fabrication of carbon and alloy steel piping, surfaces shall be descaled by any one of the following methods:

- (a) Completely grit blast inner and outer surfaces with angular silicon carbide or steel grit (Sand blasting is prohibited). Grit shall be removed completely by an air blast or other convenient means such as rotary brushing.
- (b) Pickle in commercial hot inhibited sulphuric acid. Wash in cold water followed by wash in hot water.
- (c) Clean by power driven wire brushes. The brushes shall be of the same or similar material as the metal being cleaned.

6.3 Cleaning technique and tests shall follow the guidelines of Structural Steel Painting Council Surface Preparation Specifications.

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	SUPPLY, SHOP FABRICATION AND TESTING OF POWER PLANT PIPING	SHEET 12 OF 17

7.0 CORROSION PROTECTION

7.1 The outside of carbon steel and low alloy steel piping, with exception of machined surfaces (e.g., weld ends) shall be coated with enamel or other protective paint. All weld end preparations shall be coated with deoxaluminat paint. Use of grease or oil, other than light grade mineral oil, is prohibited.

7.2 After cleaning carbon or low alloy steel piping by any method producing continuous white metal on the inside of the pipe and prior to shipment, the surface shall be coated with a readily water soluble corrosion inhibitor such as a solution of 1/2 % sodium nitrite, 1/4 % monosodium phosphate and 1/4 % disodium phosphate.

7.3 Following the application of corrosion protection systems, all components shall be covered, boxed, capped, plugged or otherwise shielded from further contamination of corrosion.

8.0 MARKING

8.1 All pipe and fittings supplied by the CONTRACTOR shall be legibly marked with its identifying pipeline description and piece number, as per the relevant component or spool piece drawing.

8.2 Materials may be marked with any method, provided the method does not result in sharp discontinuities and does not loose its identity until the piping system is erected. Materials 6 mm or thicker may be marked by stamping, which when adopted, shall be done with round nose or interrupted hot die stamps having a minimum radius of 0.8 mm. Any item too small to be legibly marked shall have a metal tag containing the necessary information securely attached to each bundle or container of such items, so that it does not lose its identity during shipping and storage.

8.3 Marking paint, ink and tape shall be certified to be free of chloride, sulphur, lead, tin, or mercury.

9.0 HANGERS AND SUPPORTS

9.1 The design loads indicated on the PURCHASER's hanger sketches include the weight of pipe, the weight of insulation and the weight of medium transported or the medium used for testing, whichever is

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heavier. All components of hanger or support assembly shall be designed for the above design load and the self-weight of hanger/support assembly. Each rod of a double rod hanger shall be designed for the full design load specified for the hanger. 9.2 All hanger components including springs shall generally conform to MSS SP58 'Pipe Hangers and Supports-Material and Design'. 9.3 The design shall take full advantage of commercially available, load rated and tested hanger components to the maximum extent possible. Uniformity and simplicity in design shall be maintained. All hangers shall be functional and shall be easily installable using conventional field erection techniques. 9.4 The materials used in the construction of hangers, supports and accessories shall be the most suitable for the service intended. 9.5 Lugs or other means of welded attachments to pipes shall be welded on in the shop and shall be of the same materials as the parent pipe. Wherever possible, pipe attachments for horizontal piping shall be a pipe clamp. 9.6 The hangers shall be designed, fabricated and assembled in such a manner that any movement of the supported pipe does not disengage them. 9.7 The hangers shall be provided with suitable linkages to permit swing. 9.8 The diameter of hanger rods for piping, NB 50 mm and smaller, shall be minimum of 9.5 mm. 9.9 The diameter of hanger rods for piping, NB 65 mm and larger, shall be minimum of 12.5 mm. 9.10 Bolted pipe clamps, used with rod hangers, shall have a minimum thickness of 5 mm for weather-protected locations and 6 mm for places exposed to weather. 9.11 Springs, for spring hangers, shall be of helical compression type and shall be provided with means to prevent misalignment, buckling and eccentric loading and with stops to prevent excessive travel. The construction shall also be such that complete release of piping load will ISSUE R4					

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be impossible in case of spring failure or misalignment. Suitable stops shall be provided for field hydrostatic test of piping. Springs shall be enclosed in spring cages. Load/travel indicators shall be provided on the spring cages.

9.12 Constant support hangers shall have a field load adjustment range of $\pm 20\%$ of the operating load specified and shall be provided with stops for field hydrostatic test of piping and also with suitable distant visible travel scales and indicators clearly showing cold and hot settings. The total travel of the unit selected shall be the calculated travel plus 20% (minimum 25 mm) to take care of possible discrepancy between calculated and actual thermal movements. Constant support hangers shall have support variation of not more than 2.5% throughout the total travel range.

9.13 Where variable spring hangers are specified, the units selected shall have support variation of not more than 25% through its total travel range.

9.14 All rigid hangers shall have a means for vertical adjustment after erection.

9.15 Pipe springs shall be fitted with an adequate malleable iron adjusting nut of the locking type, threaded to a rod that will allow adjustment after erection while supporting the load.

9.16 All spring hangers shall be furnished with forged steel turnbuckles to permit adjustment and setting of pipe elevation at site. All rigid hangers for loads 250 kg and above shall have forged steel turnbuckles. All rigid hangers, for loads less than 250 kg, shall have the hanger rods threaded to permit adjustment and setting of pipe elevation at site.

9.17 Beam clamps shall be of forged steel, each equipped with a rod to fix a nut.

9.18 All supports for carbon steel piping shall be provided with carbon steel machine bolts and nuts in accordance with applicable codes. Bolt heads shall be regular square and unfinished. Nuts shall be cold punched, semi finished, heavy hexagonal type. For supporting alloy steel piping, bolts and nuts, as per applicable codes shall be provided.

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9.19 All threaded members shall have a true and complete depth of thread. The turnbuckles or adjusting nut shall have its full length of thread in service while in use and the amount of adjustment plainly visible. All similar adjustable arrangements shall have provision for locking.

9.20 The threads on threaded parts such as hanger rods, nuts and turnbuckles shall conform to applicable codes for the coarse thread series with a 'medium' class fit or equivalent.

9.21 All hangers shall be furnished with beam clamps, rods, pipe stubs and all other materials required to make the hanger complete.

9.22 All hangers shall be designed for rigid fastening to the structure either directly or through a bracket. Anchors and guides shall be capable of withstanding the moments and forces imposed by thermal expansion.

9.23 The parts of hangers which move relative to the pipe during expansion shall be connected to the pipe clamps or lugs in such a way that these parts lie entirely outside the insulation.

9.24 All components of hangers and supports and anchors shall be given one shop primer coat of red oxide paint.

10.0 **INSPECTION AND TESTING**

10.1 All items covered by this specification shall be subject to inspection by the PURCHASER/ENGINEER at no additional cost to the PURCHASER and the CONTRACTOR shall advise the PURCHASER / ENGINEER promptly when items are ready for inspection.

10.2 All materials shall be subjected to source inspection by the CONTRACTOR to ensure compliance with material specifications mentioned herein or any other approved material specifications.

10.3 The CONTRACTOR shall permit the PURCHASER to maintain one or more of his representatives in the CONTRACTORS's shops and the shops of his SUB-CONTRACTORSs, for the purpose of inspecting various steps in the shop fabrication of the materials specified herein. The PURCHASER's representative shall at all reasonable times have free access to the VENDOR's shops and be able to witness the CONTRACTOR's heat treatment records and magnetic particle,

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flurosent particle or dye penetrant or ultrasonic or radiographic inspection records, reports of repairs, etc.

10.4 The works shall also be subject to inspection in the CONTRACTOR's / his SUB-CONTRACTOR's shop by an inspector of a selected inspection or insurance company, where required, depending upon local manufacturing, construction and safety codes. The inspection shall be as frequent as required to ensure progress of work and quality of workmanship.

10.5 Any workmanship or material inspected in the field and found not to comply with this specification, the same shall be replaced or repaired at the VENDOR's expense, if the noncompliance is the fault of the VENDOR.

10.6 All inspection shall meet the requirements of TCE standard nos. TCE.M4-185-28 and TCE.M4-185-38.

10.7 For radiography procedure, ASTM E94 and ASTM E142 shall be followed.

10.8 Radiographic Acceptance Criteria for weld ends, the examination techniques, requirements and repairs for weld ends shall meet the mandatory requirement of ASME Section VIII Division 1 Appendix 7 in all respects.

10.9 Defect Removal and Repair in Castings

(a) Defects in excess of acceptance standards shall be removed by suitable means. If removal of surface defect does not result in reduction in wall thickness below acceptable minimum, the area shall be blended smoothly into the surrounding surface. Where defect removal results in a wall thickness below the acceptable minimum, resultant cavity may be repaired by welding. The procedure and the operation shall be qualified as per applicable standards. Major weld repairs shall be stress relieved or heat treated in accordance with the material specification.

(b) The repaired area shall be reexamined and the acceptance standards shall be as followed in the original examination.

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(c) Major weld repairs made as a result of radiographic examination shall be re-radiographed after welding. The acceptance standards for porosity and slag inclusions in welds shall be as per ASME Boiler and Pressure Vessel Code, Section VIII, Division 1. 10.10 On completion of forging and subsequent heat treatment operations on chromium molybdenum fittings, the forged material shall be machined / ground and blasted to clean metal on the interior and exterior surfaces. 10.11 Unacceptable defects disclosed by visual, magnetic particle, radiographic or ultrasonic inspection, shall be repaired by removing the defects completely and re-welding. The repaired spots shall be re-examined in a way similar to the one followed for the main weld. Only qualified welders shall be employed for repair welding and shall be carried out as per approved welding procedure. 10.12 All pipes, fittings, etc., shall be tested hydrostatically at the shops, where manufactured, at test pressures which are given in the applicable codes, material specification sheets and/or Section C. After completion of test, the piping shall be completely drained prior to shipment to insure against damage from freezing. When such drainage requires removal of plugs, valves, drain cover, caps, etc., the CONTRACTOR shall ensure that these parts are reinserted or reassembled prior to shipment. 10.13 Where the pipe work is composed of pipe and standards fittings, the test pressure to be applied shall be the standard test pressure for the lowest rated standard component in the assembly.				
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SPEC.NO. TCE.M4-105-01	TATA CONSULTING ENGINEERS LIMITED HORIZONTAL CENTRIFUGAL PUMPS	SECTION: D29 SHEET 1 OF 3
1.0 <u>SCOPE</u> This specification covers the general design, materials, construction features, manufacture, shop inspection and testing at manufacturer's works and delivery at site of Horizontal Centrifugal Pumps. 2.0 <u>CODES AND STANDARDS</u> The design, materials, construction, manufacture, inspection, testing and performance of horizontal centrifugal pumps shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment is to be installed. The equipment shall also conform to latest applicable Indian or equivalent standards. Other international standards are also acceptable, if these are established to be equal or superior to the listed standards. Nothing in this specification shall be construed to relieve the VENDOR of this responsibility. 3.0 <u>DESIGN REQUIREMENTS</u> 3.1 Pumps of a particular category shall be identical and shall be suitable for parallel operation with equal load division. Components of identical pumps shall be inter-changeable. 3.2 Flow rate versus head curve shall have a stable and continuously rising characteristics towards the shut-off head. In case of unstable (drooping) characteristics the duty point shall be well away from the unstable region. Besides the actual flow rate versus head curve, curves for minimum and maximum impeller diameters shall also be shown. 3.3 The shut-off head shall be at least 110% of the differential head. 3.4 The required NPSH at duty point shall be at least one (1) metre less than the available NPSH. 3.5 The rating of the pump driver shall be the larger of the following : (a) The maximum power required by the pump from zero discharge to run-out discharge at site climatic conditions. (b) 110% of the power required at the duty point at site climatic conditions. 3.6 The corrosion allowance for pressure parts shall be 3 mm. 3.7 Pumps shall run smooth without undue noise and vibration. Noise level produced individually or collectively shall not exceed 85 dB(A) measured at a distance of 1.86 metres from the source in any direction. The overall vibration level shall be as per zones A and B of ISO 10816-1.		
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SPEC.NO. TCE.M4-105-01	TATA CONSULTING ENGINEERS LIMITED HORIZONTAL CENTRIFUGAL PUMPS	SECTION: D29 SHEET 2 OF 3
3.8 In case of fire water pumps, pumps and drivers with all the accessories shall meet the requirements of Tariff Advisory Committee (TAC) or any other standard as called for in data sheet A. Pump type shall be as approved by TAC. 4.0 <u>CONSTRUCTION FEATURES</u> 4.1 In addition to static balancing, impeller and balancing drum shall be balanced dynamically at or near the operating speed. 4.2 Pump shall be provided with renewable type casing ring. Pump having capacity 1,000 M³/Hr and above shall be provided with impeller ring in addition to casing ring. The hardness of impeller ring shall be 50 BHN higher than that of casing ring. 4.3 Pump casing shall be provided with drain and vent connection with plugged or valve connection. 4.4 Bearing shall be oil-lubricated or grease-lubricated and shall have a life of 40,000 hours of working. In case of oil-lubricated bearing, constant oil leveller with magnetic drain plug shall be provided. 4.5 Replaceable shaft sleeves shall be provided to protect the shaft where it passes through stuffing box. 4.6 Stuffing box shall be of such design that it can be repacked without removing any part other than the gland and lantern ring. 4.7 Mechanical seals shall be provided if called for in data sheet - A. If required, a flushing line shall be furnished, complete with strainer and orifice, from the pump discharge to the sealing face. When pumping liquid is not suitable for this purpose, a flushing connection shall be provided so that it can be connected to an external source. Auxiliary piping and plan shall be in accordance with appendix - D of API 610. 4.8 The allowable loads on the pump nozzles shall be at least twice the values listed in the relevant tables of API 610 without reference to any other criterion. The base plate shall be designed to cater to the above increased loads. 4.9 All pumps, except for back-pull out type, shall be provided with flexible coupling. Back-pull out type pumps shall be provided with spacer type coupling. 4.10 Coupling guard made of expanded metal and bolted to the base plate shall be furnished for all coupled pumps. ISSUE R10		

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HORIZONTAL CENTRIFUGAL PUMPS				
4.11 In addition to accessories listed in data sheet A, any other accessories required for safe and efficient operation of pump shall be provided. 4.12 All incidental piping and valves required for sealing, lubrication and cooling for stuffing box packing and/or bearing of pump shall be furnished by the VENDOR. 4.13 Leakage from the pump shall be led to the nearest surface drain by OTHERS. Pump VENDOR shall provide necessary arrangement like drip tray, base plate drain connection etc. 5.0 <u>TESTS AND INSPECTION</u> 5.1 Hydrotest pressure on casing shall be 1.5 times maximum discharge head or twice differential head whichever is higher. (Maximum discharge head = shut-off head + maximum suction head). Unless otherwise stated in data sheet A, the hydrostatic tests on the casing shall be conducted for a minimum duration of 30 minutes. 5.2 The pumps shall be tested as per IS 5120, at rated speed at MANUFACTURER's works to measure capacity, total head, efficiency and power. The negative tolerance on efficiency shall be limited to 2.5% and not 5% as indicated in IS 5120. These tests shall form the basis for acceptance of pumps except for vibration and noise. The pumps shall be tested over the range covering from shut-off head to the maximum flow. The duration of the test shall be minimum one (1) hour. Minimum five (5) readings approximately equidistant shall be taken for plotting the performance curves. 5.3 After installation, the pumps shall be subjected to testing at site also. If the site performance is found not to meet the requirements regarding vibration and noise as specified, the equipment shall be rectified or replaced by the VENDOR, at no extra cost to the PURCHASER. 6.0 <u>PERFORMANCE GUARANTEE</u> Performance parameters to be guaranteed by the VENDOR and tolerances permitted shall be as indicated in section C and/or data sheet A. BIDDER shall confirm acceptance of these by indicating values in data sheet B. Pump or any portion thereof is liable for rejection, if it fails to give any of the guaranteed performance parameters.				
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TCE.M4-105-01	TITLE HORIZONTAL CENTRIFUGAL PUMPS	SHEET 1 OF 1

DATA SHEET C

**DATA TO BE FURNISHED BY THE VENDOR AFTER THE ISSUE OF
PURCHASE ORDER**

1. List of drawings and documents to be submitted for review, approval and information with scheduled submission dates
2. Quality Assurance Plan (QAP)
3. Detailed dimensioned general arrangement drawing of pump and driver. This drawing shall indicate all the design data and information furnished in data sheets A and B.
4. Foundation drawing of pump and driver with static and dynamic loads, details of fixing, grouting and all relevant data required for design of foundation
5. Cross-section drawing of the pump with complete part list, materials of construction and relevant standards for each part
6. Pump performance curves flow rate Vs head, BkW, efficiency, NPSHR from zero flow to maximum flow and torque-speed curve
7. Scheme for pump sealing, lubrication and cooling
8. Driver dimensional drawing
9. Surface preparation and painting procedures
10. Catalogues, data sheets and drawings for instruments
11. Installation, operation and maintenance manual along with lubrication schedule

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R10

SPEC.NO. TCE.M4-113-54	TATA CONSULTING ENGINEERS LIMITED ELECTRICALLY OPERATED HOISTS	SECTION: D30 SHEET 1 OF 4
1.0 <u>SCOPE</u> This specification covers the general design, materials, construction features, manufacture, shop inspection and testing at the manufacturer's works, delivery at site and performance testing at site of Electrically Operated Hoists. 2.0 <u>CODES AND STANDARDS</u> The design, materials, construction, manufacture, inspection, testing and performance of electrically operated hoist shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment is to be installed. The equipment shall also conform to the latest applicable Indian or equivalent standards. Other international standards are also acceptable, if these are established to be equal or superior to the listed standards. Nothing in this specification shall be construed to relieve the VENDOR of this responsibility. 3.0 <u>CONSTRUCTION FEATURES</u> Electrically operated hoist shall be a complete unit with travelling trolley, hoisting motor, travel motor (if travelling trolley is motor operated), rope drum, wire rope, necessary gearing, sheaves, brakes, hook, pendent push button station, contactor panel, all wiring, conductor for travel motion (if travelling trolley is motor operated), limit switches, end stops, buffers, earthing terminals and other accessories to make the equipment complete in all respects. Electrically operated hoist shall have minimum factor of safety as five (5). 3.1 <u>TRAVELLING TROLLEY</u> The travelling trolley shall be motor driven or push pull or manual geared type as specified in data sheet A. Trolley frames shall be fabricated from rolled structural steel sections. The side plates of the trolley shall extend beyond wheel flanges, thus providing bumper protection for the wheels. The two side plates shall be connected by means of an equalising pin. The wheels shall be machined on their treads to match the profile of the monorail. 3.2 <u>ROPE DRUM</u> Rope drum shall be as per IS 3938. Rope drum shall be either cast or welded to sustain concentrated loads resulting from rope pull. Drum shall be machine grooved right and left with grooves of a proper shape for the rope used. Grooving shall be of proper length to handle entire rope required to make the specified lift plus the two dead laps at each anchor point, without overlapping. ISSUE R5		

SPEC.NO. TCE.M4-113-54	TATA CONSULTING ENGINEERS LIMITED	SECTION: D30
	ELECTRICALLY OPERATED HOISTS	SHEET 2 OF 4

3.3 WIRE ROPES

Wire ropes shall be extra flexible with well lubricated hemp core having six (6) strands of thirty-seven (37) or thirty-six (36) wires per strand with ultimate tensile strength of 1.6×10^6 KN/M². Wire ropes shall be of Right Hand Ordinary (RHO) lay construction. The rope shall be fastened to the drum with an attachment having strength equal to that of the rope. The rope fastening at the swinging end shall be aligned so as to prevent rope coming off its reeving. Rope shall be of sufficient length so that two (2) full laps shall remain on the drum at extreme low position of the hook. Reverse bends or cross bends and bird caging shall be avoided. The breaking loads for the hoist ropes shall not be less than the factor specified in IS 3938. The load shall include rated load on hooks, weight of the bottom block and the weight of rope.

3.4 LOAD CHAIN AND LOAD CHAIN WHEEL

In case chain is employed for lifting the load instead of wire rope, it shall be heat treated to give required ductility and toughness so that it stretches before breaking. The total length of the load chain shall exceed the minimum length required to give the specified range of lift by not less than three (3) links per fall to ensure that the slack end anchorage is not loaded. The load chain wheel shall be of adequate strength and shall be suitably designed to ensure effective operation of the chain and shall be properly secured with shaft, preferably with splines

3.5 SHEAVES

Sheaves shall be as per IS 3938. These shall be equipped with anti-friction bearings and shall be fully guarded to prevent the rope coming off. Equalising sheaves, if provided, shall also be as per IS 3938. Grooves shall be machined to proper shape for the rope used.

3.6 GEARS

Gears shall be cut from solid cast or forged steel blanks or shall be of stress-relieved welded steel construction or built-up from steel billets and welded together to form a one piece gear section. Pinions shall be of forged carbon or heat treated alloy steel. All gears and pinions shall be totally enclosed type upto last stage of reduction in all motions and shall be carried in fabricated steel gear boxes which shall be dust proof and firmly sealed to prevent oil leakages. For travel motion, creep speed if specified shall be achieved by one of the following methods :

- (a) Planetary gear box integral with main gear box
- (b) Planetary gear box independent with motor
- (c) Worm reducer with clutch

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However, for hoisting motion, creep speed shall be achieved only by methods (a) or (b) indicated above. Creep speed shall be generally 10 % of main speed.

3.7 BEARINGS

Bearings may be ball or roller type. All anti-friction bearings shall be of approved make, which are interchangeable with corresponding size bearings of other make. Bearing housings shall be of split type or so designed to permit easy removal of the shaft. The design shall be such that there is no ingress of dust and oil or grease does not leak out. Bearings shall have a minimum life expectancy of 20 years based on equivalent running time as per specified class.

3.8 SHAFTS AND AXLES

Shafts and axles shall be of forged steel and shall have ample strength, rigidity and adequate bearing surface for intended duties. Shafts and axles shall be accurately machined and properly supported. Shafts shall, as far as possible, be furnished straight. If shouldered, these shall be provided with fillets of ample radius or shall be tapered to avoid loss of strength and stress concentration. These shall be designed considering allowances for keys and splines.

3.9 BRAKES

All brakes shall be of ‘fail-safe’ design and shall operate automatically in case of power failure. Each of the trolley and hoisting motors shall be equipped with electrically released, spring set, friction shoe type brakes. Hoisting brake shall be designed to hold 1.5 times full load torque while trolley travel brake shall be designed to hold 1.25 times full load torque. Separate brakes shall be provided for creep motions. All brakes shall have weather-proof enclosures. Coupling halves shall not be used as brake drums.

3.10 LIFTING HOOK

The lifting hook shall be single hook type, solid, forged, heat treated, of rugged construction and provided with a standard depress type safety latch. Lifting hook shall have swivels and operate on ball or roller thrust bearings with hardened races. Lock to prevent hook from swivelling shall be provided.

3.11 BUFFERS, STOPS AND SWEEPS

3.11.1 Spring or rubber buffers shall be provided on the trolley. Suitable end stops shall be provided which shall be welded on the ends of monorail to contact the buffers mounted on the trolley.

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	ELECTRICALLY OPERATED HOISTS	SHEET 4 OF 4

3.11.2 Trolley wheel stops shall be provided before the end stops. These shall match to wheel radius. Stops to prevent trolley from running off the monorail shall be abutted against ends of monorail. Stops shall be welded to the monorail.

3.11.3 Sweeps shall be attached to the trolley to remove foreign material from the rails.

3.12 GUARDS

3.12.1 All exposed couplings, shafts, gear wheels, pinions, drives etc. shall be safely encased and guarded.

3.12.2 The sheaves of hook blocks shall be guarded to prevent trapping of hand between a sheave and the in-running rope.

4.0 ELECTRICAL EQUIPMENT

4.1 MOTORS

Drive motors shall be as per IS 325 and companion specification TCE.M4-203-01. Motor shall be suitable for frequent reversal, braking and acceleration. Pull-out torque shall be 2.15 times the rated torque.

4.2 PENDENT PUSH BUTTON STATION

The pendent push button station shall be supported independently, earthed separately independent of suspension and shall comprise the following push buttons and indicating lamps :

- (a) 'Start' and 'Stop'
- (b) Trolley travel - 'To' and 'Fro'
- (c) Hook - 'Hoist' and 'Lower'

Red lamp shall indicate supply 'ON'

4.3 MISCELLANEOUS

Controllers and resistors, controls, electrical protective devices, cables and conductors, earthing guards etc. shall be as per IS 3938. Limit switches shall be provided for overhoisting and overlowering and for two extreme ends of trolley travel.

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SPEC.NO. TCE.M4-113-54	TATA CONSULTING ENGINEERS LIMITED ELECTRICALLY OPERATED HOISTS	SECTION: D SHEET 1 OF 1

DATA SHEET C

**DATA TO BE FURNISHED BY THE VENDOR AFTER THE ISSUE OF
PURCHASE ORDER**

1. List of drawings and documents to be submitted for review, approval and information with scheduled submission dates
2. Quality Assurance Plan (QAP)
3. Motor power calculations
4. Brake selection calculations
5. Detailed to-scale dimensioned general arrangement drawing showing all the components. Drawing shall also indicate all design data and information furnished in data sheets A and B
6. Part list of all the components with materials and codes of construction
7. Flexible trailing cable arrangement drawing
8. Detailed explanatory functional write-up of control scheme, wiring diagrams and control cabinet drawings
9. Dimensional drawing for the hook
10. Installation, operation and maintenance manual with lubrication schedule

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SPEC. NO.	TATA CONSULTING ENGINEERS LIMITED	SECTION: D31
TCE.M4-113-50	CHAIN PULLEY BLOCKS	SHEET 1 OF 2
1.0 <u>SCOPE</u> This specification covers the general design, materials, construction features, manufacture, shop inspection and testing at the manufacturer's works, delivery at site and performance testing at site of Chain Pulley Blocks. 2.0 <u>CODES AND STANDARDS</u> The design, materials, construction, manufacture, inspection, testing and performance of the chain pulley blocks shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment is to be installed. The equipment shall also conform to the latest applicable Indian or equivalent standards. Other international standards are also acceptable, if these are established to be equal or superior to the listed standards. Nothing in this specification shall be construed to relieve the VENDOR of this responsibility. 3.0 <u>CONSTRUCTION FEATURES</u> The chain pulley block shall be a complete unit with travelling trolley, load chain, load chain wheel, hand chain, hand chain wheel, necessary gearing, brakes for hoisting, hook and other accessories to make the equipment complete in all respects. Chain pulley block shall be of worm or spur gear type and shall have minimum factor of safety as five (5). 3.1 <u>TRAVELLING TROLLEY</u> The travelling trolley shall be of push pull or manual geared type as specified in data sheet A. Trolley frames shall be fabricated from rolled structural steel sections. The side plates of the trolley shall extend beyond wheel flanges, thus providing bumper protection for the wheels. The two side plates shall be connected by means of an equalising pin. The wheels shall be machined on their treads to match the profile of the monorail. 3.2 <u>LOAD CHAIN AND LOAD CHAIN WHEEL</u> The load chain shall be heat treated to give required ductility and toughness so that it stretches before breaking. The total length of the load chain shall exceed the minimum length required to give the specified range of lift by not less than three (3) links per fall to ensure that the slack end anchorage is not loaded. The load chain wheel shall be of adequate strength and shall be suitably designed to ensure effective operation of the chain and shall be properly secured with shaft, preferably with splines. 3.3 <u>HAND CHAIN AND HAND CHAIN WHEEL</u> The hand chain for the hoisting and traverse mechanism shall hang well clear of the hook and both the chains shall be on the same side. The length of the hand		
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TCE.M4-113-50	CHAIN PULLEY BLOCKS	SHEET 2 OF 2

chain shall be such that the lowest point of the suspended loop shall hang 400 mm above the operating floor level. The hand chain wheels shall be provided with flanges and designed to ensure effective operation. The hand chain wheels shall be provided with roller type guarding to prevent snagging and fouling of the chain.

3.4 GEARS

Gears shall be cut from solid cast or forged steel blanks or shall be of stress-relieved welded steel construction or built-up from steel billets and welded together to form a one-piece gear section. Gears shall have proper lubrication arrangement and shall preferably be of totally enclosed type.

3.5 SHAFTS AND AXLES

Shafts and axles shall be of forged steel and shall have ample strength, rigidity and adequate bearing surface for intended duties. Shafts and axles shall be accurately machined and properly supported. Shafts shall, as far as possible, be furnished straight. If shouldered, these shall be provided with fillets of ample radius or shall be tapered to avoid loss of strength and stress concentration. These shall be designed considering allowances for keys and splines.

3.6 BRAKES

Brakes shall be of automatic type that shall stop and hold the load when hand-chain pull is released and shall permit controlled lowering of the load when hand-chain pull is applied for lowering the load.

3.7 RATCHET AND PAWL

Ratchet and Pawl mechanism shall be provided to arrest the full load from lowering due to gravity. The ratchet and pawl shall be of steel, hardened and tempered so as to attain required wear resistance and toughness.

3.8 LIFTING HOOK

The lifting hook shall be single hook type, solid, forged, heat treated, of rugged construction and provided with a standard depress type safety latch. Lifting hook shall have swivels and operate on ball or roller thrust bearings with hardened races. Lock to prevent the hook from swivelling shall be provided.

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DATA SHEET C

**DATA TO BE FURNISHED BY THE VENDOR AFTER THE ISSUE OF
PURCHASE ORDER**

1. List of drawings and documents to be submitted for review, approval and information with scheduled submission dates
2. Quality Assurance Plan (QAP)
3. Calculations for manual effort required to lift the load and for cross travel
4. Detailed to-scale dimensioned general arrangement drawing showing all the components. Drawing shall also indicate all design data and information furnished in data sheets A and B.
5. Part list of all the components with materials and codes of construction
6. Dimensional drawing for the hook
7. Installation, operation and maintenance manual with lubrication schedule

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Spec No.	TATA CONSULTING ENGINEERS LIMITED	Section : D
TCE. M4-405-01	SUPPLY AND FABRICATION OF STRUCTURAL STEEL	Sh i of i

SUPPLY AND FABRICATION OF STRUCTURAL STEEL

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	INITIALS	SIGN	INITIALS	SIGN	INITIALS	SIGN	INITIALS	SIGN	R5
PPD.BY									
CKD.BY									
APP.BY									
DATE									

Spec No.	TATA CONSULTING ENGINEERS LIMITED	Section : D
TCE. M4-405-01	SUPPLY AND FABRICATION OF STRUCTURAL STEEL	Sh 1 of 12
1.0 <u>SCOPE</u> 1.1 This specification covers the general requirements for supply where specified, fabrication and delivery at site of structural steel. Section C covers the specific requirements for the project. The two parts are complementary and are to be read together for a correct interpretation of the provisions of this specification. Where requirements of the two parts conflict, those of Section C shall govern. 1.2 This specification also covers design of all connections and substituted members, preparation of all shop fabrication drawings, inspection and shop painting of structures. 2.0. <u>APPLICABLE CODES & SPECIFICATIONS</u> The following specifications, standards and codes are made a part of this specification. All standards, specifications and codes of practices referred to herein shall be the latest editions including all applicable official amendments and revisions. In case of discrepancy between this specification and other documents referred to herein, this specification shall govern. a) <u>Materials</u> i) IS : 808 Dimensions for Hot Rolled Steel sections ii) IS : 814 Covered Electrodes for Manual Metal Arc Welding of Carbon and Carbon Manganese Steel iii) IS : 1161 Steel Tubes for structural purposes iv) IS : 1239 Mild steel tubes, tubulars and other Wrought steel fittings Part 1 - Mild steel tubes Part 2 - Mild steel Tubulars and other wrought steel pipe fittings v) IS : 1363 Hexagon Head Bolts, Screws and Nuts of product (Parts 1 to 3) Grade C (Size range M5 to M64) vi) IS : 1367 Technical Supply Conditions for Threaded Fasteners (All Parts)		
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vii) IS : 1852 Rolling and Cutting Tolerances for Hot Rolled Steel Products viii) IS : 1977 Structural Steel (Ordinary Quality) xi) IS : 2062 Steel for General Structural Purposes x) IS : 2074 Ready Mixed Paint, Air drying, Red Oxide Zinc Chrome and Priming xi) IS : 3502 Steel Chequered Plate xii) IS : 3757 High Strength Structural Bolts xiii) IS : 5369 General Requirements for Plain Washers and Lock Washers xiv) IS : 5372 Taper Washers for Channels xv) : 5374 Taper Washer for I Beams xvi) IS : 6610 Heavy Washers for Steel Structures xvii) IS : 8500 Structural Steel-microalloyed (medium and high strength qualities) b) <u>Codes Of Practice</u> i) IS : 800 Code of Practice for General Construction in Steel ii) IS : 801 Code of practice for use of Cold formed light gauge steel structural members in general building construction iii) IS : 803 Code of practice for design, fabrication and erection of vertical mild steel cylindrical welded storage tanks iv) IS : 806 Code of practice for use of steel tubes in general building construction v) IS : 816 Code of Practice for use of Metal Arc Welding for General construction in Mild Steel vi) IS : 822 Code of Procedure for Inspection of Welds			
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TCE. M4-405-01	SUPPLY AND FABRICATION OF STRUCTURAL STEEL	Sh 4 of 12
Fe410-0(St 42-0) : grade steel shall not be used a) if welding is to be employed for fabrication. b) if site is in severe earthquake zone. c) if plastic theory of design is used. 4.0 <u>USE OF STEEL SUPPLIED BY THE PURCHASER</u> The VENDOR/CONTRACTOR shall use steel supplied by the PURCHASER judiciously and to the best advantage so as to minimise splicing and wastage. All steel materials remaining after completion of the report, whether in the form of balance pieces or unutilised prime steel, shall be returned to the PURCHASER's stores by the VENDOR/CONTRACTOR at his own cost. An unaccountable wastage upto a maximum of 1% of the fabricated steel will be allowed. This wastage does not include the balance cut lengths/pieces of steel returned to the PURCHASER. 5.0 <u>DRAWINGS PREPARED BY THE OWNER</u> 5.1 Design drawings will be furnished to the VENDOR/CONTRACTOR and all drawings so furnished shall form a part of this specification. These design drawings prepared by the ENGINEER will show all the, levels, forces on members where shall necessary, size and orientation of each member, location/size of openings, to enable the VENDOR/CONTRACTOR to prepare drawings for fabrication and erection. It shall be clearly understood that these drawings are not intended to show connection details, thickness of members, cuts, notches, bends and such other details. 5.2 The ENGINEER reserves the right to make changes. Revisions to drawings, even after release for preparation of shop drawings, are very likely to be made to reflect additional data/details received and updated requirements. Revisions to drawings and any new drawings made to include additional work by the VENDOR/CONTRACTOR shall be considered a part of this specification and contract. The PURCHASER shall not entertain IS any extra claims on this account. 5.3 Where the fabrication drawings are to be furnished by the ENGINEER, he will issue to the VENDOR/CONTRACTOR the required copies of such drawings in the sequence required for the fabrication of the components in the order they will be required to be erected at site. Such drawings will be issued in such numbers as required for the VENDOR/CONTRACTOR to adhere to the project schedule.		
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5.4 Should the VENDOR/CONTRACTOR during the execution of his work, find discrepancies in the information furnished by the ENGINEER, he shall refer such discrepancies to the ENGINEER before proceeding with such work. 6.0 <u>DRAWINGS PREPARED BY THE VENDOR/CONTRACTOR</u> 6.1 The VENDOR/CONTRACTOR shall prepare all fabrication and erection drawings for the entire work. All the drawings for the entire work shall be prepared in metric units. The drawings shall preferably be of one standard size and the details shown there in shall be clear and legible. 6.2 The VENDOR/CONTRACTOR shall not commence detailing unless ENGINEER's design drawings are officially released for preparation of shop drawings. The VENDOR/CONTRACTOR shall be responsible for the correctness of all fabrication drawings. Fabrication drawings shall be revised by the VENDOR/CONTRACTOR to reflect all revisions in design drawings as and when such revisions are made by the ENGINEER. 6.3 All fabrication drawings shall be submitted to the ENGINEER for approval. 6.4 No fabrication drawings will be accepted for ENGINEER's approval unless checked and approved by the VENDOR/CONTRACTOR's qualified structural engineer and accompanied by an erection plan showing the location of all pieces detailed. The VENDOR/CONTRACTOR shall ensure that connections are detailed to obtain ease in erection of structures and in making field connections. 6.5 Fabrication shall be started by the VENDOR/ CONTRACTOR only after ENGINEER's approval of fabrication drawings. Approval by the ENGINEER of any of the drawings shall not relieve the VENDOR/CONTRACTOR from the responsibility for correctness of engineering & design of connections, workmanship, fit of parts, details, material, errors or omissions of any and all work shown thereon. The ENGINEER's approval shall constitute approval of the size of members, dimensions and general arrangement but shall not constitute approval of the connections between members and other details. 6.6 The drawings prepared by the VENDOR/CONTRACTOR and all subsequent revisions etc. shall be at the cost of the VENDOR/CONTRACTOR for which no separate payment will be made.		
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TCE. M4-405-01	SUPPLY AND FABRICATION OF STRUCTURAL STEEL	Sh 6 of 12
7.0 <u>FABRICATION</u> 7.1 <u>General</u> All workmanship and finish shall be of the best quality and shall conform to the best approved method of fabrication. All materials shall be finished straight and shall be machined/ground smooth true and square where so specified. All holes and edges shall be free of burrs. Shearing and chipping shall be neatly and accurately done and all portions of work exposed to view shall be neatly finished . Unless otherwise directed/ approved, reference may be made to relevant IS codes for providing standard fabrication tolerance. Material at the shops shall be kept clean and protected from weather. 7.2 <u>Connections</u> 7.2.1 Shop/field connections shall be as per approved fabrication drawings. 7.2.2 In case of bolted connections, taper washers or flat washers or spring washers shall be used with bolts as necessary. In case of high strength friction grip bolts, hardened washers be used under the nuts or the bolt heads whichever are turned to tighten the bolts. The length of the bolt shall be such that atleast one thread of the bolt projects beyond the nut, except in case of high strength friction grip bolts where this projection shall be atleast three times the pitch of the thread. 7.2.3 In all cases where bearing is critical, the unthreaded portion of bolt shall bear on the members assembled. A washer of adequate thickness may be provided to exclude the threads from the bearing thickness, if a longer grip bolt has to be used for this purpose. 7.2.4 All connections and splices shall be designed for full strength of members or loads indicated on ENGINEER's design drawings. Column splices shall be designed for the full tensile strength of the minimum cross section at the splice. 7.2.5 All bolts , nuts, washers, electrodes, screws etc. shall be supplied/brought to site 10% in excess of the requirement in each category and size. Rates shall cover the cost of this extra quantity. 7.2.6 All members likely to collect rain water shall have drain holes provided. 7.3 <u>Straightening</u> All materials, shall be straight and, if necessary, before being worked shall be straightened and/or flattened by pressure and shall be free from twists. Heating or		
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TCE. M4-405-01	SUPPLY AND FABRICATION OF STRUCTURAL STEEL	Sh 7 of 12
forging shall not be resorted to without the prior approval of the ENGINEER in writing. 7.4 Cutting, punching, drilling, welding and fabrication tolerances shall be generally as per relevant IS codes. 7.5 <u>Rolling And Forming</u> Plates, channels, R.S.J. etc., for circular bins, bunkers, hoppers, gantry girders, etc., shall be accurately laid off and rolled or formed to required profile/ shape as called for on the drawings. Adjacent sections shall be match-marked to facilitate accurate assembly, welding and erection in the field. 7.6 <u>High Strength Friction Grip Bolting</u> 7.6.1 Inspection after tightening of bolts shall be carried out as stipulated in the appropriate standards depending upon the method of tightening and the type of bolt used. 7.7 <u>Welding</u> 7.7.1 Welding procedure shall be submitted to ENGINEER for approval. Welding shall be entrusted to only qualified and experienced welders who shall be periodically tested and graded as per IS 817, IS:7310 (Part 1) and IS:7318 (Part 1). 7.7.2 While fabricating plated beams and built up members, all shop splices in each component part shall be made before such component part is welded to other parts of the members. Wherever weld reinforcement interferes with proper fit-up between components to be assembled for welding, these welds shall be ground flush prior to assembly. 7.7.3 Approval of the welding procedure by the ENGINEER shall not relieve the CONTRACTOR of his responsibility for correct and sound welding without undue distortion in the finished structure. 7.7.4 No welding shall be done when the surface of the members is wet nor during periods of high wind. 7.7.5 Each layer of a multiple layer weld except root and surfaces runs may be moderately peened with light blows from a blunt tool. Care shall be exercised to prevent scaling or flaking of weld and base metal from overpeening. 7.7.6 No welding shall be done on base metal at a temperature below -5 Deg.C. Base metal shall be preheated to the temperature as per relevant IS codes.		
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7.7.7 Electrodes other than low-hydrogen electrodes shall not be permitted for thicknesses of 32 mm and above. 7.7.8 <u>Inspection of Welds</u> All welds shall be inspected for flaws by any of the methods described under clause 8 "Inspection". The choice of the method adopted shall be determined by the PURCHASER/ENGINEER. 7.7.9 The correction of defective welds shall be carried out as directed by the ENGINEER without damaging the parent metal. When a crack in the weld is removed, magnetic particle inspection or any other equally positive means as prescribed by the ENGINEER shall be used to ensure that the whole of the crack and material upto 25 mm beyond each end of the crack has been removed. Cost of all such tests and operations incidental to correction shall be to the VENDOR/CONTRACTOR's account. 7.8 <u>Tolerances</u> The dimensional and weight tolerances for rolled shapes shall be in accordance with IS:1852 for indigenous steel and equivalent applicable codes for imported steel. The tolerances for fabrication of structural steel shall be as per IS:7215. 7.9 <u>End Milling</u> Where compression joints are specified to be designed for bearing, the bearing surfaces shall be milled true and square to ensure proper bearing and alignment. 8.0 <u>INSPECTION</u> 8.1.1 The VENDOR/CONTRACTOR shall give due notice to the PURCHASER/ENGINEER in advance of the works getting ready for inspection. All rejected material shall be promptly removed from the shop and replaced with new material for the PURCHASER's/ENGINEER's approval/ inspection. The fact that certain material has been accepted at the VENDOR/CONTRACTOR's shop shall not invalidate final rejection at site by the PURCHASER/ENGINEER if it fails to conform to the requirements of these specifications, to be in proper condition or has fabrication inaccuracies which prevents proper assembly nor shall it invalidate any claim which the PURCHASER may make because of defective or unsatisfactory materials and/or workmanship.		
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8.1.2 No materials shall be painted or despatched to site without inspection and approval by the PURCHASER/ ENGINEER unless such inspection is waived in writing by the ENGINEER. 8.1.3 The VENDOR/CONTRACTOR shall provide all the testing and inspection services and facilities for shop work except where otherwise specified. 8.1.4 For fabrication work carried out in the field the same standard of supervision and quality control shall be maintained as in shop fabricated work. Inspection and testing shall be conducted in a manner satisfactory to the ENGINEER. 8.2 Inspection and tests on structural steel members shall be as set forth below : 8.2.1 <u>Material Testing</u> If mill test reports are not available for any steel materials the same shall be got tested by the VENDOR/CONTRACTOR to the ENGINEER's satisfaction to demonstrate conformity with the relevant specification. 8.3 <u>Tests on Welds</u> 8.3.1 <u>Magnetic Particle Test</u> Where welds are examined by magnetic particle testing, such testing shall be carried out in accordance with relevant IS codes. If heat treatment is performed, the completed weld shall be examined after the heat treatment. All defects shall be repaired and retested. Magnetic particle tests shall be carried out using alternating current. Direct current may be used with the permission of the ENGINEER. 8.3.2 <u>Liquid Penetrant Inspection</u> In the case of welds examined by Liquid Penetrant Inspection, such tests shall be carried out in accordance with relevant IS Code. All defects shown shall be repaired and rechecked. 8.3.3 <u>Radiographic Inspection</u> All full strength butt welds shall be radiographed in accordance with the recommended practice for radiographic testing as per relevant IS code. 8.4 <u>Dimensions, Workmanship & Cleanliness</u> Members shall be inspected at all stages of fabrication and assembly to verify that dimensions, tolerances, alignment, surface finish and painting are in		
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accordance with the requirements shown in the VENDOR/CONTRACTOR's approved fabrication drawings and the ENGINEER's drawings. 8.5 <u>Test Failure</u> In the event of failure of any member to satisfy inspection or test requirement, the CONTRACTOR shall notify the ENGINEER or his authorised representative. The VENDOR/CONTRACTOR must obtain permission from the ENGINEER before repair is undertaken. The quality control procedures to be followed to ensure satisfactory repair shall be subject to approval by the ENGINEER. 8.6 The ENGINEER has the right to specify additional testing as he deems necessary, and the additional cost of such testing shall be borne by the PURCHASER, only in case of successful testing. 8.7 The VENDOR/CONTRACTOR shall maintain records of all inspection and testing which shall be made available to the ENGINEER or his authorised representative. 9.0 <u>SHOP MATCHING</u> For structures like bunkers, tanks, etc. shop assembly is essential. For other steel work, such as columns along with the tie beams/bracings may have to be shop assembled to ensure satisfactory fabrication, obtaining of adequate bearing areas etc. if so desired by the ENGINEER. All these shop assemblies shall be carried out by VENDOR/CONTRACTOR at no extra cost to the PURCHASER. 10.0 <u>DRILLING HOLES FOR OTHER WORKS</u> As a part of this Contract, holes in members required for installing equipment or steel furnished by other manufacturers or other contractors shall be drilled by the VENDOR/CONTRACTOR at no extra cost to the PURCHASER. The information for such extra holes will be supplied by the PURCHASER/ENGINEER. 11.0 <u>MARKING OF MEMBERS</u> 11.1 After checking and inspection, all members shall be marked for identification during erection. This mark shall correspond to distinguishing marks on approved erection drawings and shall be legibly painted and stamped on it. The erection mark shall be stamped with a metal dye with figures at least 20 mm high and to such optimum depth as to be clearly visible.		
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TCE. M4-405-01	SUPPLY AND FABRICATION OF STRUCTURAL STEEL	Sh 11 of 12
11.2 All erection marks shall be on the outer surface of all sections and near one end, but clear of bolt holes. The marking shall be so stamped that they are easily discernible when sorting out members. The stamped marking shall be encircled boldly by a distinguishable paint to facilitate easy location. 11.3 Erection marks on like pieces shall be in identical locations. Members having lengths of 7.0 m or more shall have the erection mark at both ends. 12.0 <u>ERRORS</u> Any error in shop fabrication which prevents proper assembling and fitting up of parts in the field by moderate use of drift pins or moderate amount of reaming will be classified by the ENGINEER as defective workmanship. In case ENGINEER rejects such material or defective workmanship, the same shall be replaced by the materials and workmanship conforming to the ENGINEER's requirements by VENDOR/CONTRACTOR free of cost at site. 13.0 <u>PAINTING</u> 13.1 All fabricated steel material, except those galvanised shall receive protective paint coating as specified in specification No. TCE.M4-405-04. 13.2 Galvanising of fabricated steel wherever specified, shall be as per TCE.M4-405-05. 14.0 <u>METHOD OF MEASUREMENT</u> 14.1 For the purpose of payment, the weight of the actual completed structures shall be calculated from the approved drawings for different items of work. The VENDOR/CONTRACTOR shall submit to the PURCHASER relevant material list containing weight of each item. 14.2 No allowances will be permitted for bolts, nuts, washers, studs, screws etc, galvanizing, welding or for rolling margins. One tonne for the purpose of payment shall mean ONE METRIC TONNE i.e. 1000 Kg. 14.3 The weight of a member made out of standard rolled section such as beams, channels, angles, etc. shall be based on the standard IS:808 without deductions for holes, notches, bevel cuts, etc. Where a component consists of a cut joist or channels, the full weight of the rolled section shall be considered only if more than half the depth of the original section is used. Otherwise, only half the section unit weight shall be considered for calculation of the weight of the components.		
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TCE. M4-405-01	SUPPLY AND FABRICATION OF STRUCTURAL STEEL	Sh 12 of 12
Deductions shall be made in the weight of gussets/plates for cuts and notches of 900 sq. cm. or larger. 14.4 For gussets/plates used in trusses, bracings, columns, beams, etc, the area shall be that of the minimum circumscribing rectangle except as stated in 14.3 above. 14.5 The weight of any built-up members shall be based on the weight of each component.		
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SPEC.NO. TCE.M4-104-02	TATA CONSULTING ENGINEERS LIMITED THERMAL INSULATION FOR HOT SURFACES	SECTION: D33 SHEET 1 OF 14

1.0 **SCOPE**

This specification covers the technical requirements and essential particulars for the supply, application and finishing of the complete thermal insulation for hot equipment, piping systems, flues, ducts, steam generator casing, fixture casing, steam turbine etc. up to an operating temperature of 565⁰C. This specification is not applicable where the insulation is to be used for dual temperature (both hot and cold) service. Unless specified otherwise in section C and/or data sheet A, the scope of supply of the CONTRACTOR shall include, but not be limited to, the following items :

- (a) Insulation materials of all types as specified and required
- (b) Finishing materials of all types as specified and required
- (c) Auxiliary materials such as binding and lacing wires, wire netting, bands, screws etc., as specified and required
- (d) Angles, clamps, lugs etc. for supporting insulation
- (e) Weather hoods
- (f) Any other material as may be required for making the insulation complete

2.0 **CODES AND STANDARDS**

2.1 The supply and application of thermal insulation and finishing covered under this specification shall comply with all currently applicable statutes, regulations and safety codes in the locality where it is to be applied. The materials and application shall also conform to the latest editions of the codes and standards listed. Nothing in this specification shall be construed to relieve the CONTRACTOR of this responsibility.

2.2 The following are some of the codes and standards relevant to this specification :

- IS 277 Galvanised Steel Sheets (Plain and Corrugated)
- IS 737 Wrought Aluminium and Aluminium Alloy Sheet and Strip for General Engineering Purposes
- IS 3144 Mineral Wool Thermal Insulation Materials - Method of Test
- IS 3677 Unbonded Rock and Slag Wool for Thermal Insulation
- IS 3690 Unbonded Glass Wool for Thermal Insulation

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IS 8154 Preformed Calcium Silicate Insulation for Temperatures up to 650°C.

IS 8183 Bonded Mineral Wool

IS 9842 Preformed Fibrous Pipe Insulation

IS 14164 Industrial Application and Finishing of Thermal Insulation Materials at Temperatures above (-) 80°C and up to (+) 750°C

BS 5970 Thermal Insulation of Pipework and Equipment (in the Temperature Range (-) 100°C to (+) 870°C)

3.0 **GENERAL DESIGN REQUIREMENTS**

3.1 All exposed portions of the plant which operate at temperatures of 65°C and above during normal operation shall be thermally insulated so that the temperature on the outer surface of the finish does not exceed 60°C based on an ambient temperature of 30°C in still air conditions, unless specified otherwise in data sheet A.

3.2 Insulation thickness for rock wool and glass wool materials have been indicated in data sheet A. These insulation thickness do not include thickness of finishing materials such as cement sand plaster, aluminium or Galvanised Steel (GS) sheet, binding and lacing wires, wire netting and bands etc.

3.3 Insulation thickness indicated in data sheet A shall be regarded as the minimum requirement. BIDDER may provide higher thickness in order to meet the design criteria indicated at para 3.1.

3.4 Equipment and piping which are not insulated from heat conservation considerations but have a surface temperature exceeding 65°C shall be insulated for personnel protection when :

- (a) The bottom of the equipment or pipe is less than 2 metres from the ground or working floor or platform or walkway, or
- (b) The equipment or pipe, or parts thereof, are within 600 mm from a working floor or platform or walkway

Equipment and piping to be insulated for personnel protection, shall be insulated to the extent that the temperature on the outer surface of the finish does not exceed 60°C.

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- 3.5 Equipment in horizontal position, which are to be insulated for personnel protection, shall be fully insulated when the equipment outside diameter is less than 1250 mm and to a height of 2 metres from the working floor or platform for larger sizes.

4.0 **MATERIALS**

4.1 **GENERAL**

- 4.1.1 All materials shall be new and fresh, incombustible, fire retardant, rot-proof, non-hygroscopic, vermin proof, fungus proof, non-injurious to health, chemically inert, non-corrosive to steel and aluminium (even if soaked in water for extended periods) and shall be guaranteed to withstand continuously and without deterioration the maximum temperature to which these shall be subjected to under the specified applications.

- 4.1.2 The insulation materials and any component of the finished insulation job shall not react chemically, singly or in combination, with water or moisture to form substances that are more actively corrosive to applied surface than water or moisture alone.

- 4.1.3 In order to protect the workers from the hazards of insulation materials, suitable protective gadgets shall be provided. Required safety precautions shall be taken during handling and application of insulation.

- 4.1.4 The insulation material shall be kept dry at all times during transport, storage and installation. Decking and covering tarpaulins alone are not adequate for any length of time and shall not be allowed except in extreme emergencies and only for short period. Stacking of insulation materials directly on ground shall not be done. No wet insulation shall be installed. If wet insulation is present, it shall be removed and replaced with new dry insulation. The insulation may be protected with plastic film but shall be vented to prevent sweating.

4.2 **INSULATION MATERIALS**

The insulation material shall be one or more of the following types as specified in data sheet A.

	<u>Material Description</u>	<u>Material Code</u>
4.2.1	Unbonded rock wool mattress as per IS 3677 Type 2 at an application density of 150 Kg/M ³ for temperatures 65 to 399 ⁰ C	U150

	<u>Material Description</u>	<u>Material Code</u>

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4.2.2		Unbonded rock wool mattress as per IS 3677 Type 2 at an application density of 200 Kg/M ³ for temperatures 400 to 565 ⁰ C		U200	
4.2.3		Unbonded glass wool mattress as per IS 3690 Type 2 at an application density of 80 Kg/M ³ for temperatures 65 to 550 ⁰ C		U80	
4.2.4		Lightly resin-bonded rock wool mattress as per IS 8183 at an application density of 100 Kg/M ³ for temperatures 65 to 399 ⁰ C		L100	
4.2.5		Lightly resin-bonded rock wool mattress as per IS 8183 at an application density of 150 Kg/M ³ for temperatures 400 to 565 ⁰ C		L150	
4.2.6		Bonded rock wool pipe sections as per IS 9842 at an application density of 144 Kg/M ³ for temperatures 65 to 565 ⁰ C		PS1	
4.2.7		Calcium silicate preformed blocks, slabs and pipe sections as per IS 8154 at an application density of 200 Kg/M ³ for temperatures 65 to 565 ⁰ C		CS1	
4.3		<u>FINISHING MATERIALS</u>			
The finishing material shall be one or more of the following types as specified in data sheet A.					
		<u>Material Description</u>		<u>Material Code</u>	
4.3.1		Portland cement and inorganic fibre with water proofing compound at an application density of 1050 to 1100 Kg/M ³		FC	
4.3.2		Aluminium sheet as per IS 737, designation 31000, condition H3 for insulation material codes U150, U 200 and U 80		AL1	
(a)		Insulation outside diameter above 450 mm - sheet thickness 18 SWG			
(b)		Insulation outside diameter 150 to 450 mm - sheet thickness 20 SWG			
		<u>Material Description</u>		<u>Material Code</u>	
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	(c) Insulation outside diameter below 150 mm - sheet thickness 22 SWG (d) Flues and ducts - sheet thickness 1.0 mm (e) Steam generator casing and rear wall enclosure - sheet thickness 1.6 mm 4.3.3 Aluminium sheet as per IS 737, designation 31000, condition H3 for insulation material codes L100, L150, PS1 and CS1 AL2 (a) Insulation outside diameter above 450 mm - sheet thickness 20 SWG (b) Insulation outside diameter 150 to 450 mm - sheet thickness 22 SWG (c) Insulation outside diameter below 150 mm - sheet thickness 24 SWG (d) Flues and ducts - sheet thickness 1.0 mm (e) Steam generator casing and rear wall enclosure - sheet thickness 1.6 mm 4.3.4 GS sheet as per IS 277, designation GP, for insulation material codes U150, U200 and U80 GS1 (a) Insulation outside diameter above 450 mm -sheet thickness 20 SWG (b) Insulation outside diameter 150 to 450 mm - sheet thickness 22 SWG (c) Insulation outside diameter below 150 mm - sheet thickness 24 SWG (d) Flues and ducts - sheet thickness 1.0 mm (e) Steam generator casing and rear wall enclosure - sheet thickness 1.2 mm	
	<u>Material Description</u> <u>Material Code</u>	ISSUE R9

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4.3.5 GS sheet as per IS 277, designation GP, for insulation material codes L100, L150, PS1 and CS1 GS2 (a) Insulation outside diameter above 450 mm - sheet thickness 22 SWG (b) Insulation outside diameter 150 to 450 mm - sheet thickness 24 SWG (c) Insulation outside diameter below 150 mm - sheet thickness 26 SWG (d) Flues and ducts - sheet thickness 1.0 mm (e) Steam generator casing and rear wall enclosure-sheet thickness 1.2 mm 4.4 <u>AUXILIARY MATERIALS</u> 4.4.1 <u>Binding and Lacing Wires</u> (a) For temperatures up to 399⁰C : Annealed GS 20 SWG (b) For temperatures from 400 to 565⁰C : Annealed SS 304 20 SWG 4.4.2 <u>Wire Netting</u> (a) For temperatures up to 399⁰C : 20 SWG GS wire with 20 mm hexagonal opening (b) For temperatures from 400 to 565⁰C : 20 SWG SS 304 wire with 20 mm hexagonal opening 4.4.3 <u>Bands</u> (a) For securing insulation material : 20 SWG GS, 20 mm wide (b) For securing aluminium and GS sheets : 24 SWG anodised aluminium or SS 304, 20 mm wide (c) For securing aluminium foil on SS surface : 24 SWG aluminium, 20 mm wide 4.4.4 <u>Screws</u>		
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Screws shall be of self-tapping type and shall be of aluminium or stainless steel for aluminium sheets and GS for GS sheets.

5.0 **INSULATION OF EQUIPMENT AND PIPING (EXCEPT STEAM TURBINE)**

5.1 **GENERAL**

- 5.1.1 The application of insulation shall be made in a professional manner. The insulation shall be applied to all surfaces when these are at ambient temperature. Ample provision shall be made for the maximum possible thermal movement and the insulation shall be applied in a manner which shall avoid breaking or telescoping due to alternate periods of expansion and contraction. A single layer of insulation shall not be more than 75 mm thick.
- 5.1.2 Insulation shall be applied after all leak tests on equipment and piping are over and the section of the plant has been specifically released by the PURCHASER for such work. If insulation has to be applied before the leak test, all welded and flanged joints shall be left exposed and insulated after satisfactory completion of the leak test.
- 5.1.3 All surfaces to be insulated shall be clean and dry before the insulation is applied. The surfaces shall be cleaned of all foreign material such as scale, dirt, rust and paint, by the use of steel wire brushes and steel scrapers, where necessary. Where a surface is not free of paint the CONTRACTOR shall notify the PURCHASER of the condition for remedial action. The insulation shall be applied after remedial action, suggested by the PURCHASER, has been taken by the CONTRACTOR.
- 5.1.4 Carbon steel and low alloy steel surfaces to be insulated shall be thoroughly cleaned by wire brushing. For operating temperatures below 125°C, the surface shall be given one coat of heat-resistant aluminium paint of coating thickness not less than 20 microns.
- 5.1.5 All stainless steel surfaces to be insulated shall be protected against chloride attack as follows :
- For operating temperatures up to 500°C, the stainless steel surfaces shall be mechanically separated from insulation surface by wrapping with 0.1 mm (42 SWG) thick aluminium foil. Application and other details shall be same as those described for steam traced piping in para 5.2.6.
 - Above 500°C, the metal surface shall be given one coat of heat-resistant aluminium paint of coating thickness not less than 20 microns.

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5.1.6 All sheet metal joints shall be sealed with bitumastic paint and made effectively weather and water-proof. All flat surfaces shall be adequately sloped to prevent pools of water collecting. The sheet shall be protected internally with 2 coats of bitumastic paint.

5.1.7 All actions shall be taken to complete the application of finishing on exposed surfaces covered with insulation before closing the day's work. If this is not practicable, adequate precautions shall be taken to protect the insulation from weather, for example by wrapping it with polythene sheet, roofing felt or other approved material.

5.2 INSULATION ON PIPING

5.2.1 All vertical pipes shall be provided with suitable insulation supports to prevent the insulation from collapsing due to its own weight. Suggested method is indicated in TCE.M4-104-54. Any welding required, shall be carried out by the CONTRACTOR with the prior permission of the PURCHASER and only under his direct supervision. Where welding is not permitted, suitable clamped supports shall be used. The insulation shall be applied starting from bottom up. Mattress type insulation materials shall be clamped from top.

5.2.2 If rock wool preformed pipe section insulation material is used, the sections shall be fitted closely to the pipe. Where there is more than one layer of insulation material, all joints shall be staggered. Each section shall be held in place by circumferential bands or wires at spacing not greater than 450 mm. If mattress is used, the insulation shall be formed to fit the pipe and applied with edges pulled together tightly at the longitudinal joint and secured by lacing wire. The insulation shall be turned to bring this joint to the lower side. Adjacent length shall be butted closely and laced together with lacing wire. Mattress insulation shall be backed-up by wire-netting on one side. For insulation thickness of more than 75 mm, where application shall be in two or more layers, each layer of mattress shall be backed up with wire netting.

5.2.3 When calcium silicate is the insulation material, all pipes up to and including 300 mm nominal diameter shall be covered with preformed rigid sections to form a robust pipe covering. Larger sizes shall be covered with segmental blocks moulded to a diameter to fit the curved surfaces. All sectional and segmental insulation shall be carefully fitted to the pipes with side and end joints butted tightly and securely wired in place at spacing not greater than 400 mm.

5.2.4 The ends of all wire loops shall be firmly twisted together with pliers, bent over and carefully pressed into the surface of the insulation. All calcium silicate

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	insulation joints shall be fully staggered and any cavities between joints and cracks if any in both inner and outer layers shall be filled with insulating cement. 5.2.5 When preformed insulation material is used, the number of segments shall be minimum and all joints shall be filled with the same basic insulation material in loose form. 5.2.6 The thickness of insulation for steam traced lines shall be the higher value as determined by the size and temperature of the steam tracer and the service line. The tracer shall be tightly wired to the main pipe at intervals of 500 mm. Aluminium foil not less than 0.1 mm thick (42 SWG) shall then be wrapped around both the pipe and tracer with an overlap of at least 25 mm and wired or banded in place. This is to prevent insulation from separating the pipe and tracer and to provide a hot air enclosure and also to provide a barrier to radiant energy leaving the pipe. The insulation proper shall then be fitted and finished in the normal way. Cross-section of preformed insulation shall be suitable for accommodating tracers. 5.2.7 All insulation shall be protected by a finishing material as specified in data sheet A. The sheets shall be installed with the longitudinal lap joints at 45° below the horizontal for horizontal pipes and the joints sealed with bitumastic paint. On vertical pipes the sheets shall be applied working from bottom up. Each section of sheets shall have a minimum overlap of 50 mm longitudinally and circumferentially. Each circumferential joint shall be made weather-proof by securing with a band of sheet material and sealing with bitumastic paint. Longitudinal lap joints shall be fixed with screws at approximately 150 mm centres. 5.2.8 Weather hoods shall be provided for insulated piping passing through roof, and external walls as per TCE.M4-104-50. 5.3 <u>INSULATION ON PIPE FITTINGS, VALVES AND SPECIALITIES</u> 5.3.1 All pipe fittings, valves and specialties shall be covered with the same type and thickness of insulation as specified for the adjoining pipe, with the special provisions and/or exceptions as listed below. On pipe fittings, insulation outside diameter shall be same as the outside diameter of adjacent pipe insulation. 5.3.2 Unless specified otherwise in section C or data sheet A, all valves and specialties, shall also be insulated to the same extent as the adjacent piping. 5.3.3 Unless specified otherwise in section C, valves and specialties of sizes 100 mm NB and larger shall be provided with removable box type insulation. Box shall be fabricated from sheet material specified for adjoining pipes. Pipe insulation	

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	on adjoining flanges shall be stopped at one bolt length plus 25 mm before flange to permit removal of the bolts and nuts. The insulation shall be applied after the finish has been applied over insulation on the adjacent piping. A typical arrangement is shown in TCE.M4-104-51. 5.3.4 Flanged joints shall be insulated. Arrangement shall be similar to that for valves shown in TCE.M4-104-51. Unions shall not be insulated. 5.3.5 Non-metallic expansion joints shall not be insulated. Metallic expansion joints identified in bill of materials shall be insulated. 5.3.6 Traps shall not be insulated. However, trap discharge lines and safety valve discharge lines shall be insulated for personnel protection only. 5.3.7 Pipe hanger clamps shall be covered with insulation along with the pipe. Upper bolts of three-bolt hanger clamps shall not be insulated. A typical arrangement is shown in TCE.M4-104-53. On piping outdoors, a weather hood packed with waterproof sealing material shall be supplied and installed. 5.4 <u>INSULATION ON EQUIPMENT</u> 5.4.1 Where the insulation material is in the mattress form, cleats in the form of wire nails or nuts or angles and flats for supporting the insulation material, shall be welded to the equipment by others. If wire nails are to be used as insulation cleats, these shall be bent and secured with the metal fabric of the mattress, after the insulation has been applied. Where insulation cleats are in the form of M6 and M10 nuts, the CONTRACTOR shall supply and install bolts of suitable length for fixing the insulation. The insulation applied to equipment shall be reinforced with wire netting. One course of wire netting shall be applied to the surface of the equipment and each layer of insulation shall be backed up with wire netting. All irregularities of the surface shall be filled and levelled over with insulating cement. All mattress joints shall be butted tightly and the mattresses shall be secured with 20 mm wide 24 SWG GS bands at 450 mm centres. After banding, all mattress edges shall be laced tightly. 5.4.2 When calcium silicate is the insulation material, segmental blocks moulded to fit the curved surfaces shall be used for cylindrical portions of the equipment. Flat blocks shall be used for equipment of diameter greater than 2500 mm and for flat surfaces. 5.4.3 For equipment up to 2500 mm in diameter and temperatures up to 200°C, the blocks shall be cut and fitted so that the inner diameter of insulation is 13 mm greater than the equipment outside diameter to take care of equipment circumferential expansion. The blocks shall be applied tightly butted and sealed.	

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with insulating cement. The insulation shall be secured by circumferential bands in such a way that tension of the bands produces compression on the butt edges rather than on the surface towards the equipment. 5.4.4 For equipment either above 2500 mm in diameter or at temperatures above 200°C, a 25 mm thick rock wool fibre mattress insulation shall be applied around the equipment prior to the application of calcium silicate. Calcium silicate blocks must be cut and fitted to the outside radius of the equipment plus the thickness of the rock wool spacer insulation. The insulation, when installed, shall not compress the fibrous mattress. 5.4.5 All equipment, unless specified otherwise, shall have a smooth aluminium or GS sheet finish as specified in data sheet A, applied in a manner similar to that specified for piping. For fixing of aluminium or GS sheets, spacer rings at 1000 mm centres shall be welded to the equipment by the CONTRACTOR. If welding is not permitted, spacer rings shall be suitably clamped. Spacer ring material shall be the same as that of the surface to be insulated. All vertical and horizontal sheets shall be overlapped a minimum of 75 mm. The lapped joints of adjoining sections of sheets shall be secured with screws. On all equipment above 2500 mm diameter and flat surfaces the sheet shall be further secured by circumferential bands at approximately 1000 mm centres. Each sheet joint shall be sealed with bitumastic paint. The roof sections shall overlap the side walls to prevent water seepage between insulation and the equipment wall. Side wall sheets shall be securely banded at intersections of the side wall and roof sections. 5.4.6 All equipment manholes, hatches, bolted or screwed cover plates, flanged ends etc. shall have removable box type insulation, with same thickness of insulation as for adjacent surfaces. Insulation adjoining such equipment openings shall be tapered towards these openings to permit removal of bolts, screws, heads, covers or plates with no damage to adjacent surface insulation or cover. A typical detail of manhole insulation is shown in TCE. M4-104-56. 5.4.7 Nozzles and other connections on tanks, heaters and other equipment shall be insulated in the same manner as the pipes. 5.4.8 Pump casing shall be completely insulated with removable type of boxes fabricated from the specified sheet material. 5.4.9 Name plates on equipment shall not be insulated. 5.5 <u>CEMENT SAND PLASTER FINISH</u> 5.5.1 On piping and equipment, where cement sand plaster finishing is specified in data sheet A, a barrier of polythene bonded hessian with the hessian layer		

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outwards or bituminised Kraft paper shall be provided over the insulation. A total of 15 mm thick cement sand (1:4) plaster shall be applied in two layers after a GS wire netting is stretched over the entire surface of the barrier and securely fastened down. The plaster shall be hand-trowelled over the wire netting to a smooth finish. Curing shall be carried out by wrapping damp hessian cloth around the plaster. The application of finishing plaster shall be terminated, at the end of day's work, at an expansion joint.

- 5.5.2 The cement sand plaster finish shall have the following properties :
- (a) A light shower of rain, falling immediately after application shall not wash off the plaster.
 - (b) At any time, one week or more after application, it shall not shatter if struck a sharp blow with a 0.7 Kg hammer. Such a blow may damage the finishing locally but shall not cause large pieces to break away.
 - (c) When set, it shall withstand prolonged exposure to the weather without additional protection.
- 5.5.3 Outdoors, the finishing plaster shall be applied immediately after application of insulation. If this is not practicable, the CONTRACTOR shall take adequate precautions to protect the insulation from weather, e.g. by wrapping it with polythene sheet, roofing felt or other approved material.

6.0 **INSULATION EXPANSION JOINTS**

Necessary insulation expansion joints shall be provided to prevent cracking of rigid insulation and hardsetting finishing cement layer. Insulation expansion joints shall be provided at intervals as shown in TCE.M4-104-54. These shall also be fitted on both sides and within 1000 mm of each bend and branch connections. At the insulation expansion joint, there shall be complete cut through the insulation and the sheet metal covering shall be provided with sliding joints.

7.0 **STEAM TURBINE INSULATION**

- 7.1 Steam turbine and its integral piping shall be lagged with calcium silicate plastic composition in multiple layers.
- 7.2 Before applying the insulation, the surface to be insulated shall be thoroughly cleaned with wire brush to remove all dirt, rust and scale. After cleaning, the insulation shall be applied in successive layers to the required thickness. Each individual layer shall be properly dried before the next layer is applied.

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	7.3 The heating of the steam turbine cylinder before the application and drying of the individual layers shall be by infra-red lamps. The CONTRACTOR shall provide all equipment and make all necessary arrangements. 7.4 The insulation shall be reinforced with GS wire netting and lacing. Where layer interface temperature is 400⁰C and above, SS 304 wire netting and lacing shall be used. Reinforcing wire netting shall be provided over each successive layer of insulation. 7.5 The insulation shall be secured to the steam turbine cylinder and steam chests. For securing the insulation properly, nuts shall be provided on the outer steam turbine casing and steam chest. Studs of suitable length shall be screwed on to the nuts and the insulation shall be held rigidly by the studs. 7.6 The studs shall be wrapped with asbestos mill board paper or rope to avoid direct contact of the wire-mesh with the studs. The studs shall be of stainless steel material. 7.7 The insulation shall be finished with a layer of hard setting insulating cement, trowelled to a smooth finish, to prevent damage. 7.8 The steam turbine shall then be covered with 1.2 mm thick aluminium appearance cladding. 8.0 <u>MEASUREMENT</u> Measurement of insulation over equipment and piping shall be as per IS 14164. 9.0 <u>GUARANTEES</u> 9.1 The CONTRACTOR shall demonstrate to the PURCHASER that the temperature of the outer surface of the finish has not exceeded 60°C. Temperature shall be measured at the middle of a segment of piping run to be mutually agreed. Two measurements, one at the top and other at the bottom, shall be taken at the measuring points. These temperatures shall be taken as the representative temperature for that length of piping. 9.2 The CONTRACTOR shall guarantee that, if the temperature on the outer surface of the finish exceeds 60°C, the CONTRACTOR shall either replace the insulation with a superior material or provide additional insulation thickness at the PURCHASER'S discretion at no extra cost to the PURCHASER. 10.0 <u>MISCELLANEOUS</u> Approval of the PURCHASER shall be obtained of samples of all materials and necessary test certificates of approved national laboratories, before despatching	ISSUE R9

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these to site. Insulation shall not be applied until specific release is given by the PURCHASER.

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DATA SHEET C

**DATA TO BE FURNISHED BY THE CONTRACTOR AFTER THE AWARD
OF CONTRACT**

1. List of drawings and documents to be submitted for review, approval and information with scheduled submission dates
2. Quality Assurance Plan (QAP)
3. List of insulation materials with specifications and properties like density, thermal conductivity etc.
4. Values for thermal conductivity at various mean temperatures for all insulation materials
5. List of finishing materials with specifications
6. List of auxiliary materials with specifications
7. Test certificates for insulation and other materials
8. Detailed insulation application and finishing procedure

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	ERECTION AND TESTING OF POWER PLANT PIPING	

1.0

SCOPE

This specification covers the minimum technical requirements and essential particulars for erection, inspection, testing and cleaning of power plant piping systems included in the CONTRACTOR's scope of work. The CONTRACTOR shall demonstrate that the piping meets the requirements of the specification and applicable codes. In the event supply and shop fabrication of piping systems are also included in the CONTRACTOR's scope of work in Section C, all references to the PURCHASER's drawings in the subsequent clauses of this section shall be understood to imply the CONTRACTOR's drawings.

2.0

CODES AND STANDARDS

The CONTRACTOR shall comply with the latest editions of applicable Codes and Standards. The CONTRACTOR shall also comply with all applicable statutes, regulations and safety codes in the locality where the piping will be erected. Nothing in this specification shall be construed to relieve the CONTRACTOR of this responsibility.

3.0

GENERAL REQUIREMENTS

3.1

The CONTRACTOR shall erect all piping, online instruments, control valves, block valves, specialities, etc., as per the PURCHASER's piping drawings for piping systems of NB 65 mm size and larger.

3.2

Unless otherwise specified in Section C, piping systems of size NB 65 mm and larger are deemed shop-fabricated and would be delivered to site in prefabricated condition. The extent of fabrication to be carried out on these pipelines at site by the CONTRACTOR is indicated in the piping layout drawings and also specified in Clauses 3.3, 3.4, 3.5, and 3.6 of this specification.

3.3

If adequate dimensional data is not available sufficiently in advance from the suppliers of control valves, flow nozzles, orifice plate assemblies, desuperheaters and such other specialities, pipe spools on either side of these specialities may be sent to site in unfabricated or semi-fabricated condition. The CONTRACTOR shall cut these spools to the required lengths, prepare their ends for purposes of welding, weld bosses for drains, vents, instruments, etc., as required, weld support lugs or shoes, if required and carry out any other fabrication work on these spools as might be required to render these

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system complete in all respects and compatible with the final piping drawings. 3.4 Flow nozzles, flow orifices and control valves on pipelines which are steam blown shall be installed after steam blowing. These pipelines would therefore be sent to site without being cut short for the flow nozzles/orifices/control valves. After completion of blow out operation, CONTRACTOR shall cut spool pieces of appropriate lengths, prepare the weld ends and install the flow nozzle / orifice assemblies / control valves. 3.5 All other fabrication work as required on prefabricated pipe work for connecting temporary piping for purposes of mass flush, chemical cleaning, steam blow out, hydraulic testing, vacuum testing, etc., dismantling the temporary pipe work and restoring the permanent pipe work to their design condition shall be carried out by the CONTRACTOR. 3.6 Where required for hydrotesting, chemical cleaning or steam blowing of piping, the CONTRACTOR shall provide necessary vents and drains, whether these are shown on piping drawings or not. 3.7 The CONTRACTOR shall install all hangers and supports, guides, restraints, anchors, vibration dampeners, shock absorbers, etc., as per the approved hanger sketches. Any field fabrication such as cutting and threading of hanger rod, etc., required for the installation of such hangers and supports shall be carried out by the CONTRACTOR. 3.8 Pipelines of size NB 50 and below are regarded as field-run piping. It is the CONTRACTOR's responsibility to plan suitable layouts for these systems at site as per the requirements of this specification and in consultation with the PURCHASER and/or the ENGINEER. The CONTRACTOR shall prepare isometric drawings indicating the layout of field-run pipe work based on the PURCHASER's flow diagrams and general arrangement drawings. The isometric drawings shall be approved by the PURCHASER/ENGINEER prior to the installation of the field run pipe work. Any layout for field-run pipe work that may be indicated on PURCHASER's layout drawings may be used for guidance. <table border="1"> <tr> <td> ISSUE R4 </td> </tr> </table>			ISSUE R4	
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3.9

While routing field run piping, the following requirements shall be taken into account by the CONTRACTOR.

3.9.1

All piping shall be routed so as to avoid interference with other pipes and their hangers and supports, electrical cable trays, ventilation ducting, structural members, equipment, etc. Adequate clearances shall be ensured with respect to the above to accommodate insulation and pipe movements.

3.9.2

All piping shall be grouped where practicable and shall be routed to present a neat appearance.

3.9.3

The piping shall be arranged to provide clearance for the removal of equipment requiring maintenance and for easy access to valves, instruments and other piping accessories required for operation and maintenance.

3.9.4

Piping shall generally be routed above ground but where specifically indicated / approved by the ENGINEER, the pipes may be arranged in pipe trenches or laid buried. Insulated pipes shall not be buried.

3.9.5

Overhead piping shall have a minimum vertical clearance of 2.3 meters above walkways and working areas and 6.0 meters above roadways unless otherwise specified by the ENGINEER.

3.9.6

Drains shall be provided at all low points and vents at all high points as per actual layout regardless of whether the same have been shown in the flow diagrams or not. Pipelines shall preferably be sloped towards the drain points.

3.9.7

Provision shall be made while preparing piping layout to install control valves, flow measuring elements and any other on line speciality or equipment supplied by OTHERS. Sufficient upstream and downstream lengths shall be provided for flow measuring devices, control valves, desuperheaters and other specialties as required, in consultation with the ENGINEER.

3.9.8

At all screwed valves and screwed connections on equipment, unions shall be provided to facilitate disassembly. Likewise, unions shall also be provided at suitable locations on straight lengths of screwed pipelines.

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3.9.9 All local instruments shall be located on pipelines so as to render them easily observable from the nearest available platforms 3.9.10 Piping with operating temperatures above or below the ambient shall be routed so as to provide adequate flexibility for the pipeline. The CONTRACTOR shall be responsible for the design and provision of suitable expansion loops, guides, restraints and anchors so as to keep the pipe stresses within the limits imposed by the governing codes. 3.9.11 Tap offs on main lines for field routed pipe work, if not indicated on PURCHASER's layout drawings, shall be suitably located by the CONTRACTOR to suit the layout evolved by him. 3.10 For field run piping, the CONTRACTOR shall plan, locate, design, fabricate and install all hangers and supports as required with due regard to general arrangement, layout of other pipeline, hangers, cable trays, ducting, structural members, etc., and in consultation with and to the approval of the PURCHASER/ENGINEER. 3.11 The CONTRACTOR shall utilise the PURCHASER's existing structural members for supporting field run piping after ascertaining that the existing member can safely bear this extra load. Any auxiliary structural steel, if necessary to be provided, shall be designed, fabricated and erected by the CONTRACTOR. Welding to structural members for hangers and supports shall be made only under the supervision of the PURCHASER/ENGINEER and in no case, shall welding be permitted across flanges of main structural members. Unless otherwise specified in Section-C, the supply of the necessary auxiliary steel is also included in the CONTRACTOR's scope. 3.12 Erection of field-run piping shall be started only after completion of erection of other piping, structures, equipment, etc., in the vicinity, unless otherwise directed by the PURCHASER / ENGINEER. 3.13 The CONTRACTOR shall install all thermowell stubs and all instrument trim piping and fittings upto the last root valve(s) and reducer(s) including the root valves and reducers as shown on the relevant flow diagrams. ISSUE R4		

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3.14	When stubs required for vents, drains and instrumentation or welded attachments required for hangers and supports are not provided on prefabricated piping, the CONTRACTOR shall install these stubs or attachments as per the PURCHASER's piping drawings, flow diagrams or hanger sketches.	
3.15	Where the CONTRACTOR's scope ends adjacent to equipment or piping installed by OTHERS, the final joint shall be the made by the CONTRACTOR. If at his terminal connections or at connections to online specialities, the supply of counter flanges is by OTHERS, the same shall be erected by the CONTRACTOR. Necessary gaskets and fasteners are included in the CONTRACTOR's scope of supply.	
3.16	The CONTRACTOR shall also install small accessory piping and any specialities furnished with equipment such as relief valves, built-in bypasses, etc.	
3.17	The CONTRACTOR shall install thermowells supplied by the PURCHASER prior to hydrotesting of the piping systems. In the event of non-availability of thermowell in time, the CONTRACTOR shall provide necessary plugs to carry out the hydro testing of the piping systems.	
3.18	The CONTRACTOR shall cold pull pipes wherever cold cuts are indicated on the PURCHASER's drawings / documents. The CONTRACTOR shall submit his cold pulling procedure for review and approval by the PURCHASER/ENGINEER, prior to starting of the operation.	
3.19	Setting and logging of all spring hangers, supports, restraints, etc., is the responsibility of the CONTRACTOR. Initial setting of all such supporting systems shall correspond to the cold values indicated on the PURCHASER's drawings. The CONTRACTOR shall check all hangers / support loads after completion of all weld joints in the piping systems and after cold pulling of pipes wherever required. In case of any significant differences between the load readings and the cold loads indicated on the PURCHASER's drawings, the CONTRACTOR shall take necessary steps to adjust the settings in such a manner as to eliminate these differences. He shall however consult the PURCHASER/ENGINEER before adjusting the hanger settings. After satisfactory completion of the settings, all load values shall be properly logged by the CONTRACTOR as per the format to be	
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furnished by the PURCHASER. The CONTRACTOR shall monitor the behavior of the hangers, supports, restraints, snubbers, etc., during initial stages of the plant startup. Upon the unit reaching its rated load and the individual piping systems obtaining their rated temperatures, the CONTRACTOR shall log all the load readings of the hangers, supports, etc., in their hot condition and compare the same with the desired hot settings indicated in the PURCHASER's drawings. In case of any significant differences, the CONTRACTOR shall take necessary steps to minimise/eliminate the differences as directed by the PURCHASER. Final hot load values of the hangers, supports, etc., shall be recorded by the CONTRACTOR as per the PURCHASER's format. All logs of hot and cold loads shall be submitted by the CONTRACTOR to the PURCHASER.

3.20 In case of critical piping, in addition to the procedure outlined in clause 3.19, additional adjustments to settings might be required for certain hangers in order to render the final weld joints at the turbine valve nozzles stress free. CONTRACTOR shall carry out all such adjustments as directed by the PURCHASER as part of his scope of work.

3.21 The CONTRACTOR shall carry out hydrostatic/pneumatic testing of all piping erected by him. All necessary equipment including temporary pipes, fittings and supporting arrangement for carrying out such tests shall be provided by the CONTRACTOR. The CONTRACTOR shall ensure that the arrangement made by him for hydrostatic/ pneumatic testing will not transfer forces and moments to permanent piping in an unacceptable manner. After the successful completion of hydro tests, the piping shall be drained and thoroughly dried. The CONTRACTOR shall restore the permanent piping to its original condition after the testing is completed.

3.22 The CONTRACTOR shall erect all temporary pipes, fittings, valves and hangers and supports required for steam blowing of main steam, cold reheat and hot reheat piping in accordance with the PURCHASER's drawings. The PURCHASER / ENGINEER will carry out the steam blowing operations. If severe vibrations are encountered during steam blowing, the CONTRACTOR shall modify the supporting arrangement and provide additional supports, if necessary, to eliminate/minimise vibrations, as directed by the PURCHASER/ENGINEER. In addition to the above, as part of the erection scope of contract, the CONTRACTOR shall supply and

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install all required temporary pipes, fittings, valves and specialities and hangers and supports for cleaning operations to be carried out by him as described in Clause 5.0. The CONTRACTOR shall ensure that the arrangement made by him will withstand the conditions during cleaning operations and that it will not transfer forces and moments to permanent piping in an unacceptable manner. After completion of cleaning operations, the CONTRACTOR shall dismantle temporary piping and hangers and supports and restore permanent piping to its final position. 3.23 Welding, nondestructive examination of welded joints and repair of weld defect areas shall conform to TCE specification no. TCE.M4-134-04, 'welding specification for power plant piping systems'. 4.0 <u>FABRICATION</u> 4.1 Unless otherwise specified on piping drawings or piping material specification Data Sheets, all pipeline joints shall be of welded construction. Butt-welded joints shall be used for pipe sizes NB 65 mm and larger and socket welded joints for pipe sizes NB 50 and smaller. The use of companion flanges to connect two pieces of pipe and the use of odd or short pieces of pipe in making up long runs is prohibited except as noted in the PURCHASER's piping drawings. 4.2 Where welded pipes or pipe fittings are used, longitudinal welds in adjoining sections shall be staggered by a minimum of 90° during erection. 4.3 Neither butt nor branch joints shall be closer than twice the pipe diameter to any other joint in the same pipe except where 'Weldolet' type fittings are used, in which case the branch weld will be made to the 'Weldolet'. 4.4 All pipe flanges and contact surfaces shall be concentric with the axis of the piping. 4.5 All threads on piping components shall be taper pipe threads as per applicable standards. Threaded connections for insertion type fluid temperature determination and sampling devices shall be seal welded when the service pressure exceeds 103.5 bar (g) or when the temperature exceeds 495° C. The threads shall be entirely covered <table border="1"> <tr> <td> ISSUE R4 </td> </tr> </table>			ISSUE R4	
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by the seal weld and such seal welding shall be done by qualified welders only.

4.6 The CONTRACTOR shall machine all welding ends to make sound welds including those to valves, fittings or equipment. The welding rod used shall be compatible with the parent material.

4.7 When pipe must be threaded before hot bending or heat treatment, all exposed thread surfaces shall be protected with high temperature silicone paint

4.8 Before commencement of fabrication or erection, the CONTRACTOR shall ensure that the drawings available with him are the latest issues on date.

4.9 Welding of joints shall be undertaken only after ensuring that the pipeline alignment is correct and conforms to the construction drawings and after obtaining the PURCHASER's clearance for the same.

4.10 At equipment terminal points, welding shall be carried out after taking into account specific requirements and/or recommendations of equipment suppliers.

5.0 CLEANING OF PIPING

5.1 All piping including valves and specialities shall be cleaned by the CONTRACTOR before and during erection to remove grease, dirt, scale and welding slag.

5.2 The CONTRACTOR should carry out the following cleaning operations after hydrostatic tests:

- (a) All piping will be mass flushed, in addition to the specific cleaning operations as described below, as required
- (b) Main steam, cold and hot reheat piping and HP & LP bypass piping shall be steam blown. Necessary target plates, for steam blowing, shall be supplied by the CONTRACTOR.
- (c) Extraction steam, condensate, boiler feed suction and discharge and heater drains and vents piping shall be alkaline flushed

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(d) Auxiliary steam piping, steam piping to turbine drives; pressure reducing stations and other users shall be steam blown.

(e) Fuel oil, fuel gas and light oil piping shall be mass flushed.

(f) Compressed air piping shall be blown by air at compressor discharge pressure.

(g) Turbine lubricating oil piping shall be pickled and passivated and flushed with DM water.

6.0 **HANGERS AND SUPPORTS**

6.1 For field run piping, the CONTRACTOR shall space hangers and supports in accordance with standard engineering practice as outlined in applicable codes. In selecting the position and type of pipe hangers, the CONTRACTOR shall endeavor to layout the work in such a manner that:

(a) Pipe load stresses imposed on the supporting steel are kept to a minimum

(b) The forces and moments on connecting equipment are kept within allowable values, and

(c) Field work is made simple and inexpensive

6.2 Unless design loads are specified by the PURCHASER / ENGINEER, the strength of all supporting components shall be based on the weight of the pipe, the weight of medium transported or the medium used for testing, whichever is higher, and the weight of insulation covering.

6.3 If vibration is encountered after a piping system is in operation, appropriate vibration control equipment shall be installed by the CONTRACTOR at the direction of the PURCHASER /ENGINEER.

7.0 **FLOOR COLLARS AND WEATHERHOODS**

7.1 At locations where pipes pass through concrete floors or brick or other walls, suitable carbon steel floor collars or wall boxes will be

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supplied and installed by the PURCHASER. The CONTRACTOR should indicate requirements. For all bare pipes, which pass through roofs and external walls, a suitable sheet metal hood shall be designed, fabricated, supplied and installed by the CONTRACTOR as a protection against the weather.

8.0 ERECTION TOOLS AND PERSONNEL

8.1 The CONTRACTOR shall deploy qualified and experienced personnel and provide all necessary erection tools and tests equipment needed for the complete erection and testing of all piping. Shipment of such tools and equipment shall be made at the CONTRACTOR's expense and liability. The PURCHASER assumes neither responsibility nor liability for tools and equipment care and their storage.

8.2 All site fabrication machinery, erection tools, rigging, scaffolding, bending, flaring, cutting, welding and stress relieving and all other equipment, thermocouples, asbestos blanket, cables, temperature recorders, X-ray and Gamma ray equipment isotopes radiographic films, penetrameters, magnetic particle test equipment and consumables for checking the M.P testing dyes for D.P. tests, etc., required for complete erection and field testing of all the piping specified, shall be furnished by the CONTRACTOR.

8.3 All transport and material handling equipment shall be provided by the CONTRACTOR.

8.4 The CONTRACTOR shall furnish all welding electrodes required for the complete erection of all piping systems including those required for welder and procedure qualification tests.

8.5 As a part of scope of erection contract, the CONTRACTOR shall furnish gaskets and fasteners (bolts, studs, nuts, washers, etc.) required for all flanged joints. These shall be as per the job specification.

8.6 The CONTRACTOR shall furnish all erection consumables such as oxygen, acetylene, argon, carbon dioxide and any other gases that may be required, filler rods temperature sensing crayons, chalks, charts for temperature recorders, etc.

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8.7

The CONTRACTOR shall furnish all equipment and materials as required for cleaning, flushing, blowing out and testing of the piping systems. These shall include but not be limited to pumps, blowers and compressors with prime movers, instruments, pipe work with supports, valves, strainers and other specialties, blanks, plugs, spool pieces, dummy plates, electrical accessories, etc. (All to be taken back by the CONTRACTOR after completion of work). Where systems for which alkaline flushing is required, necessary tanks, pumps and chemicals shall be provided by the CONTRACTOR.

8.8

The CONTRACTOR shall provide services of erection superintendent, managers, engineers, supervisors, foreman, fitters and riggers, welders, transport and crane operators, clerical and administrative staff, skilled and unskilled labour.

9.0

INSPECTION AND TESTING

9.1

All fabrication/erection work covered by this specification shall be subject to inspection by the PURCHASER / ENGINEER at no additional cost to the PURCHASER and the CONTRACTOR shall advise the PURCHASER/ ENGINEER promptly at various stages of erection for inspection.

9.2

The PURCHASER/ENGINEER shall have free access to the CONTRACTOR's /his SUB-CONTRACTOR's works at the site or elsewhere at all times when any fabrication testing work is being carried out and the CONTRACTOR shall provide all necessary facilities/cooperation to the PURCHASER/ ENGINEER in this regard.

9.3

The PURCHASER's representatives shall, at all times, have facility to witness the CONTRACTOR's operator's qualification tests conducted by the CONTRACTOR. They shall also have access to the CONTRACTOR's heat treatment records and magnetic particle, fluorescent particle or dye penetrant, ultrasonic and radiographic records, reports and repairs, etc.

9.4

Any workmanship by the CONTRACTOR/his SUB-CONTRACTOR inspected in the field and found not to comply with this specification the same shall be repaired at the CONTRACTOR's expense, if the noncompliance is the fault of the CONTRACTOR.

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	9.5 Only approved welders shall be permitted to correct any defect with the prior approval of the CONTRACTOR's welding supervisor. 9.6 On completion of erection, the inside of all pipes, valves, fittings, etc., shall be clean and free from loose scale and foreign matter before subjecting the line to any test/inspection. 9.7 Prior to erection, the CONTRACTOR shall examine and ensure that all prefabricated spools and components received by him either from his works or from the PURCHASER conform in respect of overall dimensions to the certified drawings available with him. Necessary steps shall be taken by the CONTRACTOR to rectify any inaccuracies exceeding the limits of manufacturing tolerances on materials supplied by him. No dislocation in the pipe work or cold pull of pipe work arising from improper fitup would be acceptable to the PURCHASER. 9.8 All piping systems shall be tested hydrostatically / pneumatically by the CONTRACTOR, after erection, at pressures given in the applicable codes listed in Data Sheet A or Section C or as given in the Line Designation Schedule. The test pressures shall be maintained until all welded/flanged joints are inspected for leakage or at least for thirty minutes. 9.9 Wherever possible, underground lines should be tested before backfilling. Where it is essential to backfill any section of a line before testing, such a section should be subjected to test pressure for a period of at least two hours and checked for pressure drop. 9.10 Mechanical equipment and pressure relieving devices should be blanked off or removed from the line during pressure testing and control valves should be set in open position for the duration of the test. 9.11 Orifice plates should not be erected until hydrostatic testing and cleaning operations are completed. 9.12 Lines having check valves should have the source of test pressure located on the upstream side. 9.13 Expansion joints, instruments, filters and similar equipment for which the maximum permissible cold test pressure is lower than the	ISSUE R4

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hydrostatic test pressure applied to the system, shall be removed or blanked off from the line before testing. The CONTRACTOR shall consult the PURCHASER/ENGINEER for specific guidance

9.14 Test pressure readings may be taken at the lowest point of the system being tested provided the effect of static head is taken into account.

9.15 When conditions require a test pressure to be maintained for a period of time during which the testing medium in the system might be subjected to thermal expansion, provision may be made for the relief of excess pressure.

9.16 After hydrostatic test, leaky joints, if any, shall be cut and repaired or completely replaced, and test repeated until the test has satisfactorily passed.

9.17 After completion of hydrostatic test, safety valves, orifice plates, etc., withheld for the hydrostatic tests, shall be installed in an approved manner. Orifice plates shall however be installed after completion of cleaning operations.

9.18 Clean water at a temperature not less than dew point or 10°C which ever is higher, nor exceeding 50°C shall be used for hydrostatic test.

9.19 The rate of pressure increase must not exceed 7 bars per minute.

9.20 No personnel shall be allowed near piping/equipment under test when the hoop stress induced by the test pressure is near the yield strength or when test pressures over 35 bar being applied. The pressure should be lowered by 10% before inspecting for the leaks.

9.21 When draining the test liquid, the pipeline vent shall be opened to avoid vacuum.

9.22 A block valve shall be installed on the pipeline from the test pump to the pipe line/equipment under test.

9.23 All bolted joints for pipes, valves and fittings which are subject to high pressure or high temperature conditions are to be tightened up after the initial heating and before any thermal insulation is applied. The

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CONTRACTOR shall notify the PURCHASER before this operation is carried out. 10.0 <u>UNDERGROUND PROTECTION</u> Underground protection for buried pipes shall be as per TCE specification No.TCE.M4-134-102, 'underground protection for piping'. The CONTRACTOR shall supply and apply all the necessary materials in this regard. All equipment necessary for application and testing of protection such as kettles, thermometers, recorders, holiday detectors, etc., shall be supplied by the CONTRACTOR 11.0 <u>INFORMATION TO BE FURNISHED AFTER THE AWARD OF CONTRACT</u> The CONTRACTOR shall furnish all the information as called for in Data Sheet C. <table border="1"> <tr> <td> ISSUE R4 </td> </tr> </table>			ISSUE R4	
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DATA SHEET C

**INFORMATION TO BE FURNISHED BY THE CONTRACTOR
AFTER THE AWARD OF CONTRACT**

1.0 Prior to erection, the CONTRACTOR shall submit the following:

- (a) Erection sequence sufficiently detailed to describe and identify the type of operations, inspection and/or test at each point in the stage of erection to enable the PURCHASER to keep in readiness the corresponding equipment or facilities to perform his duties and to select inspection points for witnessing.
- (b) Cold pulling procedures.
- (c) Welding procedure and performance qualification reports.
- (d) NDT procedures.
- (e) Weld repair procedures.
- (f) Heat treatment and/or stress relieving procedures.
- (g) Hydrostatic / pneumatic test procedures.

2.0 Site Weld Data:

- (a) Identification of the weld procedure specification, procedure qualification record & performance of the welder, preheating, postweld heat treatment data, results of nondestructive examinations along with the name of the INSPECTOR and the date of inspection.
- (b) Certification of ASNT-TC-1A qualification.
- (c) Weld procedure specification & performance qualification records and its test reports.
- (d) Weld filler material test reports.

3.0 Hydrostatic or Pneumatic test records hold time and the results of the tests (after the testing of the piping system is completed).

4.0 Test certificates and reports as required by statutory regulations.

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TCE.M4-134-04	WELDING SPECIFICATION FOR POWER PLANT PIPING SYSTEMS	SHEET 1 OF 17
1.0	<u>SCOPE</u>	
1.1	This specification shall apply to all welded pipe joints of carbon and alloy steels including stainless steels for power plant piping systems. This specification is applicable to shop fabrication, site fabrication and field erection. The welded joints are hereby defined as including:	
1.1.1	All the line joints of the longitudinal and circumferential butt welded and socket welded type.	
1.1.2	The attachment of castings, forgings and flanges to pipe.	
1.1.3	Welded manifold headers and all other sub-assemblies.	
1.1.4	Welded branch connections with or without saddles and reinforcement rings.	
1.1.5	Fabrication of built-up fittings.	
1.1.6	The attachment of smaller connections for drips, drains instruments, branch lines, weldolets, sockolets, thermowells, couplings, etc.	
1.1.7	Any other similar joints not specified above but encountered during fabrication and/or erection stage. It is imperative that the CONTRACTOR makes every effort to secure the same high degree of competent supervision and workmanship during field erection as is intended for shop fabrication in view of the adverse field conditions of weather, piping location etc.	
1.2	Material specifications generally covered are as follows :	
1.2.1	<u>Alloy Steel Piping</u> Ferritic alloy steel pipes to SA 335 grades P11, P12, P22, P-91 or equivalent: austenitic alloy steel pipes to SA 312 Grade TP 304, 316, etc. or equivalent and corresponding materials for fittings, flanges valves etc.	
1.2.2	<u>Carbon Steel Piping</u> Carbon steel pipes to SA106 grade A,B,C or SA 53 Grade A,B; SA 672 Gr B60 C1.12, IS-1239, IS-1978, API-5L grade B, etc. or equivalent and corresponding materials for fittings, flanges, valves, etc.	
2.0	<u>CODES AND STANDARDS</u>	
	The welding of fusion welded system shall comply with all currently applicable statutes, regulations and safety codes in the locality where it will be installed. It shall also conform to the latest applicable standards. Nothing in this specification shall be construed to relieve the CONTRACTOR of this	
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responsibility. In particular, the welding and fabrication shall conform to the latest editions of the following codes and standards. 2.1 ASME code for power piping (ASME B31.1) 2.2 Indian Boiler Regulations (IBR) 2.3 ASME Boiler and Pressure Vessel Codes: Section II, Part A “Ferrous Material Specifications” Section II, Part C “Specifications for Welding Rods, Electrodes and Filler Metals” Section V “Non Destructive Examination” Section VIII “Rules for Construction of Pressure Vessels” Section IX “Welding and Brazing Qualifications”. 2.4 Standards of Pipe Fabrication Institute, USA. 2.5 BS 2633 “Specification for Class 1 Arc Welding of Ferritic Steel Pipe Work for Carrying Fluids”. 2.6 Any other codes/ standards specified in Section C 2.7 The above mentioned codes and standards form an integral part of this specification. In the event of conflict between this specification and the codes and standards listed above, the stricter requirement of the two shall govern. 3.0 <u>WELDING PROCESSES</u> 3.1 The welding processes that are used in the fabrication and welding are restricted to shielded metal arc welding (SMAW) and gas tungsten arc welding (GTAW) or a combination of the two. 3.2 GTAW root pass shall be employed for all alloy steel piping and carbon steel piping. Subsequent welding after root pass can be carried out by SMAW with coated electrodes. Exceptions are as follows : (a) For pipes of thickness less than 6mm, the entire welding shall be carried out by GTAW only. When using GTAW welding process, welding without the addition of filler metal shall not be done.		

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(b) For LP piping systems such as water and air piping systems entire welding including root pass may be carried out by SMAW. 3.3 Where special welding techniques are recommended by equipment manufacturer for piping connecting to equipment, appropriate qualification tests and welding techniques shall be followed. The specific and detailed instructions of equipment manufacturer regarding welding, preheating, stress relieving etc. shall be strictly adhered to by the CONTRACTOR at no extra cost to the Purchaser. 4.0 <u>PROCEDURE AND PERFORMANCE QUALIFICATIONS</u> 4.1 No production welding shall be undertaken until the procedure qualification tests which are to be used have been established as per ASME Boiler and Pressure Vessel Code- Section IX and/or IBR. Test results and specimens from qualification tests of the welding process and welding operators-shall be made available to the PURCHASER/ ENGINEER, for approval, where results of existing procedure qualifications and of welders, performance tests are acceptable to the PURCHASER/ ENGINEER, such results shall be kept on file and be subject to review regularly. Where doubt exists regarding the acceptability of any qualification test, a retest shall be made. All such qualifications tests and specimen testing shall be conducted in the presence of the PURCHASER/ENGINEER. 4.2 The costs of all procedure qualification and tests shall be borne by the CONTRACTOR. 4.3 The CONTRACTOR shall prepare a written specification containing the information detailed in section IX of ASME Boiler and Pressure Vessel Code. Form QW-482, - "Welding Procedure Specification" (WPS) and the qualification test data and other information detailed in Form QW-483.- "Procedure Qualification Record" (PQR). These documents shall be provided to the PURCHASER/ENGINEER for review and approval. The CONTRACTOR shall prepare certificate of Welder/Welding operator Performance Qualification Test (WPQ) containing the information detailed in Form QW-484 : "Manufacturer's Record of Welding or Welding Operator Qualification Test" of ASME Section IX . These shall be kept on field and made available to the PURCHASER/ ENGINEER upon request. 5.0 <u>WELDERS AND SUPERVISORS</u> 5.1 Unless otherwise agreed, the CONTRACTOR shall advise the PURCHASER/ENGINEER, in writing at least three (3) weeks before any welder is employed on the work, the names and qualifications of the proposed welders and welding supervisors. It shall be the CONTRACTOR's responsibility to ensure that all welders employed by him or his SUB-CONTRACTORS on any part of the Contract either in the		
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	CONTRACTOR'S /his SUB-CONTRACTOR's works or at site are fully qualified as required by the code. Each welder shall qualify for all types of welds and materials he may be called upon to weld. 5.2 Should the PURCHASER/ENGINEER require test or retest of any welder, the CONTRACTOR shall arrange for the same at no extra cost to The PURCHASER/ENGINEER. 5.3 Welding supervisors shall have qualifications such as Engineering Degree/Diploma in welding technology with adequate knowledge of non-destructive testing and a minimum of 5 years experience in supervising welding of pipe joints. 5.4 All welding including tack welding shall be carried out by approved welders only. Any weld made by other than an approved welder shall be cut out and rewelded. 5.5 For purposes of identification and to enable tracing full history of each joint, each welder employed on the work shall be given a designation. The welder's designation and the date on which the joint was made shall be stamped on the relevant piping and marked on the relevant drawings also. Copies of the drawings so marked shall be furnished to the PURCHASER/ENGINEER for record purposes. Alternatively, record charts may be used. 5.6 For each welder, a record shall be maintained showing the procedures for which he is qualified. The details of production welds, the date of welding the type of defects occurred and their frequency. The record shall be available for review by the PURCHASER/ENGINEER and those welders whose work required a disproportionate amount of repair shall be disqualified from welding. Requalification of welders disqualified shall be entirely at the discretion of the PURCHASER/ENGINEER. 6.0 <u>PREPARATION OF WELD ENDS</u> 6.1 Surfaces to be welded shall be smooth, uniform and free from fins, tears and other defects which would adversely affect the quality of the weld. All welding faces and adjoining surfaces, for a distance of atleast 150 mm from the edge of the welding groove or 12mm from the toe of the fillet in the case of socket welded or fillet welded joints shall be thoroughly cleaned of rust, scale, paint, oil or grease both inside and outside prior to welding. 6.2 Unless otherwise specified, joints for pipes 50mm NB and smaller, shall be socket welding type and for pipes 65mm NB and larger, shall be of the butt-welding type. All butt welds shall be full penetration welds.	
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6.3	<u>BUTT JOINTS</u>	
6.3.1	Butt joints shall be prepared as per ASME B 16.25 and/or IBR unless otherwise specified.	
6.3.2	While meeting the alignment requirements of piping joints as per Cl. 127.3.1 C of ASME B31.1, care shall be exercised that the trimming depth in case of excess mis-alignment does not interfere with Radiography/Ultrasonic Test (RT/UT) interpretations. In such cases the trimming width from the tip of the edge preparation along the pipe shall be large enough that it is well away from the weld face.	
6.3.3	Unless noted otherwise, all butt welds shall be made without using backing rings.	
6.4	<u>T, CORNER AND LAP JOINTS</u>	
	These shall be prepared as follows :	
	a) Fillet welds shall have a throat dimension equal to the nominal thickness of either of the joint members.	
	b) Weld edges of full penetration groove welds for T joints shall be prepared with a minimum included angle of 45 deg.	
6.5	The ends shall be prepared by machining , grinding or flame cutting. Where flame cutting is used, the effect on the mechanical and metallurgical properties of the base metal shall be taken into consideration. Flame cutting of alloy steel pipes is not allowed. However, flame cutting of carbon steel pipes is permitted. Wherever practicable, flame cutting shall be carried out by machine. Machine flame cut edges shall be substantially as smooth and regular as those produced by edge planing and shall be cleaned free of slag. Manual flame cutting shall be permitted only where machine flame cutting is not practicable and with the approval of the PURCHASER/ENGINEER, and such surfaces shall be ground or dressed to a smooth finish as required by the specification and to the satisfaction of the PURCHASER/ENGINEER. Slag, scale or oxides shall be removed by grinding to bright metal atleast 2mm beyond the burnt area.	
6.6	Thermal cutting of carbon steel piping shall be performed under the same conditions of preheat and post heat as for the welding of carbon steel material. However, post weld heat treatment is not required when :	
	a) The heat affected zone produced by thermal cutting is removed by mechanical means immediately after cutting However, in any case, all remaining slag scale or oxides shall be removed by grinding to bright metal at least 2mm beyond the burnt area, or	
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b) Thermal cutting is part of fabrication, manufacturing or erection sequence leading to a weld end preparation where welding immediately follows. 6.7 For the piping systems that are supplied by the PURCHASER/ ENGINEER but being erected by the CONTRACTOR, bevelling of pipes for butt welds shall be carried out as indicated on the respective piping fabrication drawings, where required. For systems which the CONTRACTOR supplies and erects, the pipe ends shall be bevelled to conform to applicable codes/standards. At connections to equipment, the bevelling of piping shall conform to the requirements of the equipment connections. 6.8 Any change in the joint configuration shall be done after the approval from the PURCHASER/ENGINEER. 6.9 All weld joint fit-up shall comply with the tolerances specified on the design drawings or applicable codes and standards. 6.10 If the CONTRACTOR uses a header arrangement with central location of oxygen and acetylene for cutting and edge preparation operations, the arrangement shall be in accordance with best safety practices and standards and shall be approved by the PURCHASER/ENGINEER. 6.11 Before fitting up the weld joint, the profile and dimensions of the weld end preparation shall be checked by the PURCHASER/ENGINEER. If the specified tolerances are exceeded, this shall be corrected (with prior approval) by grinding, machining or any other method acceptable to the PURCHASER/ ENGINEER. 6.12 All fit-ups shall be examined by the PURCHASER/ENGINEER prior to welding the root pass. 7.0 <u>WELDING OF PIPES</u> 7.1 All vertical welding shall be carried out in the uphill direction unless otherwise approved by the PURCHASER/ ENGINEER. 7.2 No single run in SMAW shall exceed 8 mm in size. 7.3 Each leg of the fillet weld shall have a length of atleast 1.25 times the nominal wall thickness of the pipe. Socket and fillet welds shall have a minimum of two weld layers. 7.4 All tack welds shall be made using a qualified procedure and qualified welders. Any preheat requirements specified on the welding procedure shall also apply to tack welds.		
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	7.5 All tack welds shall be examined visually for defects, and if found defective shall be completely removed. 7.6 As the welding proceeds, tack welds shall be either removed completely or shall be properly prepared by grinding or filling their stopping and starting ends so that they may be satisfactorily incorporated in the final weld. 7.7 The maximum weaving of any SMAW or GTAW run shall be of 3 times the electrode dia. 7.8 Welded-on branches for all piping systems shall be full penetration type connection. 7.9 Preheating prior to tack welding and welding as called for in clause 8.0 shall be employed as a means of crack prevention and improving general weld reliability. At no time during welding shall the temperature of the joint be allowed to fall below the minimum preheat temperature. Excessive preheating shall be avoided. 7.10 Irrespective of the class of steel, root runs shall be made without interruption except for changing the electrodes or to allow the welder to reposition himself. Root runs made in the shop may afterwards be allowed to cool by taking suitable precautions to ensure slow cooling e.g. by wrapping in a dry asbestos blanket. Welds made at site shall not be allowed to cool until the thickness of weld metal deposited exceeds one third of the final weld thickness or 10 mm, whichever is greater. 7.11 When welding alloy steels, it is strongly recommended that interruption of welding shall be avoided. Where such interruption is unavoidable, either the preheat shall be maintained during interruption or the joint shall be wrapped in dry asbestos blankets to ensure slow cooling. Before recommencing welding preheat shall be applied again. 7.12 No welding shall be done if there is impingement of rain, snow, sleet or high wind on the weld area. 7.13 Welded-on bridge pieces and temporary attachments should preferably be avoided. Where approved by the PURCHASER/ ENGINEER, they may be used. Material of these shall be compatible with parent material. All these pieces shall be removed carefully without damaging the parent material after welding of pipe joints and the weld area ground flush and subjected to magnetic particle examination before applying any postweld heat treatment, which shall embrace the area occupied by the bridge pieces also. These pieces shall be welded by qualified welders and with electrodes compatible with the parent material. The preheating requirements shall be applied and maintained during the welding of pieces.	
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7.14	The arc shall be struck only on those parts of parent metal where weld metal is to be deposited. In the event of any inadvertent arc strikes the defects shall be removed by grinding and the area examined by liquid penetration or magnetic particle testing method.	
7.15	(a) Oxides shall not be permitted to form during welding or heat treatment or both, on the internal surfaces of pipes which will not be subsequently cleaned. Inert gas purging will be an acceptable method to prevent such oxidation. All joints in materials which contain greater or equal to 5% chromium shall be purged to assure that less than 1% of oxygen is present on the joint underside before initiation of the welding. The purging operation shall be maintained for two passes. Refer Cl. 7.15 (b) for flow rate during purging. The CONTRACTOR may submit examples of any other procedures for consideration of the PURCHASER/ENGINEER. (b) Argon gas used in GTAW process for shielding and purging shall be of minimum 99.95% purity. Purging shall be carried out at a flow rate depending on diameter of pipe until 6 times the volume between dams is displaced. In no case shall the initial purging period be less than 10 minutes. After initial purging, the flow of the backing gas shall be reduced to a point where only a slight positive pressure prevails. Any dams used in purging shall be fully identified and removed after welding and accounted for in order to avoid leaving them in the system.	
7.16	Thorough check shall be exercised to ensure that the required inter pass temperature is maintained.	
7.17	All equipment necessary to carry out the welding for supporting of the work, for the preheating and post weld heating including thermal insulation for retaining the heat and for the protection of the welder shall be provided by the CONTRACTOR.	
7.18	After deposition, each layer of weld metal shall be cleaned with a wire brush to remove all slag, scale and defects, to prepare for the proper deposition of the next layer. The material of the wire brush shall be compatible with pipe material. Special care shall be taken to secure complete and thorough penetration of the fusion zone into the bottom of the weld. It is recommended that the root run be checked by liquid penetrant or magnetic particle procedures.	
7.19	The cleaning of the root from the second side of butt welds is to be carried out wherever feasible by gouging, grinding, chipping, machining or other approved methods. The gouged surface must be cleaned to remove any carbon or oxidised metal before commencing the welding. The welding groove shall be examined by dye penetrant or magnetic particle method to ensure that the root is free from defects.	
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7.20 Repair of weld metal defects shall meet CL 127 .4.11 of ASME B31.1.

7.21 Upon completion of welding , the joints shall be wrapped in dry asbestos blankets to ensure slow cooling, unless post-weld heat treatment is applied immediately.

7.22 No welding or welded parts shall be painted, plated, galvanised or heat treated until inspected and approved by the PURCHASER/ ENGINEER. Welds shall be prepared/ground in such a way that weld surfaces merge smoothly into the base metal surface.

7.23 Except where necessary to grind flush for non-destructive examination purpose, the centre of reinforcement for butt welds shall be as indicated below:

Component Thickness (mm)	Max Reinforcement (mm)
Upto 12	1.6
Over 12 to 25	2.4
Over 25 to 50	3.2
Over 50	4.0

The reinforcement shall be crowned at the centre and tapered on each side of the joined members. The exposed surface of the weld shall be ground where required to present a workman like appearance and shall be free from depressions below the surface of the joined members. The exposed surface of the butt welds shall be free from undercuts greater than 0.8 mm in depth, overlaps or abrupt ridges or valleys and shall merge smoothly into the pipe surface at the weld toe. However, undercuts shall not encroach on the minimum section thickness.

7.24 Any weld repair shall be subject to the approval of the PURCHASER/ENGINEER.

7.25 The same area on the weld shall not be repaired more than twice. The joint shall be remade in case of more than 2 repairs.

7.26 Postweld heat treatment shall be carried out as per Cl. 132 of ASME B31.1.

7.27 IDENTIFICATION OF WELDS

Wherever code symbol stamps are required on carbon steel and ferritic alloy steel piping they shall be applied directly to the pipe with low stress dotted design metal die stamps or to a small stainless steel plate especially provided for such marks. These plates shall be lightly tack welded to the pipe using electrodes (of diameter 3 mm or less) of the type specified for the material. Before making the required tack weld, the pipe material in the

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immediate surrounding area shall be preheated, as required, by electric means or propane or natural gas burners. Cooling shall take place under asbestos insulation in a draft free area. Stress relieving of these welds is not required. Steel stamping directly on the surface of alloy steel piping with other than low stress die stamps shall not be permitted. Use of oxy acetylene gas for pre-heating is not allowed. 7.28 <u>SEAL WELDS</u> 7.28.1 Seal welding shall be done by qualified welders and in accordance with approved drawings 7.28.2 Threaded joints that are to be seal welded shall be made without the use of thread lubricating compound. 8.0 <u>PREHEATING</u> Preheating prior to cutting, tack welding and welding shall be employed as a means of crack prevention and improving general weld reliability. The general requirements listed in para 9.0 "Stress Relieving" shall be applied for preheating. Preheating when performed shall be in accordance with Cl. 131 of ASME B31.1 Preheating requirement for thermal cutting shall be the same as applicable to welding. 8.1 <u>CARBON STEEL /ALLOY STEEL</u> 8.1.1 At no time during the welding operation shall the temperature of the weld area be allowed to fall below the specified temperatures. Before performing any tack welding which may be required in preparing alloy/carbon steel pipe for welding or other fabrication, or before attaching thermocouples, the pipe area to which the tack weld is to be made shall be evenly heated to these temperatures preferably by resistance heating or induction coils. Propane or natural gas torches or preferably burner rings shall be employed where it is impossible to use electric heating. The use of oxy-acetylene is prohibited. The metal temperatures in this procedure shall be determined by the use of thermocouples and potentiometers except that temperature sensitive crayons may be used as temperature indicators in tack welding thermocouples. 8.1.2 Welded joints for piping NB 100mm and larger shall be heated by means of induction coil or resistance heating . Welded joints in smaller pipe shall be heated by means of electrical resistance coils or suitable propane or natural gas torches.		

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8.2	<u>AUSTENITIC STAINLESS STEEL</u> Welded joints in austenitic stainless steel piping need not be preheated except where the ambient temperature is below 0°C. For this condition , the joint shall be heated to 40°C by propane, natural gas or electrical means before any welding is performed.	
9.0	<u>POSTWELD HEAT TREATMENT</u> Postweld heat treatment of piping welds is required when so specified in code clause 132 of ASME B31.1 and shall be performed as described below. However for carbon limitation on carbon steel material of all piping refer Cl. 9.2.1.	
9.1	<u>GENERAL REQUIREMENTS</u>	
9.1.1	A complete automatic temperature recording shall be used during preheating and stress relieving operations. Where propane gas burners or electrical resistance coils are employed, a complete temperature record of the preheating and stress relieving operation shall be made by means of a box type potentiometer. Other means of recording temperatures are permissible subject to the PURCHASER/ENGINEER'S approval.	
9.1.2	Stress relief may be local or full furnace. Local stress relief shall be performed with electric induction or electric resistance coils. Suitable gas burning equipment using natural gas or propane may be employed.	
9.1.3	During stress relieving / preheating cycle, no water or liquid cooling medium shall be employed.	
9.1.4	Where members being joined are unequal in thickness, the dimension of the heavier section shall govern the selection of width of the heated band and the duration of the holding period.	
9.1.5	When local stress relief is performed, the area of the welded joint and the adjacent material to be postweld heat treated, shall be as called for in para 132.7 of ASME B31.1	
9.1.6	For local stress relief using electrical methods, a minimum of two thermocouples tack-welded to the surface and potentiometers, shall be used on the pipe under at least 4 layers of asbestos paper. The hot junctions of the thermocouples shall be located on either side of the joint atleast 12mm from the edge of the joint, but no farther away than 100mm. When employing induction heating , at least six turns of induction cable shall be wrapped on top of the asbestos paper protecting the thermocouples with the first turn approximately 150mm from the centre of the weld.	
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9.1.7 Local stress relief using natural gas torches or ring burners may be employed. However, the procedure shall be limited to pipes below 100mm NB and must be approved by the PURCHASER/ENGINEER. 9.1.8 The stress relieving temperature shall be maintained for a period of time proportioned on the basis of one hour per 25 mm of wall thickness of the thickest section at the joint, but in no case less than one hour. 9.1.9 For tubing joints and socket welded joints, pads, bosses and couplings, one thermocouple shall be positioned at a minimum distance of two pipe wall thickness from the weld. 9.1.10 For welds used for attachment of base brackets, two thermocouples shall be used for determinations of preheating and stress relieving temperatures. They shall be tack welded directly to the header and located 180 deg apart on the circumference of the header and midway between adjacent legs. 9.1.11 Piping on both sides of any joint shall be adequately supported throughout the preheating, welding and stress relieving operations to prevent distortion. When a butt welded joint is to be post-weld heat treated and the piping is cold sprung, the forces required to position the pipes shall be maintained by external means until the completion of the heat treatment procedure. 9.1.12 All heating and cooling must be performed in still air 9.2 <u>CARBON STEEL</u> 9.2.1 Welded joints of carbon steel piping where the nominal pipe wall thickness of the heaviest material being joined is greater than 19mm or the carbon content more than 0.25% for piping system under IBR and 0.3% for non-IBR piping systems shall be stress relieved upon completion of welding operation. 9.2.2 When the height of a boss above the OD of the pipe is 19 mm or greater the weld shall be stress relieved 9.2.3 When the wall thickness of a coupling or a pad is greater than 19 mm the weld shall be stress relieved 9.2.4 When local stress relief is employed, the welded joint shall be heated to a temperature of not less than 600°C. This temperature level shall be maintained within the limits of 600 °C to 650 °C for one hour per 25mm of wall thickness, but in no case less than 1 hour. The weld area shall then be allowed to cool undisturbed in still air to a temperature not exceeding 315 °C.		
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All welded joints which are locally stress relieved in pipes 100mm NB and larger shall be heated by means of electric induction coils or resistance heating. Welded joints in pipes smaller than 100mm NB shall be stress relieved by means electric resistance coils or suitable propane or natural gas torches only. 9.2.5 <u>Heating and Cooling</u> Carbon steels after having reached their specific stress relief temperatures, may be cooled in the furnace or under wraps i.e leaving the induction coils or resistance heaters and insulation in place. This means that at the stress relief temperatures, the power to the furnace or heating coils may be shut off and cooling is allowed to take place in the furnace or with all insulation and coils remaining on the pipe. For furnace stress relief, the doors of the furnace may be opened after the power is shut off, at 315 deg C. The thermocouples controlling the temperatures shall remain during the cooling cycle so that excessive cooling, if it occurs, can be observed and immediately corrected. The rate of heating and cooling shall conform to CI.132.5 of ASME/B31.1. The stress relieving coils and insulation shall be removed only after the piping has cooled to below 315 deg C, or if stress relieved in a furnace, the pipe may be removed from the furnace and permitted to cool in still air, when this pipe has cooled below 315 °C. 9.3 <u>ALLOY STEEL</u> 9.3.1 All welds in alloy steel piping shall be stress relieved after the welding operation in accordance with C1.132 of ASME B31.1. Immediately after welding the material shall be wrapped in asbestos and allowed to cool. 9.3.2 <u>Local Stress Relief</u> All welded joints in pipes 100 mm NB size and larger shall be locally stress relieved by means of electric induction coils or resistance heating. Welded joints in smaller pipe sizes shall be stress relieved by means of electric resistance coils or propane or natural gas torches only. 9.3.3 For full furnace stress relief of a welded assembly the entire fabricated section shall be heated uniformly to the temperature specified. The temperature shall be maintained for a period of time proportioned on the basis of one hour per 25 mm wall thickness of the piece having the greatest wall thickness in the furnace charge, but in no case less than one hour. 9.3.4 <u>Heating and Cooling</u> The rate of heating and cooling shall conform to CI. 132.5 ASME of B31.1 ISSUE R5		

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9.4 <u>AUSTENITIC STAINLESS STEEL</u> Joints in austenitic stainless steel piping need not be stress relieved after welding. 10.0 <u>ELECTRODES</u> 10.1 (a) The specification and size of the electrodes, voltages and amperages, thickness of beads and number of passes shall be as specified in the approved welding procedure or otherwise agreed in writing Only basic coated electrodes shall be used, which will deposit weld metal having the same or higher physical properties and similar chemical composition to the members being joined. For each batch of approved brand, certificate showing compliance with the specification shall be secured and shall be submitted to PURCHASER/ENGINEER for review before being released for use on project piping. All electrodes shall be purchased in sealed containers and stored properly to prevent deterioration. All low hydrogen electrodes shall be baked at 350 deg. C for 1 hour and stored in ovens kept at 80-100 deg C before being used. Recommendations of the electrode manufacturer shall be followed. (b) For welding of all grades of steel and alloys by the GTAW process, a 2% thoriated tungsten electrode conforming to SFA-5 .12 EWTH-2 (AWS-A5.12, EWTH-2) classification shall be used. 10.2 <u>CARBON & ALLOY STEEL</u> All electrodes to be used on alloy and carbon steel shall conform to ASME Boiler and Pressure Vessel Code Sec 2 Part C or any other equivalent code. 10.3 As welding electrodes deteriorate under adverse conditions of storage leading to dampness in the electrode coating, they should normally be stored in air conditioned rooms or in hot boxes or ovens in their original sealed containers whose temperatures shall be maintained within specific limits. The condition of electrodes shall be frequently inspected. Electrodes with damage to coating shall not be used. Electrodes shall remain identified until consumed. 10.4 The type of electrodes used should be only those recommended by the manufacturer for the use in the position in which the welds are to be made. Electrodes which have the areas of flux covering broken away or damaged shall not be used.		
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11.0	<u>INSPECTION AND TESTING</u>	
11.1	The PURCHASER/ENGINEER shall have accessibility to inspect the welding or any other related operations at any time and at any stage of fabrication.	
11.2	The PURCHASER/ENGINEER may require non-destructive testing of any weld for reasons other than those given in the specification. The responsibility for the cost of such testing shall be mutually decided between the PURCHASER/ENGINEER and the CONTRACTOR.	
11.3	The CONTRACTOR shall inform the PURCHASER/ENGINEER when the weld preparation and setting up for welding of various members selected by the PURCHASER/ENGINEER is in progress so that the PURCHASER/ENGINEER can inspect the assembly before welding starts.	
11.4	The responsibilities of the PURCHASER/ENGINEER's representative shall in no way reduce the CONTRACTOR's responsibilities to ensure that the work is carried out in accordance with the specification.	
11.5	Non-Destructive Test (NDT) shall be carried out at appropriate time as below. Radiographic Testing (RT) on welds shall be carried out after final heat treatment except for welds on PI Group material for which (Refer ASME Sec. IX) RT can be performed either before or after final heat treatment.	
11.6	All requirements specified in TCE.M4-185-28 and TCE.M4-185-38 shall be strictly followed.	
11.7	<u>EXAMINATION METHODS OF WELDS</u>	
11.7.1	Non destructive examinations of welds shall be carried out in accordance with TCE. M4-185-28 and TCE.M4-185-38.	
11.7.2	<u>Penalty Clause</u>	
	Where radiography specified is less than 100%, the penalty shall be as follows:	
	(a) For every weld found defective two additional penalty joints on either side of the joint shall be marked for RT.	
	(b) If any of the penalty joints is found defective, entire weld joints represented by the defective joint shall be radiographed.	
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(c) If the penalty joints referred under point (a) above are found acceptable, the original defective weld shall be repaired to the required standard and re-radiographed. 11.7.3 In addition, at the discretion of the PURCHASER/ENGINEER and the INSPECTORS, and where requested by them, the CONTRACTOR shall perform radiography and other tests of the joints of any other piping. Refer 11.2 on cost of such testing. 11.7.4 (a) Where access holes for radiography have been provided in the piping, the CONTRACTOR shall employ single wall thickness radiography. The access holes shall be plugged and seal welded only after the radiograph is found acceptable (b) Where no access holes for radiography are provided in the piping, the CONTRACTOR shall employ double wall radiography, with elliptical projection technique. (c) The CONTRACTOR shall ensure that isotopes of sufficient strength and quality are used in order that the radiographs taken are of proper density, contrast and visibility. (d) Access hole plug welding shall be examined by magnetic particle or liquid penetrant methods. 12.0 <u>QUALIFICATIONS AND CERTIFICATION OF NON-DESTRUCTIVE EXAMINATION PERSONNEL</u> Organisations performing code required, non-destructive examinations shall use personnel competent and knowledgeable to the degree specified by ASME. 13.0 <u>ACCEPTANCE STANDARDS</u> The acceptance standards for radiographic, ultrasonic, magnetic particle, liquid penetrant and visual examinations etc. shall conform to ASME B31.1. 14.0 <u>REPAIR WELDING</u> 14.1 All defects in welds requiring repair shall be removed by flame or arc gouging, grinding, chipping or machining. The major repairs may involve. (a) Cutting through the weld (b) Cutting out a length of pipe containing the weld, or (c) Removing the weld metal down to the root depending upon the magnitude of the defects.		
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- 14.2 After removing the defect, the welds shall be examined by the same non-destructive testing methods as specified for the original weld and the same acceptance criteria shall hold good.
- 14.3 All the repair welds shall be made using same or other specified welding procedures as those used in making the original welds including preheating and stress relieving as originally required.

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SPEC.NO. TCE.M4-101-03	TATA CONSULTING ENGINEERS LIMITED	SECTION: D
	STEAM GENERATOR PRESSURE PARTS POWER PLANT SERVICE	SHEET 1 OF 9

1.0 **SCOPE**

This specification covers the design, material, construction features, manufacture, inspection and testing at the VENDOR's/his SUB-VENDOR's works, delivery to site and performance testing of the pressure parts of the steam generator comprising furnace waterwall system, steam Drum / Separator, superheater, reheater system and economizer.

2.0 **CODES AND STANDARDS**

The design, material, construction, manufacture, inspection, testing and performance of the steam generator pressure parts shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed. The equipment shall also conform to the standards. Nothing in this specification shall be construed to relieve the VENDOR of this responsibility.

2.1.5 Indian Boiler Regulations.

2.1.2 International Standards Organisation Regulation:R831.

2.1.3 American society of Mechanical Engineers including its boiler Construction Code ASME Section-1, Pressure Vessels Code ASME Section VIII and Power Test Codes.

2.1.4 American National Standard Institute including its ANSI Code for pressure Piping ANSI B 31.1

2.1.5 American Society For Testing Materials.

2.1.6 American Welding Society.

2.1.7 National Board of Boilers and Pressure Vessel Inspectors.

2.2 In all cases of disparity between American or equivalent standards and the Indian Boiler Regulations, the provisions of the latter shall prevail. It shall be the responsibility of the VENDOR to satisfy the Indian Boiler Inspectorate authorities that all stipulations of these regulations have been complied with before fabrication of the units is started.

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3.0 **DESIGN AND CONSTRUCTION FEATURES**

3.1 **FURNACE**

- 3.1.1 Furnace shall be water cooled on all four sides and the bottom by means of closely spaced tangent tubes or welded ligament membrane wall construction. Furnace roof may be either steam or water cooled.
- 3.1.2 Furnace of coal firing shall have the following special features. Furnace shall be of dry-bottom type designed for balanced draft operation. It shall have a bottom hopper with stainless steel seal plates suitable for connection to a water impounded ash hopper. The seal plates shall be of type 430 stainless steel with a minimum thickness of 6 mm.
- 3.1.3 The lowest waterwall header shall be set above the floor level with a minimum distance from the bottom header to the floor level as indicated in Data Sheet-A to allow sufficient room for the water impounded ash hopper. The slope of the furnace bottom hopper wall shall not be less than 55 degrees to the horizontal. The clear width of the hopper throat shall not be less than 1200 mm so that larger self-bonded ash deposits shedding from the furnace wall will pass through the opening.
- 3.1.4 The furnace wall tubes shall be suitably bent at the required location to accommodate burners, observation and access doors/ports, soot blowers, recirculated gas port, furnace temperature probe(s), and furnace TV camera(s).
- 3.1.5 Furnace construction shall be such that the walls can be transported in panel with headers attached where feasible.
- 3.1.6 Field welds in large diameter thick walled headers or pipes shall be avoided to the extent possible.
- 3.1.7 Provision shall be made for the installation of additional soot blowers in the furnace after the unit is commissioned, if the operational experience warrants the same.
- 3.1.8 The design of the pressure part shall be as per applicable codes stated in Data Sheet-A. However, the minimum design pressure shall be at least 1.05 times the maximum operating pressure.
- 3.1.9 Hot bent alloy tubes shall be annealed at 870-900⁰C and the cold bent tubes stress relieved at 705-760⁰C. All bends made in carbon steel and alloy steels during fabrication shall be magnaflux.
- 3.1.10 The maximum skin temperature to which the tubes will be subjected shall not exceed the oxidation limit as applicable to the material.

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3.1.11 The furnace shall be designed so that the temperature of the gases leaving the furnace will be kept as low as possible and is consistent with the heat requirement of the superheater and reheater.

3.1.12 The net heat release shall be calculated on the basis of the higher heating value of the fuel corrected by subtracting radiation loss, unburned combustible loss, latent heat of water in the fuel and water formed by burning of hydrogen in the fuel and adding the sensible heat in both the fuel and the combustion air.

3.2 **STEAM DRUM / SEPARATOR**

(Steam drum shall be read as SEPARATOR wherever applicable.)

3.2.1 Steam Drum / Separator shall be of the electrically fusion welded type designed and constructed in accordance with the codes specified in Data Sheet-A. The welded joints shall be stress relieved and radiographed. Shop hydrostatic test at one and a half times the maximum operating pressure shall be carried out.

3.2.2 The Drum / Separator shall not be exposed to come in contact with the flue gases and shall be located outside the flue gas path.

3.2.3 Drum / Separator shall be equipped with suitable Drum / Separator internals to separate water from steam and to direct the flow of water and steam in a manner so as to obtain an optimum distribution of Drum / Separator metal temperature over the entire operating load range of the steam generator.

3.2.4 The internal surface of the Drum / Separator shall be shot blasted, cleaned free of mill scales, rust, corrosion products, dirt, grease, moisture or other loose foreign material.

3.2.5 The Drum / Separator internal system shall comprise the cyclone Drum / Separators, steam washers or scrubbers with moisture Drum / Separators, driers, baffles, hood, internal feed piping and sampling connections. The design of the Drum / Separator internal shall be such as to guarantee the steam quality specified over the entire load range.

3.2.6 In the case of natural circulation steam generator, the Drum / Separator internals shall be designed to maintain a low pressure drop across the Drum / Separator so as not to reduce the circulation in the boiler and cause overheating and tube failure.

3.2.7 The arrangement and fabrication of the Drum / Separator internals shall be designed to permit easy removal and replacement through the Drum / Separator manhole.

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3.2.8 Manholes with forged steel covers secured by forged steel yokes and bolts shall be provided at each end of the Drum / Separator. Manhole plates shall be supported on hinges.

3.2.9 Nozzles and connections on the Drum / Separator catering for the following services shall be provided:

- Steam outlets
- Safety valves
- Feedwater entry
- Downcomer
- Intermittent blowdown
- Feedwater regulator controller
- Drum / Separator level recorder
- Multiport Bi-colour Drum / Separator level indicator
- Drum / Separator level indicator - wide range
- Continuous blowdown
- Chemical Feed
- Two (2) steam pressure gauges
- Sampling connections
- Vents and drains
- Test connections with caps
- Two (2) manholes size 300 x 400 mm hinged
- Acid washing connections

3.2.10 Number, location and size of all connections shall be subject to the approval of the PURCHASER. All nozzles shall be of the long body type so that this will extend through the steam generator lagging. Ends of nozzles smaller than 50 mm shall have plane ends for socket welding. Nozzles 50 mm and longer shall have bevelled ends for butt welding. Where backing rings are required, the ends shall be machined in accordance with the codes. Where backing rings are not required weld preparation shall be in accordance with codes.

3.2.11 The design of the Drum / Separator shall be as per applicable codes stated in Data sheet-A. However, the minimum design pressure shall be at least 1.05 times the max operating pressure.

3.2.12 The Drum / Separator shall be supported from the steam generator ceiling by means of U bolts and hangers.

3.2.13 All tubes or attachments to the Drum / Separator shall be full strength welded - no rolled or rolled and seal welded joints shall be used.

3.2.14 The nozzles for welding to the Drum / Separator shall be heat treated by normalising. All nozzles shall be full of penetration welds. They shall be ground flush with the inner diameter of the Drum / Separator.

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3.3 **SUPERHEATER**

- 3.3.1 The superheater shall be located within the steam generator setting except that all headers shall be located outside of the high temperature gas swept space.
- 3.3.2 Superheater shall be designed to provide rated steam temperature from the maximum continuous rating (MCR) of the steam generator upto the steam temperature control points. The drop in temperature below the steam temperature control point shall be as low as possible.
- 3.3.3 The superheater elements shall be arranged to form high and low temperature sections in the gas path and to produce the uniform steam distribution and steam temperature variation of not greater than $\pm 15^{\circ}\text{C}$ across the width of the steam generator at all operating conditions and loads. The superheater surface may be either convective or a combination of radiant and convective sections according to the standard practice of the MANUFACTURER. Radiant wall superheaters, if furnished, shall be designed for up-flow steam. Down-flow radiant wall superheaters will not be accepted.
- 3.3.4 The superheater elements may be seamless tubing or welded tubing. The elements at the butt end of the superheater shall be made of heat resisting, high creep strength alloy steel. All elements shall be suitable for long life under the temperature conditions for which they are designed. Superheater welds exposed to the hot gases shall be of the butt type.
- 3.3.5 The superheater design and materials shall be in accordance with codes/standards referred in Data Sheet-A. However, the minimum design pressure shall be at least 1.05 times the maximum operating pressure.
- 3.3.6 Hot bent alloy tubes shall be annealed at $870\text{-}900^{\circ}\text{C}$ and the cold bent tubes stress relieved at $705\text{-}760^{\circ}\text{C}$. All bends made in carbon steel and alloy steels during fabrication shall be subjected to non-destructive testing.
- 3.3.7 Return bends in superheater pendent elements shall have a minimum tube bend radius of one time the tube outside diameter for hot bending and one and a half times tube outside diameter for cold bending.
- 3.3.8 The maximum skin temperature to which the tubes will be subjected shall not exceed the oxidation limit as applicable to the material.
- 3.3.9 Attemperators are to be of the spray type fitted with an inner removable lining, so arranged that the lining may be removed readily without recourse to extensive cutting of the construction welds. Ample provision shall be allowed to enable internal inspection of the vessel by means of the intrascope.

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3.3.10 Elements in each section of the superheater shall be uniformly spaced. If vacant lanes are required, they shall be designed to eliminate gas by-passing. Elements shall be spaced wide enough apart to prevent plugging, and it is preferred that the spacing be greater in the high temperature section of the superheater.

3.3.11 Superheated elements in the high temperature section of the superheater shall be arranged so that the hot discharge ends of the elements are protected from the entering gases by at least one (1) loop of the cooler tubes of the high temperature superheater elements in front of them.

3.3.12 Banks of superheater elements shall be spaced for convenient element replacement. The spacing between banks of superheater elements shall be adequate for soot blowers but in any case shall not be less than 610 mm both for vertical and horizontal elements.

3.3.13 The superheater supports or hangers exposed to hot gases within the setting shall be provided wherever required and these shall be of a heat-resisting material suitable for long service under the service condition.

3.3.14 Spacers preferably shall be water cooled tubes of the boiler circulation system.

3.3.15 Adequate provision shall be made in the design of all superheater tube supports, hangers and spacers for differential expansion of various components.

3.4 **REHEATER**

3.4.1 Reheater shall be designed to provide rated steam temperature from the maximum continuous rating (MCR) of the steam generator upto the steam temperature control points. The drop in temperature below the steam temperature control point shall be low as possible.

3.4.2 The reheater elements shall be arranged to ensure uniform steam distribution and steam temperature variation of not greater than $\pm 15^{\circ}\text{C}$ across the width of the steam generator at all operating conditions and loads. The reheater surface may be either convective or a combination of radiant and convective sections according to the standard practice of the MANUFACTURER. Radiant wall reheaters, if furnished, shall be designed for up-flow steam. Down-flow radiant wall reheaters will not be accepted.

3.4.3 The reheater design and materials shall be in accordance with codes/standards referenced in Data Sheet-A. . However, the minimum design pressure shall be at least 1.05 times the maximum operating pressure

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3.4.4 Hot bent alloy tubes shall be annealed at 870-900⁰C and the cold bent tubes stress relieved at 705-760⁰C. All bends made in carbon steel and alloy steels during fabrication shall be magnaflux.

3.4.5 Return bends in reheater pendant elements shall have a minimum radius of 75 mm to prevent exfoliated scale from inside the tubes from plugging the bends.

3.4.6 The maximum skin temperature to which the tubes will be subjected shall not exceed the oxidation limit as applicable to the material.

3.4.7 Elements in all sections of the reheater shall be uniformly spaced. If vacant lanes are required, they shall be designed to eliminate gas bypassing.

3.4.8 Banks of reheater tubes shall be spaced for convenient element replacement i.e., the sum of the two (2) spaces adjacent to a bank shall be at least equal to the depth of the bank, but the clean face-to-face distance between element banks shall not be less than 55.83 cm for vertical elements, for 63.5 cm for horizontal elements.

3.4.9 The reheater supports or hangers exposed to the hot gases within the setting shall be provided by the VENDOR where required, and these shall be of a heat-resisting material suitable for long life under the service conditions.

3.4.10 Attemperators are to be of the spray type fitted with an inner removable lining, so arranged that the lining may be removed readily without recourse to extensive cutting of the construction welds. Ample provision shall be allowed to enable internal inspection of the vessel by means of the intrascope.

3.5 **ECONOMIZER**

3.5.1 The economizer shall comprise of carbon steel tubes designed and constructed in accordance with codes and standards referred in Data Sheet-A.

3.5.2 The economizer shall be of non-steaming type and shall have provision for recirculation of water while starting the unit. The design of the economizer shall be such that the tube elements can be easily replaced when necessary.

3.5.3 An adequate number of access doors shall be provided above and below the tube banks for inspection and maintenance.

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3.5.4

It shall be ensured that the economizer design pressure exceeds the boiler design pressure by an amount at least equal to the pressure drop (friction and static) through the economizer at the maximum continuous rating of the steam generator.

3.5.5

The maximum skin temperature to which the tubes will be subjected shall not exceed the oxidation limit as applicable to the material.

3.5.6

The economizer may be of single or twin type as required to meet pressure drop conditions and space conditions for removal of elements.

3.5.7

It shall be designed for up-flow of water and down-flow of flue gas throughout.

3.5.8

The banks of economizer elements shall be spaced for convenient element replacement, i.e., the sum of the two (2) spaces adjacent to a bank shall be at least equal to the depth of bank, but the clear face-to-face distance between banks shall not be less than 63.5 cm.

3.5.9

The feed pipe to the steam Drum / Separator shall be through thermal sleeves so that excessive thermal stresses will not be set up in the Drum / Separator or nozzle.

3.6

HEADERS

3.6.1

All headers shall be located outside the gas path.

3.6.2

Handhole openings in headers shall be so located as to provide suitable access to maintenance. All handhole plates shall be designed for seal welding. A minimum number of header manholes required to facilitate cleaning and inspection of the headers shall be provided.

3.6.3

Header vents, drains, pressure gauges, steam and safety valve connections shall be of weld-end type. Instrument tapping as required including test connections shall be provided.

3.6.4

The superheater and reheater outlet headers shall be of the extended type to accommodate the safety valves.

3.6.5

All tubes or attachments to headers shall be full strength welded. No rolled or rolled and seal welded joints shall be used.

3.6.6

All headers shall be thoroughly cleaned and be free of scale by shot blasting on the inside.

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	ENQUIRY /SPECIFICATION NO.					
	SR.NO.	ITEM		BIDDER →		
NOTE TO BIDDER				SIGNATURE		
1. ITEMS WHICH DEVIATE FROM THE SPECIFICATION SHOULD BE MARKED WITHIN ASTERISK(*) (DETAILS TO BE GIVEN IN SCHEDULE OF DEVIATIONS)				OF BIDDER		
2. THIS DATA SHEET SHALL BE FILLED UP COMPLETELY AND A COPY SHALL BE ENCLOSED WITH EACH COPY OF THE BID.				DATE		