

373942/2021/PS-PEM-MAX

	5 x 800 MW YADRADRI TPS BASIC TECHNICAL FEATURES FOR LT MOTORS (FOR BHEL-PEM SCOPE PACKAGES)	Doc. No.	PE-DC-417-565-E003
		Rev. No.	02
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4.6.10 Minimum clearances to be provided between phase to phase and phase to earth shall be as under-

Voltage Rating of Motor Minimum Ph-Ph & Ph-Earth clearance

0.415 kV : 25 mm

Note: In case it is not possible to maintain these clearances, the live parts shall be totally insulated from earth and other Phases. Adequate clearances shall be provided for cable connections.

4.7 Grounding

The frame of each motor shall be provided with two separate and distinct grounding pads complete with tapped hole, GI bolts and washer.

The cable terminal box shall have a separate grounding pad.

4.8 Rating Plate

In addition to the minimum information required by IS, the following information shall be shown on motor rating plate:

- Temperature rise in Deg.C under rated condition and method of measurement.
- Degree of protection.
- Bearing identification no. and Type of lubrication, Quantity and frequency/ time interval
- Location of insulated bearings.

5.0 ACCESSORIES

5.1 SPACE HEATERS

Motor of rating 30 kW and above shall be provided with space heaters, suitably located for easy removal or replacement. The space heater shall be rated 240 V, 1 Phase, 50Hz and sized to maintain the motor internal temperature above dew point when the motor is idle. The minimum cable size for space heater shall be 2.5 sq.mm copper cable.

5.2 DELETED

5.3 INDICATOR/ SWITCH

5.3.1 Dial type local indicator with alarm contacts shall be provided for the following:

Hot and cold air temperature of the closed air circuit for CACA motor.

5.3.2 Alarm switch contact rating shall be minimum 2.0 A at 220V D.C. and 10A at 240V A.C.

5.4 ACCESSORY TERMINAL BOX

5.4.1 All accessory equipment such as space heater, temperature detector, current transformers etc., shall be wired to and terminated in terminal boxes, separate from and independent of motor (power) terminal box.

5.4.2 Accessory terminal box shall be complete with double compression brass glands and pressure type terminals to suit owner's cable connections.

DRAIN PLUG

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Motor shall have drain plugs so located that they will drain the water, resulting from the condensation or other causes from all pockets of the motor casing.

5.5 LIFTING PROVISIONS

Motor weighing 25 Kg. or more shall be provided with eyebolt or other adequate provision of lifting.

5.6 DOWEL PINS

The motor shall be designed to permit easy access for drilling holes through motor feet or mounting flange for installation of dowel pins after assembling the motor and driven equipment.

7.0 PAINTING

Colour scheme for motors shall be shade 631 of IS-5.

8.0 TESTING

8.1 Type Tests

For LT Motors, type test reports for type tests as per IS: 12615/ IEC: 60034 conducted on equipment similar to those proposed to be supplied shall be submitted. The type Test should have been conducted within last 5 years from enquiry date.

8.2 Routine Tests

All motors shall be subjected to routine tests as per IS: 12615/ IEC: 60034 in the presence of customer or customer representative.

9.0 Variable Frequency Drive motor details:

- i) The motor shall be suitable for operation with a solid-state power supply consisting of an adjustable frequency inverter for speed control.
- ii) The motor shall be suitable for the current waveforms produced by the power supply including the harmonics generated by the drive.
- iii) The Motor shall be designed to operate continuously at any speed over the range 20-100 % of rated speed.
- iv) The permitted voltage variation should take into account the steady state voltage drop across the AC drive and all other system components upstream of the motor.
- v) Motors required to be transferred to DOL, by-pass mode shall be rated for specified variations in system line voltage and frequency. Starting current of motor in DOL, bypass mode shall be limited to value in motor specifications.
- vi) The motor shall be constructed to withstand torque pulsations resulting from harmonics generated by the solid-state power supply.
- vii) The motor insulation shall be designed to accept the applied voltage waveform, within the V_{peak} and dv/dt limits as per IEC-61800-4.
- viii) The drive manufacturer shall be solely responsible for proper selection of the motor for the given load application and the output characteristics of the drive.

REV-0, DATE: 07.03.2015

ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR(FOR EPC PROJECTS)**PACKAGES : CONDENSATE POLISHING UNIT****SCOPE OF VENDOR: SUPPLY, ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT****PROJECT:**

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
1	415V MCC	BHEL	BHEL	415 V AC, 3 phase, 3 wire supply shall be provided by BHEL based on load data provided by vendor at contract stage for all equipment supplied by vendor as part of contract. Any other voltage level (AC/DC) required will be derived by the vendor.
2	Local Push Button Station (for motors)	BHEL	BHEL	Located near the motor.
3	Power cables, control cables and screened control cables for a) both end equipment in BHEL's scope b) both end equipment in vendor's scope c) one end equipment in vendor's scope	BHEL BHEL BHEL	BHEL Vendor BHEL	1. For 3.b) & c): Sizes of cables required shall be informed by vendor at contract stage (based on inputs provided by BHEL) in the form of cable listing. Finalisation of cable sizes shall be done by BHEL. Vendor shall provide lugs & glands accordingly. 2. Termination at BHEL equipment terminals by BHEL. 3. Termination at Vendor equipment terminals by Vendor.
4	Junction box for control & instrumentation cable	Vendor	Vendor	Number of Junction Boxes shall be sufficient and positioned in the field to minimize local cabling (max 10-12 mtrs) and trunk cable.
5	Any special type of cable like compensating, co-axial, prefab, MICC, optical fibre etc.	Vendor	Vendor	Refer C&I portion of specification for scope of fibre Optical cables if used between PLC/ microprocessor & DCS.
6	Cable trays, accessories & cable trays supporting system 100/ 50 mm cable trays/ Conduits/ Galvanised steel cable troughs for local cabling	BHEL Vendor	BHEL Vendor	Local cabling from nearby main route cable tray (BHEL scope) to equipment terminal (vendor's scope) shall be through 100/ 50 mm. cable trays/ conduits/ Galvanised steel cable troughs, as per approved layout drawing during contract stage.
7	Cable glands ,lugs and bimetallic strip for equipment supplied by Vendor	Vendor	Vendor	1. Double compression Ni-Cr plated brass cable glands 2. Solder less crimping type heavy duty tinned copper lugs for power and

REV-0, DATE: 07.03.2015

ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR(FOR EPC PROJECTS)**PACKAGES : CONDENSATE POLISHING UNIT****SCOPE OF VENDOR: SUPPLY, ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT****PROJECT:**

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
				control cables.
8	Conduit and conduit accessories for cabling between equipment supplied by vendor	Vendor	Vendor	Conduits shall be medium duty, hot dip galvanised cold rolled mild steel rigid conduit as per IS: 9537.
9	Lighting	BHEL	BHEL	
10	Equipment grounding (including electronic earthing) & lightning protection	BHEL	BHEL	Refer note no. 4 for electronic earthing
11	Below grade grounding	BHEL	BHEL	
12	LT Motors with base plate and foundation hardware	Vendor	Vendor	Makes shall be subject to customer/ BHEL approval at contract stage.
13	Mandatory spares	Vendor	-	Vendor to quote as per specification.
14	Recommended O & M spares	Vendor	-	As specified elsewhere in specification
15	Any other equipment/ material/ service required for completeness of system based on system offered by the vendor (to ensure trouble free and efficient operation of the system).	Vendor	Vendor	
16	a) Input cable schedules (Control & Screened Control Cables) b) Cable interconnection details for above c) Cable block diagram	Vendor Vendor Vendor	- - -	Cable listing for Control and Instrumentation Cable and electronic earthing cable in enclosed excel format shall be submitted by vendor during detailed engineering stage.
17	Electrical Equipment & cable tray layout drawings	Vendor	-	For ensuring cabling requirements are met, vendor shall furnish Electrical equipment layout & cable tray layout drawings (both in print form as well as in AUTOCAD) of the complete plant (including electrical area) indicating location and identification of all equipment requiring cabling, and shall incorporate cable trays routing details marked on the drawing as per PEM interface comments. Cabling arrangement of the same (wherever overhead cable trays, trenches, cable ducts, conduits etc.) shall be decided during contract stage. Electrical equipment layout & cable tray layout drawing shall be subjected to BHEL/ customer approval without any commercial implications to BHEL.

REV-0, DATE: 09.03.2015

ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR(FOR EPC PROJECTS)**PACKAGES : CONDENSATE POLISHING UNIT****SCOPE OF VENDOR: SUPPLY, ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT****PROJECT:**

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
18	Electrical Equipment GA drawing	Vendor	-	For necessary interface review.

NOTES:

1. Make of all electrical equipment/ items supplied shall be reputed make & shall be subject to approval of BHEL/customer after award of contract.
2. All QPs shall be subject to approval of BHEL/customer after award of contract without any commercial implication.
3. In case the requirement of Junction Box arises on account of Power Cable size mis-match due to vendor engineering at later stage, vendor shall supply the Junction Box for suitable termination.
4. Vendor shall indicate location of Electronic Earth pit in their Civil assignment drawing.

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STANDARD ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR (FOR EPC PROJECTS)

PACKAGE: ELECTRIC HOIST & CHAIN PULLEY BLOCKS

PROJECT : 5X800 MW YADADRI TPP

SCOPE OF VENDOR: SUPPLY , ERECTION & COMMISSIONING OF VENDOR'S EQUIPMENT

<u>S. NO</u>	<u>DETAILS</u>	<u>SCOPE SUPPLY</u>	<u>SCOPE E&C</u>	<u>REMARKS</u>
1	Isolating Switch	Vendor	Vendor	BHEL will provide one number 415 V(3ph, 3W) supply feeder only up to isolating switches for cranes/hoists. Any other voltage level (AC/DC) required will be derived by the vendor. Motor starter shall be part of crane/hoist control panel.
2	Power cables, control cables, screened control cables and any special cables (if required) between equipment supplied by vendor.	Vendor	Vendor	Cable from supply feeder to isolating switch shall be in BHEL scope.
3	Cabling material (cable trays, accessories, cable tray supporting system, conduits etc).	Vendor	Vendor	
4	Equipment Earthing	Vendor	Vendor	All equipment metallic enclosures / frames, metal structure etc. shall be grounded at two points each to the nearest grounding points / risers provided by BHEL.
5	Motors	Vendor	Vendor	
6	Cable glands and lugs for equipment supplied by vendor	Vendor	Vendor	1. Double compression Ni-Cr plated brass cable glands 2. Solder less crimping type heavy duty tinned copper lugs for power & control cables.
7	a) Input cable schedules (C & I) b) Cable interconnection details for above c) Cable block diagram	Vendor Vendor Vendor	- - -	Cable listing for Control and Instrumentation Cable in enclosed excel format shall be submitted by vendor during detailed engineering stage.
8	Equipment layout drawings	Vendor	-	
9	Electrical Equipment GA drawing	Vendor	-	For necessary interface review.

CABLE SCHEDULE FORMAT

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	TITLE :		SPECIFICATION NO. PE-TS-417-155A-A001	
	5X800 MW YADADRI THERMAL POWER STATION		SECTION : I	
	TECHNICAL SPECIFICATION FOR CONDENSATE POLISHING UNIT		SUB-SECTION: IC	
			REV. NO. 00	DATE :

SECTION – I
SPECIFIC TECHNICAL REQUIREMENTS
SUB-SECTION IC - Specific Technical Requirements (C&I)

373942/2021/PS-PEM-MAX

FORM NO. PEM-6666-0



Technical specification for
CONTROL & INSTRUMENTATION
 5x800 MW YADADRI TPS, NALGONDA

SPEC NO.: **PE-TS-417-145-I**

VOLUME

SECTION

REV. NO.

00

DATE : 16.08.2018

SHEET

OF

SPECIFIC TECHNICAL REQUIREMENT

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Specific Technical Requirement For
CONDENSATE POLISHING
SYSTEM

5X800 MW
YADADRI TPS, NALGONDA

1. The bidder shall provide complete Instrumentation for control, monitoring and operation of entire CONDENSATE POLISHING SYSTEM. The requirements given are to be read in conjunction with detailed Technical specification. Further in case of any discrepancy in the requirement within the same section noted by the bidder in the specification, the same will be brought to the notice of BHEL in the form of pre bid clarification. In absence of any pre bid clarification, the more stringent requirement as per interpretation of customer/owner shall prevail without any commercial and time implication.
2. CONDENSATE POLISHING SYSTEM shall be operated & controlled from DCS (DCS is in BHEL's scope). Local Control Panel ,wherever required ,will be in bidder's scope.
3. **Redundancy of sensors shall be provided, irrespective of instrumentation shown in the PID, by bidder as per following:**
 - (i) Triple redundancy for all analog and binary inputs required for protection of system /drives.
 - (ii) For all other control functions & alarms, dual redundancy of the sensors shall be provided by the bidder.
4. The quantity of instruments mentioned in tender P &ID is minimum and redundancy shall be in line with point no. 3 mentioned above. Bidder shall also include in his proposal all the instruments and devices that are needed for the completeness of the plant auxiliary system/ equipment supplied by the bidder, even if the same is not specifically appearing in the P & ID. During detail engineering if any additional instruments are required for safe & reliable operation of plant, bidder shall supply the same without any implication.
5. All the instruments shall be supplied along with necessary fittings, accessories, valve manifold, root valves, Junction box, Canopy & Structural steel as required. Instrument Installation, along with hardware shall be in bidder scope.
6. The junction boxes/LIEs for termination of instruments, solenoid valve, limit switches etc. are in bidder's scope. All instruments shall be terminated on JB/LCP in field and both instrument and JB & LCP are in bidder scope.
7. Double root valves shall be provided where pressure is above 40 Kg/cm².
8. The solenoid operated valves/ damper/gates shall have limit switches for open/ close feedback. Solenoid valve shall be rated for 24 V DC only.
9. Diaphragm seal with capillary shall be provided with Instruments having contact with corrosive media e.g. resin line with DM water.
10. All pneumatic operated regulating control valves shall be envisaged with smart positioner.

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Specific Technical Requirement For
CONDENSATE POLISHING
SYSTEM

5X800 MW
YADADRI TPS, NALGONDA

11. Electrical Actuators shall be with integral starter.
12. BHEL shall provide 230 VAC UPS supply feeder at a single point. Further distribution to various instruments shall be in Bidder's scope. Bidder to include necessary power distribution board in his scope. Any power supply other than the above, if required by any instrument/device, has to be derived by the Bidder and all necessary hardware/software for the same shall be in bidder's scope. Bidder to furnish UPS / Electrical load data along with the bid.
13. Power supply derived for Transmitters, contact interrogation, interposing relay and solenoid shall generally be ungrounded 24V D.C only. In all cases redundancy in power modules shall be considered.
14. All transmitters & electronics items including JB's will be explosion proof / intrinsically safe as per hazardous area classification.
15. The make shall be as per approved vendor list. The model of various instruments/items/systems shall be subject to approval of owner/purchaser during detailed engineering stage. No commercial implication in this regard shall be acceptable. In case of any conflict or repetition of clauses in the specification, the more stringent requirements among them are to be complied with.
16. All Instruments must have separate tapping lines. Sharing of the same tapping pipe for redundant instruments or various different instruments is not acceptable.
17. Electronic instruments shall not be located close to hot lines, vessels or other hot equipment. Ambient temperatures exceeding 80 °C shall not result in calibration difficulties or rapid deterioration of electronic components.
18. Mandatory spares as per specification, shall be supplied by bidder.
19. Vendor representative shall be available for 6-7 days during commissioning time at site.
20. The design, manufacture, inspection, testing, site calibration and installation of all C&I equipment and systems covered under this specification shall conform to the latest editions of applicable codes and standards eg. ANSI, ASME, IEEE, ISO, IEC, IGCI, AWS, NFPA, AISC, IGS, SAMA, UBC, UL, NESC, NEMA, ISA, DIN, VDE, IS etc.
21. For instrument & control cable scope of supply refer 'Electrical scope sheet between BHEL & vendor'.
22. Bidder shall provide Cable Schedule in BHEL excel format which shall be provided during detailed engineering. Also, Cable engineering i.e schedule and interconnections for Complete System shall be in Bidders' scope. DCS side details for hardwired signals shall be furnished by BHEL during detailed engineering stage.

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Specific Technical Requirement For
CONDENSATE POLISHING
SYSTEM

5X800 MW
YADADRI TPS, NALGONDA

23. Every panel-mounted instrument, requiring power supply, shall be provided with a pair of easily replaceable glass cartridge fuses of suitable rating. Every instrument shall be provided with a grounding terminal and shall be suitably connected to the panel grounding bus.
24. Provision for separate Terminal block/wiring diagram for power and control blocks of control panel to be ensured.
25. Bidder to note that all the transmitters/instruments supplied by Bidder shall be rack mounted. The racks shall be preassembled and provided by Bidder. Also no instruments / analyzers & JB's/Racks should be protruding on the walkway.
26. Each valve/instrument shall be fitted with a stainless steel or aluminum nameplate indicating the valve/instrument service and reference number in accordance with the approved equipment coding system.
27. The equipment shall be of modern, compact design incorporating the latest developments in proven technology.
28. Generally, equipment shall be supplied from one composite range of measurements and control equipment as marketed by a reputable manufacturer of international standing and shall have a minimum of three years' operational use on similar projects.
29. Editable & pdf copy of following Drawings/Documents and data shall be furnished after award of the contract:
 - Control & operational write-up for the system
 - Recommended control scheme/ logic diagram
 - Process manuscript for implementation in DCS
 - List of Drives (Solenoid valves etc)
 - I/O list (DCS)
 - GA & wiring diagram of local panel.
 - Power requirement.
 - Local control panel and field instruments quality plan.
 - Local control panel & instruments data sheet.
 - JB grouping document.
 - Cable schedule and cable interconnection drawing.
 - Instrument schedule
 - Alarm Schedule
 - SOE schedule
 - Instrument hook-up diagram.
 - Mandatory spare BOQ
 - UPS load list
 - Any other document decided during detailed engineering.

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Specific Technical Requirement For
CONDENSATE POLISHING
SYSTEM

5X800 MW
YADADRI TPS, NALGONDA

30. Transmitters shall be provided instead of switches.
31. Solenoid valves shall be kept in pneumatic junction boxes only. Air distribution for SOV's shall be through SS manifold with SS isolation valves and auto drain traps and SS tubing from SOV to valves shall not be more than 6 meters.
32. The equipment shall be of modern, compact design incorporating the latest developments in proven technology.
33. Electronic instruments shall not be located close to hot lines, vessels or other hot equipment. Ambient temperatures exceeding 80 °C shall not result in calibration difficulties or rapid deterioration of electronic components.
34. The specifications for instruments mentioned in the specification are minimum requirements. Datasheets of instrument shall be subject to customer/owner approval.

NOTES :

1. All equipment items shall be of latest design with proven on track record from reputed experienced manufacturers of specified type and range of equipment. The make/model of various instruments/items/systems and instrument sub-vendor shall be subject to approval of BHEL/Customer during detailed engineering stage.
2. The above given scope is indicative & minimum. Any item/ equipment not indicated above however required for the completeness of the system is to be supplied by bidder without any technical, commercial and delivery implication to BHEL.
3. Documents of C&I System shall be submitted to end user/owner for approval during detail engineering. Changes, if any, shall be accommodated by the bidder without any price/time implication.
4. Uniformity of make and type of instruments and control components shall be followed throughout for rationalization of spares' inventory, except for certain proprietary items where this requirement cannot be met.
5. In case of any discrepancy in Sub-Section-I and sub-Section-II of the specification, sub-Section-I shall prevail.

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	TITLE:		SPECIFICATION NO. PE-TS-417-155A-A001	
	5X800 MW YADADRI THERMAL POWER STATION		SECTION : II	
	TECHNICAL SPECIFICATION FOR CONDENSATE POLISHING UNIT			
			REV. NO. 00	DATE :

SECTION – II

GENERAL TECHNICAL REQUIREMENTS

- SUB-SECTION IIA - GENERAL TECHNICAL REQUIREMENTS (MECH.)
- SUB-SECTION IIB - GENERAL TECHNICAL REQUIREMENTS (ELECTRICAL)
- SUB-SECTION IIC - GENERAL TECHNICAL REQUIREMENTS (C & I)

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	TITLE :		SPECIFICATION NO. PE-TS-417-155A-A001	
	5X800 MW YADADRI THERMAL POWER STATION		SECTION : II	
	TECHNICAL SPECIFICATION FOR CONDENSATE POLISHING UNIT		SUB-SECTION : IIA	
			REV. NO. 00	DATE :

SECTION – II

GENERAL TECHNICAL REQUIREMENTS

SUB-SECTION IIA - GENERAL TECHNICAL REQUIREMENTS (MECH.)

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INTENT OF SPECIFICATION

INTENT OF SPECIFICATION

- 1.00.00 This specification is intended to cover supply and installation of complete Plant Equipment & accessories along with all facilities as detailed hereinafter for 5 x 800 MW Yadadri Thermal Power Station (YTPS).

This specification is intended to cover design, engineering, manufacture, supply, fabrication, assembly, inspection / testing at vendor's & sub-vendor's works, painting, Supervision of fabrication of Pressure Vessels and Atmospheric Tanks, maintenance / special tools & tackles, mandatory spares alongwith spares for erection as required, startup and commissioning spares as required, forwarding, proper packing, shipment and delivery at site, unloading, handling, transportation & storage at site, in site transportation, assembly, erection & commissioning, final painting at site, minor civil work, trial run at site, preparation and submission of drawing /documents including "As Built" drawings and O & M manuals, layout drawings in 2D & 3D (As applicable) and carrying out performance guarantee / Functional / Demonstration tests at site (As applicable) & equipment /system guarantee/Aux. Guaranteed power consumption etc. inclusive of all prevailing taxes, duties and other levies and handover in flawless condition of the package specified above for above mentioned project to the end customer complete with all accessories for the total scope defined as per BHEL NIT & tender technical specification no. **PE-TS-417-155A-A001** for condensate polishing unit package of **5X800 MW YADADRI THERMAL POWER STATION.**

~~The specification consists of Volumes : I to X, the detailed index of which has been furnished elsewhere.~~ This specification shall be read and construed in conjunction with the drawings and annexures to determine the scope of work. The quantities shown on drawings and annexures are indicative. Any variation arising during detailed engineering stage will be taken into account by the Contractor without any extra cost and time to the Owner.

The Bidder shall be responsible for providing all material, equipment and services, specified or otherwise which are required to meet the intent of this specification, ensuring high degree of reliability and ease of operation and maintenance. The equipment and system/sub-systems shall conform to all aspects of high standards of engineering, design and workmanship and shall be capable of performing in continuous commercial operation, in a manner acceptable to the Owner and shall also be in line with the current practice for reliable and efficient functioning of the plant.

Owner shall interpret the meaning of the specification, drawings, requirement of operation, maintenance, redundancy etc., and shall have a right to reject or accept any work or material which in his assessments is not technically complete to meet the requirements of this specification and/or applicable National and International Standards mentioned elsewhere in this specification.

Bidder is required to carefully examine and understand the specifications and seek clarifications, if required, to ensure that he has understood the specifications as intended by the Owner. In the absence of any specific clarifications made by the Owner during bidding stage, the interpretation of

Owner shall be final. The Bidder's offer should not carry any sections like clarifications, interpretations and/or assumptions. All such points are required to be clarified during bidding stage.

In the event of conflict between requirements of any two clauses of this specification/documents or requirements of different codes/standards, specified, the more stringent requirement as per the interpretation of the Owner shall apply.

The Bidder may also make alternate offer, provided such offers are superior in his opinion, in which case, adequate technical information and justifications, operating feed back data etc. shall be enclosed with the offer, to enable the Owner to assess the superiority and reliability of the alternative offered without the need to seek any further clarification or explanation. In case of each alternative offer, its implications on the performance, guaranteed efficiency, heat rate auxiliary power consumptions and definite advantages the Owner can positively derive shall all be clearly brought out along with commercial implications, if any for the Owner to make an overall assessment. In any case, the base offer shall necessarily be in line with this specification. Under no circumstances shall the specified equipment/plant be brought out as an alternative offer.

In case all the above requirements are not complied with, the offer may be considered as incomplete and liable to be treated as non-responsive.

- 2.00.00 Whenever a material or article is specified or described by the name of a particular brand, manufacturer or vendor, the specific items mentioned shall be understood as establishing type, function and quality desired.
- 3.00.00 In case there is any difference of content/information between "Hard Copy" and "Soft Copy" of this specification document, the statement/information as printed in hard copy shall prevail.

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SCOPE OF SUPPLY AND SERVICES

SCOPE OF SUPPLY AND SERVICES

A. SUPPLY OF EQUIPMENT AND SYSTEMS

The Works as detailed hereinafter of this Project for 5x800 MW Yadadri Thermal Power Station (YTPS), CPU package shall be contracted on a Single Package turnkey basis for complete plant, equipment and systems. The scope of CPU package will be as mentioned in Sub-section I-A, I-B & I-C of this specification and bidder to refer the same.

~~continuous operation under two shift and cyclic modes during certain periods is also envisaged. The design would cover adequate provision for quick start up and loading of the units to full load at a fast rate.~~ The main plant and its auxiliaries with their controls would be designed to permit operation of the units on house load without there being any necessity to shut down the units in the event of sudden loss of total load due to tripping of transmission lines or any other grid disturbances. The design of the plant equipments and control system would permit participation of the plant in automatic load frequency control.

1.00.00 One (1) no. super-critical once through dry bottom, balanced draft, outdoor type pulverized coal fired with oil as start-up and stabilising fuel steam generating unit, complete with all major auxiliary plant and equipment consisting of, but not limited to, the following :

- a) Furnace/ evaporator complete with spiral/ vertical rifle/ ribbed tubes, headers, steam generating tubes, risers, furnace bottom hoppers etc. for once through boiler.
- b) Economiser, Superheater, Reheater, Separator other Pressure Parts, Soot Blowing System etc. including circulation pumps (for low load and start up).
- c) Integral pipework, valves and specialties along with supporting system.
- d) Draft plant including tri-sector type air-preheaters, ducting and accessories upto chimney inlet flange.
- e) Fuel (Coal) preparation and firing systems including start-up/ stabilisation system with fuel oil and mill rejects handling & disposal system.
- f) Integral instrumentation, safety interlocks and controls for steam generator.
- g) Galleries, platforms and structural steelwork.
- h) Electrostatic precipitators.

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	pumps are to be complete with accessories for sealing and lubrication, flexible/hydraulic couplings, gear box, integral instrumentation, handling devices, etc. and Auxiliary steam turbine and ancillaries for Boiler feed pump device as specified in Volume: IIC of this specification.
6.00.00	Low pressure and high pressure feed heaters and deaerator complete with integral instrumentation and valves, supports, platforms, rails, handling devices etc. as specified in Volume: IIC of this specification.
7.00.00	Turbine oil purification system and central turbine oil storage and transfer system as specified in Volume: IIC of this specification.
8.00.00	Complete piping, valves and specialties as indicated hereunder, but not limited to, the following: a) Power cycle piping consisting of main steam, hot reheat, cold reheat, extractions, auxiliary steam, air evacuation, cascade drains, condensate, feed water, cycle make-up, drains to waste and atmospheric vents etc. Blanking devices for emergency stop and reheat stop valves and other items as required for steam blowing operation along with steam blowing piping and quick opening valve as specified in Volume: IID of this specification. b) Large diameter piping for condenser and auxiliaries Cooling Water Systems as detailed in Volume III-E of this specification. c) Low pressure piping for various water (cooling, service, drinking, plant make-up etc.) air (instrument, service air etc.), steam (other than that covered in item [a] above) and other services as detailed in Volume III-E of this specification.
9.00.00	Steel storage tanks/ vessels such as, condensate storage tank, potable water tank to be constructed under this specification, waste drain and other tanks not specifically mentioned but required for completion of various systems supplied under this specification. Refer Volume III-E of this specification for detailed scope.
10.00.00	Thermal insulation including cladding material as required for conservation of heat and for personnel protection, as specified in Volume: II-D of this specification.
11.00.00	Complete Control and Instrumentation (C&I) systems in turnkey basis. Any item not specifically mentioned in this specification but required for completion of the total C&I system shall be included. The major C&I systems shall comprise of but not be limited to Distributed Digital Control and Management Information System (DDCMIS), SG and TG integral control and instrumentation systems, Plant Auxiliaries and Off site Plants Controls and monitoring systems, Performance Analysis Diagnostics and Optimisation (PADO) system, Master Clock system (MCS), Rotating Machine Condition Monitoring System (RMCMS) , Close Circuit Television (CCTV) System for plant surveillance, Furnace and Flame viewing System, PA and EPABX systems, Computerised Maintenance & Inventory Management System (CMIMS), Ambient Air Quality Monitoring System (AAQMS), Steam and

Water Analysis System (SWAS), Continuous Emissions Monitoring System (CEMS), Microprocessor based Alarm Annunciation System, HART management system, Power supply, C&I Laboratory, Erection Hardware Field instruments and sensors, Performance and Guarantee test instruments, Primary flow elements, Pneumatic, motorized and hydraulically operated valves and dampers, cables, Panel, desks and cabinets, Racks, Maintenance, calibration, commissioning, site testing instruments, Special tools and tackle, Spares and Consumables etc.

Volume VI of this specification shall be referred for further details of C&I requirements.

12.00.00 Complete cooling water system consisting of, but not limited to, the following major equipment :

- a) Cooling Tower
- b) Condenser Circulating Water (CW) pumps, drives and accessories.
- c) Auxiliary Cooling Water (ACW) pumps, drives and accessories.
- d) Closed circuit DM cooling water pumps, drives and accessories.
- e) Heat exchangers for closed circuit DM cooling water systems.
- f) Cycle make-up pumps, Condensate Transfer Pumps and Condensate Storage Tank.

For detailed scope, refer to Volume: III-A and VII-D of this specification.

13.00.00 Complete Instrument Air and Service Air System consisting of but not limited to the following:

- a) 3x50% Instrument Air Compressor
- b) 3x50% Service Air Compressor
- c) 3x50% Refrigerant type Air Dryer
- d) 6 Nos. Air Receiver

For detailed scope, refer to Volume III-E of this specification.

14.00.00 Ventilation and Air-conditioning system including all equipment, piping, false ceiling, insulation, ducting etc. as required for all buildings and facilities.

14.01.00 The Air-conditioning system shall cover the following areas as a minimum :

- a) TG Building Room

Unit Control Room, Control Equipment Rooms, Shift Charge Engineer's Rooms, Computer Room, Uninterrupted Power Supply (UPS) Rooms, Automatic Voltage Regulator (AVR) Rooms if any, Steam and Water Analyzer

However, for detailed scope, refer to Volume III-D of this specification.

15.00.00 Fire Protection System for all plant, equipment and facilities under this specification comprising of, but not limited to, the following :

- a) Hydrant Protection System.
- b) Spray Water System.
- c) Smoke/Fire Detection System.
- d) Inert Gas Flooding System
- e) Fixed foam Protection System
- g) Portable Fire Extinguishers
- h) Fire Tender

For detailed scope, refer to Volume III-E of this specification.

16.00.00 Sump Pumps complete with drives and accessories for drainage of pits from all buildings/facilities, inclusive of, but not limited to the following areas:

- a) Power House and Boiler Area.
- b) Fuel Oil (F.O) Unloading, Forwarding and Pressurizing Pump House.
- c) Transformer Area.
- d) Coal handling plant.
- e) Other Auxiliary Buildings.

For detailed scope, refer Volume III-F of this specification.

17.00.00 Miscellaneous Cranes complete with drives, electrical and all other accessories for the following buildings, as a minimum.

- a) Turbine Hall
- b) Mill building
- c) CW Pump House.
- d) Store Building
- e) ESP Control-cum-Fly Ash Equipment Bldg.
- f) Air Compressor Building

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	g) Clarified Water Pump House
	h) Fire Water Pump House
	i) Coal handling plant
	For detailed scope, refer Volume III-F of this specification.
18.00.00	Miscellaneous hoists & Lifting devices complete with drives and accessories for all buildings and facilities, not covered by item 17.00.00 above as also required for handling during operation & maintenance of any equipment weighing above 500 Kg supplied under this specification but not covered by any of the cranes mentioned under item 17.00.00. For detailed scope refer Volume III-F of this specification.
19.00.00	Elevators complete with drives, electricals, control and instrumentation and all other accessories, inclusive of, but not limited to the following facilities.
	a) Stack Elevator.
	b) Boiler Elevator.
	c) Power House Building Elevator.
	d) Service Building Elevator
	e) Elevators in coal handling plant
	For detailed scope refer Volume III-F of this specification.
20.00.00	Not used.
21.00.00	Plant Water System
	Raw Water System, Clarified Water System, Potable Water System, Service Water System consisting of all equipment, facilities and auxiliaries but not limited to the following :
	a) Rerouting of existing raw water 1200 NB GRP pipe with MS pipe inside plant boundary of approximate length 2 km is under TSGENCO scope. However, the supply of Raw water pumps are under the bidder's scope.
	b) Raw Water Reservoir and pump house
	c) Intake Valve Chamber modification and extension
	d) Coal Handling Plant Dust Suppression system
	e) Ash Handling Plant Supply Pumps
	f) Service Water Pumps.

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	g) Plant Water Transportation Pumps.
	h) Potable Water Storage Tank
	i) Service Water Storage Tank
	For detailed scope refer Volume III-B of this specification.
22.00.00	Water Treatment System
	All equipment/system consisting of, but not limited to the following :
	a) River Water Pre-Treatment System
	b) Demineralisation System.
	b) Side Stream Filtration System.
	c) CW Chemical Treatment.
	d) CW Chlorination System.
	For detailed scope refer Volume III-C of this specification.
23.00.00	Waste Water Treatment System
	a) Complete Waste Water Treatment System with all equipment and auxiliaries as detailed in Volume III-C.
	Bidder to note that the plant will be a Zero Discharge Plant.
	b) Centralised Sewage Treatment System
24.00.00	Coal Handling Plant
	Complete Coal Handling Plant including all equipment and auxiliaries as detailed in Volume IV-A..
25.00.00	Ash Handling Plant
	Complete Ash Handling Plant including all equipment and systems as detailed in Volume IV-A..
26.00.00	Complete Mill Reject System
27.00.00	H ₂ , CO ₂ and N ₂ Gas Cylinders as detailed in Volume III-E.
28.00.00	Complete electrical equipment and accessories as specified under "Electrical Equipment & Accessories – "Volume V-A and Volume V-B" of this bid document.
29.00.00	Complete civil, structural, architectural & building service works, underground and overground, including all design, preparation of design and construction

drawing for power house, miscellaneous plant buildings & other indoor/outdoor facilities as included in this package including supply of materials, labour, tools & machinery as required. The services shall include but not be limited to the following:

- a) Foundation for all the equipment supplied under this package including installation of anchor bolts, sleeves and other embedded fixtures. ~~Foundation of Turbine generators, TDBFPs located on operating floor, MDBFP located on mezzanine floor, ID fans, FD fans, PA Fans and Coal Mills shall be conventional machine foundations.~~
 - b) Fabrication & erection of all types of steel work as required for buildings, platforms, stairs, ladders, hangers & supports, pipe and cable rack structures, conveyor galleries and trestles, equipment mounting structures, switchyard gantries and towers etc.
 - c) ~~Installation of grounding & lightning protection mat for all equipment & building including risers, sub-grids, down conductors, shielding masts etc. as necessary.~~
 - d) ~~Soil investigation of area under this package, Land grading over existing grades as necessary for installation of equipment/structures including provision for retaining walls where required, excavation, backfilling, disposal of excess soil, concrete paving, boulder soling of various areas as specified.~~
 - e) ~~Brickwork, plastering, flooring and floor finish, doors, rolling/ sliding shutters, windows/louvers, internal partitions, glazing, false ceiling, false flooring, external cladding, roof protection, painting, sanitary & plumbing works etc. as specified and necessary for all the buildings constructed under this package.~~
 - f) ~~Permanent & construction roads around power house and other buildings, as well as arterial roads, culverts and area drainage as specified elsewhere in this specification.~~
- Apart from the power house building & mill building the following miscellaneous plant buildings/structures will be required to be constructed under this specification package:
- g) ~~C.W. Pump house with electrical annex including cooling tower, water conveying concrete duct from cooling towers, forebay, etc.~~
 - h) ~~ESP Control-cum-Fly Ash Equipment Building.~~
 - j) ~~Mill Reject System Compressor House, Mill reject Silo~~
 - k) ~~Condensate Transfer RCC Pump House~~
 - l) ~~Pipe and Cable Racks, Trenches & Culverts.~~
 - m) ~~Transformer foundation with fire barrier wall, pits, rails etc.~~
 - n) ~~Fire water storage tanks & fire water pump house including~~

equipment, foundation & pipe supports with their foundation.

- o) Fire Station Building
- p) Ash Silo , ash dyke and pump-houses and sumps required for ash handling plant
- q) Coal Handling Plant
- r) Chimney
- s) Service building and all other non-plant building and utilities mentioned elsewhere in this specification

The above list is not exhaustive and any building required to be constructed, as incidental to this contract shall be deemed to be included under the scope of the present specification.

For further details refer Volume VII-A & Volume VII-B of this specification.

Set of spares for all plants and equipment for all systems, as recommended by the respective manufacturer/bidder for regular reliable operation of minimum two (2) years. Bidder is to develop recommended list of spare parts with prices by items and this shall be furnished separately in the prescribed format. Sufficient description and drawings are to be provided to permit analysis and evaluation of spares recommended.

Set of tools and tackle, fixtures etc. in new condition, as required for regular operation and maintenance of the plant and equipment offered. Adequate means shall be provided for lifting and handling of each item of plant and equipment including slings etc. Price for such tools & tackle, fixtures etc. shall be furnished separately in the prescribed format.

B. SERVICES TO BE RENDERED BY THE BIDDER

The services to be rendered by the Bidder shall include but not be limited to the following :

- 1.00.00 Dismantling of all existing structures/buildings in colony (excluding the temple) needs to be done by the EPC contractor, and the disposal of the debris is to be made at a distance of about 5 km from the plant site, location of which will be identified by the TSGENCO site engineer.
- 2.00.00 Construction of residential colony including recreation club, hospital building, indoor stadium, shopping complex, STP in residential colony, rain water harvesting structures, potable water treatment plant in colony, Bank building including ATM building
- 3.00.00 Services for complete engineering, co-ordination and project management as detailed in Section-IV of this specification volume. Necessary site survey, measurement, collection of data/detail about existing installations wherever

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	applicable for interfacing with existing plant.
4.00.00	Services for shop tests and quality assurance, etc. as detailed elsewhere in this specification.
5.00.00	Services for construction, fabrication, equipment erection, testing as well as trial run & commissioning of various equipment and accessories under the contract. The details of such services are indicated in Section-VI of this specification volume. Bidder shall arrange tower crane for erection and construction work, wherever necessary. Moreover, all erection tools and tackle necessary for all the equipment as well as for generator stator handling and erection shall be arranged by the bidder.
6.00.00	Supply of all mandatory, erection/commissioning and recommended spares, special tools & tackle including required after-sales services during and after the warranty period.
7.00.00	Supply of all consumables required for the works as per provision of respective clauses specified in conditions of contract.
8.00.00	Furnishing of all document, drawings, design basis reports, optimization, study reports, instruction manuals, etc. including "As built" drawings, as called for in the specification both in requisite no. of hard copies and in soft form (CD).
9.00.00	Operation and Maintenance training.
10.00.00	Obtaining approval from statutory bodies in India. However, Owner shall provide assistance to do so.
11.00.00	Equipment shop painting.
12.00.00	Any other service, although not specifically called for but required for a turn-key contract of the size and nature indicated in this specification.
13.00.00	For details of services under clause B, subsequent sections of this Lead specification may be referred.
C.	EXCLUSIONS
	Raw water intake system, other than modification of the GRP pipe with MS pipe inside plant boundary.
D.	TERMINAL POINTS
	The terminal points of the complete package to be supplied shall be as follows. For all terminal points scope of this contract shall include making the joint including supply of mating flanges, gaskets, bolts, nuts etc and including any isolation valve. Terminal Points mean Engineering, Procurement and Erection in entirety.
1.00.00	Railway line terminal point

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For railway line terminal point, refer to RITES report attached.

2.00.00 Plant Water System

Inlet of existing intake valve chamber. However, intake GRP pipe needs to be rerouted/modified by MS pipe as detailed in Volume III-B of this specification.

3.00.00 **Electrical**

400kV Switchyard line take-off gantry (including droppers for line side equipment) for power evacuation through new switchyard/transmission lines.

E. FACILITIES TO BE PROVIDED BY THE OWNER

1.00.00 Land, free of charge as available for the construction of plant.

2.00.00 Construction water shall be provided free of cost at one point.

3.00.00 Employer will arrange power source free of cost at 11 kV level at one point. Street lighting and distribution system to be done by EPC contractor. High mast lighting is to be provided. Adequate lighting from safety point of view is to be provided in the construction area.

4.00.00 Potable/drinking water to be provided at one point.

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PROJECT MANAGEMENT AND SITE SERVICES

(DEVELOPMENT CONSULTANTS
(e-PCT-TS-K-02-2014-15-Vol. IIA-5.docx)

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CONTENT

CLAUSE NO.	DESCRIPTION
1.00.00	PROJECT MANAGEMENT SERVICES
2.00.00	SITE SERVICES
3.00.00	PROJECT INFORMATION AND MANAGEMENT SYSTEM, INCLUDING DCOUMENT MANAGMENT SERVER (DMS)

PROJECT MANAGEMENT AND SITE SERVICES

1.00.00 PROJECT MANAGEMENT SERVICES

1.01.00 Responsibility

The Bidder shall identify a separate and independent project management team headed by a Project Manager for the execution of this project. Responsibilities of this project Management team shall cover the areas listed below :

- a) Planning and Monitoring
- b) Engineering Management
- c) Contracts Management
- d) Project Safety Management
- e) Quality Assurance, Inspection & Expediting
- f) Construction Management
- g) Spares Management
- h) Erection & Commissioning Management

Detailed responsibilities in the above areas are discussed below :

1.02.00 Organisation

1.02.01 Headquarters

The headquarters of the project management team shall be headed by a senior level executive designated as the Project Manager who shall be responsible to Owner for the execution of the project. He should have adequate financial power and authority to give decision.

Separately, designated leaders shall be identified for each of the areas mentioned under 1.01.00, who, in turn, will report to the Project Manager for all matters relative to this contract.

1.02.02 Central Co-ordination Cell

The central coordination cell shall have sufficient technical personnel to coordinate technical matters and to quickly resolve day to day queries or

	references made by Owner and his Consultants without having the need to refer to his headquarters each time.								
1.02.03	Site Organisation The site should have a competent construction manager for all site operations with adequate financial power and sufficient level of authority to take site decisions. The organisation chart for site should indicate the various levels of experts to be posted for supervision in the various fields in civil construction, erection, commissioning etc.								
1.02.04	Organisation Chart The Bidder shall furnish a detailed organisation chart for the project management team, clearly identifying the key personnel in each of the areas mentioned at 1.01.00 above. The expected number of executives at different levels shall also be indicated, separately for headquarters, central coordination cell and site organisation.								
1.03.00	Implementation Schedule The schedule for the completion of the Project would be as follows : <table> <tr> <th colspan="2">Period in Months from Zero date (Taken as advance payment date of EPC Package)</th></tr> <tr> <td>a)</td><td>Boiler Hydro-test By Bidder</td></tr> <tr> <td>b)</td><td>Boiler light up By Bidder</td></tr> <tr> <td>e)</td><td>Commercial operation 50</td></tr> </table> To achieve these targets, the Contractor shall furnish to the Owner, various schedules as defined below:	Period in Months from Zero date (Taken as advance payment date of EPC Package)		a)	Boiler Hydro-test By Bidder	b)	Boiler light up By Bidder	e)	Commercial operation 50
Period in Months from Zero date (Taken as advance payment date of EPC Package)									
a)	Boiler Hydro-test By Bidder								
b)	Boiler light up By Bidder								
e)	Commercial operation 50								
1.03.01	Engineering Schedules These schedules shall cover various design submissions indicating different engineering activities to be performed. Such schedules shall be furnished by the Bidder for each and every plant/systems/ equipment item covered in the scope of this specification.								
1.03.02	Manufacturing Schedule The Contractor shall submit to the Engineer his manufacturing and delivery schedules for all equipment within thirty (30) days from the date of issue of the Letter of Intent (LOI). Such schedules shall be in line with the detailed network for all phases of the work of the Contractor. Such schedules shall be reviewed, updated and submitted to the Engineer, once in every two months thereafter, by the Contractor. Schedules shall also include the materials and equipment purchased from outside suppliers.								

1.03.03 Erection Schedules

In order to achieve the overall completion schedule, the Contractor shall provide the Owner all the information covering erection sequence, testing and commissioning activities. These schedules may be based on the recommended erection procedures and will be subject to discussions/agreements with the Owner subsequent to the award of contract.

1.03.04 The successful Bidder shall have to provide all the above schedules (i.e. 1.03.01, 1.03.02 & 1.03.03) in a tabular form in addition to that in the form of L2 & L3 networks and these shall necessarily include information not limited to the earliest and latest dates for various activities/submissions and also any related constraints. However, the Bidder shall include in his proposal a Level-1 (L-1) network showing the major activities and various milestones to achieve the above mentioned completion schedule.

1.03.05 The Contractor shall provide the Owner the original disc/software for all such schedules alongwith requisite no. of copies (as required by the Owner) within an agreed time schedule. This time schedule will be agreed between Owner/Bidder at the time of award of contract. The Contractor's project management software shall be compatible with that of the Owner and the input data shall be furnished to the Owner in a manner compatible with Owner's project management software, SAP.

1.04.00 Detailed Responsibilities

1.04.01 Planning & Monitoring

a) Planning

The Bidder shall prepare a Master Network Schedule in the form of PERT network.

The network shall be prepared on a Work Breakdown Structure for the project which sub-divides the project into a set of manageable systems/sub-systems. The master network will identify milestones of key events for each system/package in the areas of engineering, procurement, manufacture and despatch and erection and commissioning. The master network shall represent the Level-I plan and will form the basis for development of detailed second and third tier execution plans. The master network shall conform to the overall schedule prescribed by Owner.

The master network should be submitted along with the bid which would be mutually discussed and finalised before the Award of Contract. This master network would clearly indicate the responsibility of the Bidder and project management team. This master network would form a part of the contract. The master network shall also identify a complete list of inputs to be furnished by the Owner which may be required for proper interfacing and tie-up. Scheduled dates for providing such inputs shall also be indicated, which will be mutually discussed and finalised.

b) Monitoring & Progress Reporting

The progress reports would be emanated every month, one from the head office of the Contractor and another from the site office. The progress report emanating from the head office should necessarily include the following sections:

- i) Report on key milestones.
- ii) Management summary indicating critical areas with details of actions initiated and effect of any on the project.
- iii) Action needing attention of the Owner/Consultant.
- iv) Detailed package-wise status of engineering submissions, quality plan submissions and approval, procurement manufacture and despatch.

The monthly report generated from the site office should necessarily include:

- i) Report on key milestones.
- ii) Management summary indicating critical areas with details of actions initiated and effect if any on the project.
- iii) Action needing attention of the Owner/Consultant.
- iv) This report would also cover the areas pertaining to the receipt of the equipment at the port, port clearance, transport, receipt at site, erection and commissioning.

In addition to the above, as the project execution progresses, the Contractor shall also be responsible for generating more frequent reports in the form of fax/e-mail information on progress in critical areas so that actions can be expedited. The exact format of the progress report shall be finalised after award of Contract.

1.04.02 Engineering Management

Based on the master network for the project (L-1) the Contractor will prepare an exhaustive list of engineering activities for the equipment/systems covered in his scope and a detailed programme of accomplishing the same within the time frame specified in the master network. This schedule will form the Level-2 (L-2) network for engineering activities.

Based on (L-2) network, the Contractor shall further develop the Level-3 (L-3) network for engineering activities which will indicate schedule for data availability, drawing release date and document submission dates.

Detailed (L-2) and (L-3) networks would be submitted sequentially by the Contractor within two months from the date of issue of Letter of Intent and finalised within one (1) month thereafter.

All such networks shall be provided in MS PROJECT software as well as in other format / software suitable to Owner.

The engineering management team should also co-ordinate all interface engineering activity between the Contractor and the equipment sub-vendors so as to ensure the correctness and completeness of related engineering documentation before the same is submitted to the Owner.

TSGENCO is implementing SAP ERP. Hence the bidder apart from submission of the hard copies shall upload all the documents, drawings etc. in soft format in the relevant C- folder environment (web based) and comply with the additional requirements, if any.

1.04.03 Contracts Management

Based on the master network, the Contractor shall submit L-2 programmes of manufacture and despatch. In addition, the master network shall also include periods considered for site activities viz. erection, commissioning etc. These L-2 programmes would be submitted in 2 months time from the date of award of contract and finalised within one (1) month thereafter. The Contractor will also submit site mobilisation plan. This programme would be submitted at the time of finalisation of award of contract and agreed immediately thereafter so that immediate development of the various activities at site could take place.

The Contractor should also submit L-3 programmes for the manufacturing, despatch of the various items. These networks shall also show the customer hold points (CHP) which have to be cleared by Owner or their authorised representative(s) before further manufacture can take place. These L-3 programmes for the manufacture and despatch would clearly identify responsibilities of the Contractor, sub-Contractor and Owner. These networks shall be submitted within one (1) month of the date of finalisation of the various sub-contracts by the Contractor.

In case all the manufacture is being done by the Contractor then the L-2 programmes would be themselves amplified to cover details of the manufacture, inspection, clearance by Owner and despatch.

The Contractor shall also submit the programme for procurement of boughtout items, detailed shipping schedule and cash flow statement for Owner's approval.

1.04.04 Quality Assurance, Inspection and Expediting

The Contractor shall submit the list of manufacturers/sub-vendors from whom the equipment are expected to be procured and the quality assurance plans thereof for the manufacture shall be approved by the QA group of Owner before the manufacture is commenced. The list of major suppliers would be submitted along with the bid and this shall be mutually discussed and approval will be given by the Owner during contract negotiation meeting prior

to placement of Letter of Intent. This approved list will be binding to the bidder. In the said list, Owner reserves the right to include reputed/reliable vendors of his own choice. Regarding the various other sub-vendors, the list would be submitted within six (6) months of the award of the contract that shall be scrutinized by the Owner to accord approval. In such list Owner reserves the right to include vendors of his own choice. No further vendor approval will be given after twelve (12) months. On the quality plans, the customer hold points will also be identified based on which Owner would give clearance for the manufacture to proceed further.

Quality assurance/Inspection group of Owner or its representative would issue a material despatch clearance certificate (MDCC) after the inspection clearance which will enable the Contractor to despatch the equipment and claim the payment. In the despatch programme, the Contractor shall indicate a schedule of estimated programme, tonnages specifically identifying various oversize dimensioned consignments (ODC). Further the Contractor will also be required to ensure at all stages of shipment that packing of all shipments despatched are suitable for ocean freight to India, handling at the port of entry, inland transportation and preservation at site upto erection. All despatch details & item lists shall be made available to both Owner & site immediately after shipping.

The Contractor shall also expedite all despatches from their own works/works of their sub-vendors, so as to match with the various activities mentioned at 1.04.03 above.

1.04.05 Construction Management

Based on the L-1 Master Network Programme, within two (2) months of the issue of Letter of Intent, the Contractor shall submit a programme of construction/ erection/ commissioning, either in continuation with the manufacture and despatch or separately for the implementation. These programmes would be amplified showing when the civil drawings shall be released by him and construction of civil works shall be completed by him to facilitate start of erection and subsequent activities and shall form the basis for site execution and detailed monitoring. The three monthly rolling programme with the first month's programme being tentative based on the site conditions would be prepared based on these L-3 programmes. The Contractor shall also be involved along with the Owner to tie up detailed resource mobilisation plan over the period of time of the contract matching with the performance targets.

The L-3 programme would be jointly finalised by the site in charge of the Contractor with the Owner's project coordinator as well as the site planning representative. The erection programme will also identify the sequential erectable tonnages that are required for various equipment which should be taken care of in the despatch programmes.

Erection and commissioning of the equipment shall also be done under the supervision of experts from the respective equipment/ system supplier.

1.04.06 Spares Management

Alongwith the proposal for the plant and equipment, the Contractor shall also submit proposals/schedule for the following:

- a) Mandatory spares
- b) Recommended spares

While the award for mandatory spares will be finalised at the time of the award of contract, recommended spares will be finalised thereafter.

1.05.00 **Project Progress Review Meetings**

Keeping in mind the overall responsibility of the Contractor it is intended that periodic progress reviews on the entire activities of execution of the project will be held initially at least once in two (2) months at Hyderabad/site/ at the discretion of the Owner.. During peak period it may be held once in a month. These meetings will be attended by reasonably higher officials of the Contractor and their leading sub- contractors and will be used as a forum for discussing all areas where progress needs to be speeded up. Actions will be placed on the concerned agencies and decisions will be taken to expedite/speed up the progress. Minutes of such meetings will be issued reflecting the major discussions and decisions taken and circulated to all concerned for reference and action. The Contractor shall be further responsible for ensuring that suitable steps are taken to meet various targets decided upon such meetings.

In addition to the above, and to streamline the construction and erection at site, a suitable frequency and forum of periodic meetings between the Contractor and the Owner will be decided upon as part of erection coordination procedure. Site co-ordination meeting may be held on weekly basis.

1.06.00 **Owner's Consultant**

The Owner would appoint a consultant to assist him in some of the areas mentioned at 1.01.00 above. The details of interaction and procedures for coordination between Owner / Owner's Consultant and Contractor/ Contractor's project management team shall be finalised during contract negotiations.

1.07.00 **Commissioning Management**

1.07.01 For commissioning of the various equipment/system covered under the scope of contract, Owner will form an organisation structure which may consist of the following committees. The Contractor shall nominate his representative on one or more of the committee as decided by the Owner:

- a) Steering Committee
- b) Commissioning Panel.
- c) Working Parties
- d) Testing Teams.

1.07.02 Commissioning documents shall be prepared by the Contractor in the

following manner and submitted for Owner's approval :

a) Field Quality Plan

This document shall be prepared for the various equipment/ systems under commissioning and shall have the following objectives to fulfill and shall be submitted for Owner's approval at least six (6) months before their actual commissioning :

- i) Establish design data against which Plant Performance will be compared.
- ii) Set-out the testing objectives and proposals.
- iii) Define the documentation required.

b) Testing/Commissioning Schedule

These shall be prepared for the various equipment/systems under consideration and shall contain sections like detailed testing method, programme, safety, individual responsibility and results.

c) Standard Check Lists

Standard check lists are intended for use at the completion of erection to ensure correct erection, testing and to a limited extent operation for repetitive items.

1.07.03 Test Reports

After the completion of commissioning activity of equipment/ systems, the Contractor shall prepare the test reports which shall include all the relevant information related to various commissioning checks, tests carried out, any deviations/commissions noticed with respect to the intended design requirements, sequence of various commissioning activities as actually adopted vis-a-vis as recommended in the procedures, programme schedules achieved and any other such information as required. These test reports shall be submitted in requisite number of copies to the Owner and this should be duly signed jointly by the Owner/Consultant and the Contractor/Equipment supplier, who are involved during the commissioning activities.

2.00.00 **SITE SERVICES**

These services shall be rendered by the Bidder as part of the overall project management service. The services shall broadly include but not be limited to the following :

2.01.00 Arranging material despatch from the shop by rail/road and/or sea as applicable.

2.02.00 Monitoring movement of materials & follow-up as necessary with Railways, road transport, port clearance etc. from the time of despatch F.O.R. works/ F.O.B. port of shipment by Contractor till receipt of the same at site.

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- 2.03.00 Unloading of materials at Railway Station/Railway Siding inside project area/ Road Transportation, transportation to site store, assessment of lost/damaged items in transit and arranging insurance claims and replacement of lost/damaged items. The Contractor shall submit to the Engineer a report detailing all the receipts during the week as well as storing, preservation of material at site.
- 2.04.00 Issuing materials from site store/open yard from time to time for erection as per the construction programme. The Contractor shall be the custodian of all the materials issued till the plant is officially taken over by the Owner after complete erection and successful trial run & commissioning.
- 2.05.00 Transportation of materials to their respective places of erection and erection of the complete plant & equipment as supplied under this specification.
- 2.06.00 Trial run and commissioning of individual equipment/sub-systems and the plant as a whole to the satisfaction of the Owner, including supply of temporary equipment & services for chemical cleaning, steam blowing as well as performance guarantee tests.

Apart from Boiler, proper chemical cleaning shall be carried out in following pipe lines/equipment before commissioning

- a) Deaerator
- b) Boiler feed suction, recirculation leak-off lines
- c) Boiler Feed discharge line by passing heaters
- d) Attenuation lines
- e) Condensate suction & discharge piping upto deaerator by passing the feed water heaters.
- f) Fuel oil lines.

Provision for preservation of individual equipment after trial run and commissioning e.g. Nitrogen blanketing etc. as necessary shall also be in the scope of the Bidder.

Safe disposal of effluent after chemical cleaning shall be done by the contractor.

- 2.07.00 Supply and application of the final paints and first fill lubricants on all the equipment to be erected under this specification. Supply of chemicals, lub oils and other consumables upto COD.
- 2.08.00 For the purpose of erection and commissioning the Contractor's scope of work shall include but not be limited to the following :
- 2.08.01 Deployment of all skilled and unskilled manpower required for erection, supervision of erection, watch & ward, commissioning and other services to

	be rendered under this specification.
2.08.02	Deployment of all erection tools & tackle, construction machinery, transportation vehicles and all other implements in adequate number and size, appropriate for the erection work to be handled under the scope of this specification.
2.08.03	Supply of all consumables, e.g. welding electrodes, cleaning agents, diesel oil, grease, lubricant etc. as well as materials required for temporary supports, scaffolding etc. as necessary for such erection work except those listed under exclusion elsewhere in this specification.
2.08.04	Construction of all civil/structural/architectural works, including construction of foundation for all equipment supplied as required, grouting of equipment on foundation after alignment, and all other incidental civil activities as detailed elsewhere.
2.08.05	All structural steel fabrication and erection work as detailed elsewhere in the specification.
2.08.06	Providing support services for the Contractor's erection staff e.g. construction of site offices, temporary stores, residential accommodation and transport to work site for erection personnel, insurance cover, watch & ward for security and safety of the materials under the Contractor's custody etc. as required.
2.08.07	Maintaining proper documentation of all the site activities undertaken by the Contractor as per the proforma mutually agreed with the Owner; submitting monthly progress reports as also any such document as and when desired by the Owner; taking approval of all statutory authorities e.g. Boiler Inspector, Factory Inspector, Inspector of Explosives, Electrical Inspector etc. for respective portions of work under the jurisdiction of such statutes or laws.
2.08.08	The Contractor shall provide 'Industrial Relations' unit and 'Medical' unit to take care of his erection staff and the Owner shall have no obligation in the regard.
2.08.09	The successful Bidder shall arrange for Tower cranes of adequate capacity for speedy erection activities.
2.09.00	Site Organisation The Contractor shall maintain a site organisation of adequate strength in respect of manpower, construction machinery and other implements at all times for smooth execution of the contract. This organisation shall be reinforced from time to time, as required, to make up for slippages from the schedule without any commercial implication to the Owner. The site organisation shall be headed by a competent construction manager having sufficient authority to take decisions at site. On award of contract, the Contractor shall submit to the Owner a site organisation chart indicating the various levels of experts to be deployed on the job. The Owner reserves the right to reject or approve the list of personnel

proposed by the Contractor. The persons, whose bio-data have been approved by the Owner, will have to be posted at site and deviations in this regard will not generally be permitted.

The Contractor shall also submit to the Owner for approval a list of construction equipment, erection tools, tackle etc. prior to commencement of site activities. These tools & tackle shall not be removed from site without written permission of the Owner.

2.10.00 **General Guidelines for Field Activities**

2.10.01 The Contractor shall execute the works in a professional manner so as to achieve the target schedule without any sacrifice on quality and maintaining highest standards of safety and cleanliness.

2.10.02 The Contractor shall co-operate with the Owner and other Contractors working in site and arrange to perform his work in a manner so as to minimise interference with other Contractors' works. The Owner's engineer shall be notified promptly of any defect in other Contractor's works that could affect the Contractor's work. If rescheduling of Contractor's work is requested by the Owner's engineer in the interest of overall site activities, the same shall be complied with by the Contractor. In all cases of controversy, the decision of the Owner shall be final and binding on the Contractor without any commercial implication.

2.10.03 The Engineer shall hold weekly meetings of all the Contractors working at Site at a time and a place to be designated by the Engineer. The Contractor shall attend such meetings and take notes of discussions during the meeting and the decisions of the Engineer and shall strictly adhere to those decisions in performing his Work. In addition to the above weekly meeting, Engineer may call for other meetings either with individual contractors or with selected number of contractors and in such a case the Contractor, if called will also attend such meetings.

2.10.04 Time is the essence of the Contract and the Contractor shall be responsible for performance of his Work in accordance with the specified construction schedule. If at any time the Contractor is falling behind the schedule, he shall take necessary action to make good of such delays by increasing his work force or by working overtime or otherwise accelerate the progress of the work to comply with the schedule and shall communicate such action in writing to the Engineer, satisfying that his action will compensate for the delay. The Contractor shall not be allowed any extra compensation for such action.

2.10.05 The Engineer shall however not be responsible for provision of additional labour and or materials or supply or any other services to the Contractor except for the co-ordination work between various Contractors as set out earlier.

2.10.06 The works under execution shall be open to inspection & supervision by the Owner's engineer at all times. The Contractor shall give reasonable notice to the Owner before covering up or otherwise placing beyond the reach of inspection any work in order that same may be verified, if so desired by the Owner.

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- 2.10.07 Every effort shall be made to maintain the highest quality of workmanship by stringent supervision and inspection at every stage of execution. Manufacturer's instruction manual and guidelines on sequence of erection and precautions shall be strictly followed. Should any error or ambiguity be discovered in such documents, the same shall be brought to the notice of the Owner's engineer. Manufacturer's interpretation in such cases shall be binding on the Contractor.
- 2.10.08 The Contractor shall comply with all the rules and regulations of the local authorities, all statutory laws including Minimum Wages, Workmen Compensation etc. All registration and statutory inspection fees, if any, in respect of the work executed by the Contractor shall be to his account.
- 2.10.09 All the works such as cleaning, checking, leveling, blue matching, aligning, assembling, temporary erection for alignment, opening, dismantling of certain equipments for checking and cleaning, surface preparation, edge preparation, fabrication of tubes and pipes as per general engineering practice at site, cutting grinding, straightening, chamfering, filling, chipping, drilling, reaming, scrapping, shaping, fitting-up bolting/welding, etc., as may be applicable in such erection and are necessary to complete the work satisfactorily, are to be treated as incidental and the same shall be carried out by the Contractor as part of the work.
- 2.10.10 In case of any class of work for which there is no such specification as laid down in the contract such as, blue matching, welding of stainless steel parts, etc., the work shall be carried out in accordance with the instructions and requirements of the Engineer and as per the Standards.
- 2.10.11 It may sometimes be necessary to remove some of the erected structural members to facilitate erection of bigger/pre-assembled equipment. In such cases, the removal and re-erection of such members, which are essential, and if so agreed by the Engineer, will have to be done by the Contractor.
- 2.10.12 Attachment welding of necessary instrumentation tapping points, thermocouple pads, root valves, condensing vessels, flow nozzles and control valves etc., both for regular measurement and performance testing to be provided on equipment, its auxiliaries or pipelines covered within the scope of this tender, will also be the responsibility of the Contractor and the same will be done as per the instructions of Engineer. The erection and welding of all above items will be the Contractor's responsibility, even if :
- a) Product groups under which these items are re-leased are not covered in the scope of this tender.
 - b) Items are supplied by an agency other than the Contractor.
- 2.10.13 Preservation of all materials/equipment under custody of the Contractor during storage, pre-assembly & erection, commissioning etc., shall be the responsibility of the Contractor. All necessary preservatives and consumables like paints, etc., shall be arranged by the Contractor. Necessary touch up painting, periodic application of preservatives/paints on pressure parts/other equipment even after erection until completion of work shall be carried out by

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- the Contractor. The Contractor shall fabricate piping, install lub oil systems and carry out the acid cleaning of fabricated piping. The Contractor shall also service the lub. oil system, carryout the hydraulic test of oil coolers, etc.
- 2.10.14 It is responsibility of the Contractor to do the alignment etc. if necessary, repeatedly to satisfy Engineer, with all the necessary tools & tackle, manpower, etc. The alignment will be complete only when jointly certified so, by the Contractor's Engineer & Owner. Also the Contractor should ensure that the alignment is not disturbed afterwards.
- 2.10.15 Additional platforms for approaching different equipment as per site requirement, which may not be indicated in drawings, shall be fabricated and erected by the Contractor. The materials required for these works shall be supplied by the Contractor and he will have to fabricate them to suit the requirement.
- 2.10.16 Equipment and material which are wrongly installed shall be removed and reinstalled to comply with the design requirement at the Contractor's expense, to the satisfaction of the Owner/ Consultant.
- 2.10.17 Before erection of any equipment on a foundation, the Contractor shall check and undertake if necessary rectification of foundation bolts, reaming of holes, drilling of dowels, matching of bolts and nuts, making new dowel pin, etc.
- 2.10.18 Assistance for calibrating/testing the power cylinders, valves, gauges, instruments, etc., and setting of actuators coming under various groups shall be provided by Contractor.
- 2.10.19 It shall be the responsibility of the Contractor to provide ladders on columns for initial works till such time stairways are completed. For this, the ladder should not be welded on the column and should be prefabricated clamping type. No temporary welding on any structural member is permitted except under special circumstances with the approval of Owner.
- 2.10.20 Structural materials required for the supporting/operating platforms required for the valves at various levels for the same operation of valves will be arranged by the Contractor.
- 2.10.21 For civil, structural and architectural works, volume VII-A, VII-B, VII-C may be referred. For Instrumentation and Electrical works Vol. VI, V-A and V-B may be referred.
- 2.11.00 **Safety**
- Safety and overall cleanliness of work site shall be given top priority.
- 2.11.01 The Contractor shall ensure the safety of all workmen, materials and equipment either belonging to him or to others working at site. He shall observe safety rules & codes applied by the Owner at site without exception.
- 2.11.02 The Contractor shall notify the Owner of his intention to bring to site any equipment or material which may create hazard. The Owner shall have the right to prescribe the conditions under which such equipment or material may be

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- handled and the Contractor shall adhere to such instructions. The Owner may prohibit the use of any construction machinery, which according to him is unsafe. No claim for compensation due to such prohibition will be entertained by the Owner.
- 2.11.03 Storage of petroleum products & explosives for construction work shall be as per rules and regulation laid down in Petroleum Act, Explosive Act and Petroleum and Carbide of Calcium Manual. Approvals as necessary from Chief Inspector of Explosives or other statutory authorities shall be the responsibility of the Contractor.
- 2.11.04 The Contractor shall be responsible for safe storage of his and his sub-contractor's radioactive sources.
- 2.11.05 All requisite tests & inspection of handling equipment, lifting tools & tackle shall be done by the Contractor and certified copies shall be supplied to the Owner. Defective equipment shall be removed from service. Any equipment shall not be loaded in excess of its recommended safe working load.
- 2.11.06 All combustible waste and rubbish shall be collected and removed from the worksite at least once each day. Use of undercoated canvas paper, corrugated paper, fabricated carton, plastic or other flammable materials shall be restricted to the minimum and promptly removed.
- 2.11.07 The Contractor shall provide adequate number of fire protection equipment of the required types for his stores, office, temporary structures, labour colony etc. Personnel trained for fire-fighting shall be made available by the Contractor at site during the entire period of the Contract.
- 2.11.08 All electrical appliances used in the work shall be in good working condition and shall be properly earthed. No maintenance work shall be carried out on live equipment. The Contractor shall maintain adequate number of qualified electricians to maintain his temporary electrical installation.
- 2.11.09 All workmen of the Contractor working in construction site shall wear safety helmets, safety boots and safety belts. The Contractor shall take appropriate insurance cover against accidents for his workmen as well as third party.
- 2.11.10 All the worksites shall be provided with adequate lighting facilities e.g. flood lighting, hand lamps, area lighting etc. by the Contractor for proper working environment during night times.
- 2.11.11 All safety precautions shall be taken for welding and cutting operations as per IS-818.
- 2.11.12 All safety precautions shall be taken for foundation and other excavation marks as per IS-3764.
- 2.12.00 **Taking Delivery & Storage**
- 2.12.01 The Contractor shall arrange issue of all equipment and materials to be erected under the contract from the stores/open yard at site by signing on standard indent forms. After completion of work, detailed auditing of the

	materials so issued shall be submitted to the Owner.
2.12.02	The Contractor shall arrange for proper and safe storage of materials till the same are taken over by the Owner as per terms of the contract. Manufacturer's instructions for preservation shall be strictly followed.
2.12.03	All empty containers, packing materials, gunny bags, transport frames and also surplus and unused materials reconciliation prior to completion of contract shall be the property of the Owner and returned to the Owner by the Contractor.
2.13.00	Site Welding & Heat Treatment
2.13.01	Welding shall be done in accordance with IS-813, IS-816, IS-9595 & other relevant IS/International standards and as per instructions of Contractor. Only those welders, who are qualified as per IS-817 for ordinary welds and as per IBR/ASME Section-IX for high pressure welds, shall be employed in the job.
2.13.02	All welders shall be tested and approved by Engineer before they are actually engaged on the work even though they may possess the requisite certificates. The Owner reserves the right to reject any welder without assigning any reason. The welder identification code as approved by the Engineer shall be stamped by the welder on each joint done by them. The Contractor will be responsible for the periodic renewal, re-testing of the welders as demanded by Owner.
2.13.03	The Engineer is entitled to stop Contractor's any welder from his work if his work is unsatisfactory for any technical reason or there is a high percentage of the rejection of joints welded by him, which in the opinion of Engineer will adversely affect the quality of welding even though the welder has earlier passed the tests. The welders having passed the tests do not relieve the Contractor from his contractual obligations, to check the performance of the welders.
2.13.04	All charges for testing of welders including destructive and non- destructive tests if conducted by Owner or by the inspection authority at site shall have to be borne by the Contractor. The necessary test materials and consumables will have to be arranged by the Contractor and all testing facility made available, as required.
2.13.05	All welded joints shall be subject to acceptance by Engineer. Inspection of welds shall be in accordance with IS-822 or equivalent code.
2.13.06	Preheating/post heating and stress relieving after welding are part of fabrication and erection work and shall be performed by the Contractor in accordance with the instruction of Engineer. Contractor shall arrange to supply heating equipment with automatic recording devices. Also the Contractor shall have to arrange for the labour, heating elements, thermocouples, compensating cables, insulation materials like mineral wools, asbestos cloth, ceramic beads, asbestos rope, etc. required for the heat-treatment and stress relieving works. During pre- heat/stress relieving operations, the temperature shall be measured at one or more points as required by attaching thermocouples and recorded on a continuous printing

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- type recorder. All the record graphs for the heat treatment works carried out shall be got signed by the Engineer prior to the commencement of each cycle and handed over to Engineer on completion. The graphs will be the property of Owner. The Contractor has to provide thermo-chalks temperature recorders, thermocouple attachments, units, graph sheets, etc. required for the job and maintain them in good condition.
- 2.13.07 All electrodes shall be baked and dried in the electric/electrode drying oven to the required temperature and for the period specified by the Engineer before they are used in erection work. The electrodes used shall be as per IS-814, IS-815, IS-1442, IS-7280 and other codes as applicable, and shall be of approved reputed manufacture. The electrodes shall meet the requirement of the pipe material. No electrode manufactured more than 12 months ago and the type covered under certificate issued after conducting tests more than 6 months ago shall be used. All electrodes shall be preserved at works and at site as per manufacturer's recommendations.
- 2.13.08 Oxy-acetylene flame or Exothermic chemical heating for stress relieving is not permitted. Heating shall be by means, of electric induction coil or electric resistance coil.
- 2.13.09 It may become necessary to adopt inter layer radiography/MPT/UT depending upon the site/technical requirement necessitating interruptions in continuation of the work and making necessary arrangement for carrying out the above work.
- 2.13.10 Gas tungsten arc welding process (TIG) shall be adopted for all root pass welds except for structural works until 4.75 mm thickness is deposited. Subsequent welding after root pass can be carried out by manual metal arc welding with coated electrodes. For pipes of thickness less than 6 mm the entire welding has to be carried out by TIG welding.
- Fillet weld shall be made by shielded metal arc process as per applicable codes.
- However, the Engineer will have the option of changing the method of welding as per site requirement. The method adopted for manual arc welding shall be weaving technique and the width of weaving shall not exceed 1.5 times of the dia. of the electrode.
- In case of deviation from welding process and electrodes, the Contractor shall take approval of the Owner prior to adoption of same.
- 2.13.11 The root pass for butt joints shall be such as to achieve full penetration with complete fusion of root edges.
- 2.13.12 Each pass shall be cleared and freed of slag before the next pass is deposited.
- 2.13.13 On completion of each run, craters, weld irregularities, slag etc. shall be removed by grinding or chipping.
- 2.13.14 Each layer of welding shall have an even and smooth appearance.
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- 2.13.15 Welding sequence shall be adjusted in such a way that distortion due to welding shrinkage is minimised. Further any movement, shock or vibration during welding shall be avoided to prevent weld cracks.
- 2.13.16 Proper protection of welders and the work shall be taken during periods of rain. No welding shall be carried out when surface to be welded are wet from any cause.
- 2.13.17 Following will be stages of inspection during welding :
- a) Two pieces to be joined shall be individually checked for the weld edge preparation and profile dimensionally and to the template. Dye penetrant check shall be carried out on edge prepared surfaces at random. The percentage will depend upon on criticality as specified by Engineer.
 - b) Joint fit up will be a stage of inspection. Misalignment after fit up may vary from 0.3 mm to 1.6 mm depending on outside diameter and thickness.
 - c) All joints shall be offered for visual inspection after root run. Subsequent welding should be made only after the approval of root run.
- 2.13.18 All welded joints shall be painted with anti-corrosive paint immediately on completion of radiography and stress-relieving.
- 2.14.00 For further details on procedures of work at site on civil, architectural, electrical and instrumentation & control services, refer Volume : V, VI & VII of this specification.
- 3.00.00 **PROJECT INFORMATION AND MANAGEMENT SYSTEM, INCLUDING DCOUMENT MANAGMENT SERVER (DMS)**
- 3.01.00 Contractor shall submit as part of its Work Scope detailed documentation as outlined in this section and / or required by the Technical Requirements. The content and format of the documentation to be submitted are subject to Owner's approval.
- 3.02.00 Contractor shall utilise a computer based system for control and management of project documentation. The system must be capable of producing customized reports and information on demand. This control system should have been successfully applied to similar projects and be familiar to the project control personnel selected. Contractor's detailed project documentation plan shall identify all documentation requirements for the project, the party responsible for production of the document, the basic content of the document and the required timing for issue. This plan shall include, but not be limited to the details of all Drawings to be produced, plant specification / definition documentation, equipment orders and manuals. The documentation identified shall be entered into the computer based control system The database thus created shall be capable of being sorted and

ordered on a variety of selected parameters such as document type, subject description, responsible party, start date and finish date, to enable review and update to be conducted only on those documents which are relevant.

3.03.00 Regular documentation control progress reports shall be prepared by the Contractor to record the status of documentation. In the event either Party or Engineer expresses concern with the content of such progress reports, the accuracy of progress reports, status of documentation production and other such matters, the concern will be identified to the Project Manager. Within five days of notification of this concern, the Project Manager will attend a meeting with relevant Owner Representatives and provide details of specific actions to be initiated to satisfactorily overcome the difficulties identified. It will be the Project Manager's responsibility to initiate whatever action is necessary to ensure that the production of documentation is completely in accordance with Project Information Management System (PIMS).

3.04.00 Within 90 days after Effective Date of Contract, the Contractor shall establish an integrated PIMS which will support the needs of Project and management, detail design and engineering, procurement, construction and operation, and maintenance.

PIMS shall utilise software which links various software and database programs to form a composite system. The typical scope of PIMS shall include, but not be limited to, the following:

- (a) Power plant systems and equipment data, from which Project specific flow diagrams, data sheets and other integrated data are derived. The Power plant systems and equipment data, from which Project specific flow diagrams, data sheets and other integrated data are derived. This data shall include, but not be limited to, the following:
 - (i) System descriptions and design requirements and design criteria
 - (ii) Equipment and material technical specifications for all engineering disciplines
- (b) Detail engineering data to create flow diagrams, plant arrangements, piping configurations, equipment layout and design, electrical and instrumentation systems, structures, and other systems. The software tool used shall be capable of manipulation and storage of plant layout and design information. The 3D model of the plant shall also contain details of the various components like pipe, structural steel work, etc., and relevant information shall be available on-line from relevant data base. Software shall be multi-user, multi-access nature allowing the designers of Contractor and major Sub-Contractors, if required, to work in interactive real time environment and software shall be capable of interference checking. The software shall allow access to different types of information held in the database. It shall estimate the type and quantity of materials required to build the plant and it shall be possible for such data to be taken off the system at any time.

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- (c) Construction data to monitor and manage site activities, including material control, scheduling and progress, quality control, start-up and testing, operation, maintenance, training, and all other site functions.
 - (d) Plant design and construction records to provide data for safe and efficient maintenance and operation. Records to include may be maintenance schedule, man power tracking, tools, spare parts, and test equipment inventory, equipment list, drawing, control, technical specifications, and equipment instruction manuals.

3.05.00 The PIMS shall be installed in a distributed processing array system and operated through personal computer work stations at the Contractor's site office. A complete integrated system shall be implemented. This system shall be utilised by Contractor during the Project execution.

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ENGINEERING SERVICES

DEVELOPMENT CONSULTANTS
(e-PCT-TS-K-02-2014-15-Vol. IIA-6&7.doc)

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ATTACHMENTS

ANNEXURE-1	DISTRIBUTION SCHEDULE
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DEVELOPMENT CONSULTANTS

(e-PCT-TS-K-02-2014-15-Vol. IIA-6&7.doc)

ENGINEERING SERVICES

1.00.00 **GENERAL**

1.01.00 As part of the overall project management activity, the Contractor shall be responsible for proper engineering and co-ordination of activities during various phases of execution of the contract. The Contractor shall identify a person, designated as Project Manager, with whom the Owner, the Consulting Engineer or the Review Consultant shall interact on matters related to engineering as well as execution of the contract. The Project Manager shall be the single-point contact person on behalf of the Contractor and shall be responsible for all engineering co-ordination. The Owner/Consultant/Review Consultant shall interact with the Project Manager only on all matters of co-ordination between the Owner and the Contractor or on matters involving the Contractor, his manufacturing units and sub-vendors. For the purpose of expediting the Owner or his representative may sometimes interact with the manufacturing units or sub-vendors of the contractors. However such interaction will not, under any circumstance, dilute the responsibility of the Contractor to provide a fully engineered and co-ordinated package under this contract.

1.02.00 On finalization of the contract, a procedure for exchange of engineering information will be mutually agreed and finalized between the Owner and the Contractor.

2.00.00 **DESIGN COORDINATION MEETING**

The Contractor and his sub-vendors will be called upon to attend design co-ordination meetings with the Engineer, other Contractors and the Consultants of the Owner during the period of execution of contract. The Contractor including his sub-vendors shall attend such meetings at their own cost at Owner's or Consultant's office in Kolkata or at mutually agreed venue as and when required and fully cooperate with such persons and agencies involved during those discussions.

3.00.00 **CO-OPERATION WITH OTHER CONTRACTORS AND CONSULTING ENGINEERS**

The Contractor shall agree to cooperate with the Owner's other Contractors and Consulting Engineers and freely exchange with them such technical information as is necessary to obtain the most efficient and economical design and to avoid unnecessary duplication of efforts. The Engineer shall be provided with copies of all correspondences addressed by the Contractor to other Sub- contractors and Consulting Engineers in respect of such exchange of technical information.

4.00.00	GUIDELINES FOR ENGINEERING SERVICES
4.01.00	Prior to commencement of the engineering work as part of design submissions, all aspects of design viz., criteria for selection and sizing of all equipment and systems, design margins etc. including that for structural steel and civil work shall be outlined and these shall form the basis for the detailed engineering work.
4.02.00	Engineering work shall be performed on modern and proven concepts and internationally accepted good engineering practices but fully compatible with the Indian environments. Owner shall have the right to review and approve the engineering work by themselves and/or through consultant and ask for any clarifications and changes/modifications to the work performed by Contractor.
4.03.00	At any stage during the performance of assignment, the Contractor may be required to make certain changes/modification/improvements in design/drawing/other documents which are applicable to 800 MW Unit, which in the opinion of the Owner could result in better improved design, layout, operability, plant availability, maintainability, reliability or economy of the plant and its systems/sub-systems in view of revised and more accurate information/data available at a later date(s) or feedback(s) received during execution / operation of similar units. Such changes / modifications/improvements required could be identified by Owner and/or consultant and mutually discussed. Owner requires the Bidder to incorporate such action in the subject assignment appropriately without any additional cost liability and time implication to the Owner and same shall be within the responsibilities and scope of the Contractor.
4.04.00	During the course of review of detailed engineering stages, it may be essential in the opinion of Owner to obtain certain classified data for review purposes only. In case Owner so desires, the Bidder shall submit such data to Owner.
4.05.00	During the course of review of detailed engineering, it may be essential in Owner's opinion to obtain data and information on similar equipment and plants engineered by the Bidder. In case Owner so desires the Bidder shall submit such data and information to the Owner.
4.06.00	It is not the intent to give details of every single task covered in the total engineering work to be carried out by Contractor, however, all engineering work required for the satisfactory completion of the plant/systems as specified shall be carried out by the Contractor. Broadly, the following are the minimum requirements in respect of scope of major items of work:
4.06.01	Preparation, updating and finalisation of scheme drawings, control and interlock diagrams, detailed and fully dimensioned layout drawings (plant layout and equipment layout detailed plan, elevation and cross-sectional drawings at different elevations / floor levels) covering all mechanical, electrical, C&I, civil and structural items, equipment, systems and facilities. Drawings and Schedules prepared by the Contractor from time to time, as detailed designs are developed, shall be submitted for Owner's / Consultant's

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	approval before the work is taken up. Revisions, corrections, additions to drawings and schedules shall not be considered to change the scope of work.
4.06.02	Preparation of detailed technical specifications including data sheets, tender drawings and bill of material for all bought out items, as also finalisation of corresponding sub-contractors.
4.06.03	Review of sub-contractor's data, drawings, design calculations, schedules, bill of materials, instruction manuals etc. for all equipment, before forwarding them to Owner/Consultant for approval.
4.06.04	Preparation of civil construction drawings for all equipment showing foundation details and full details regarding equipment loads, floor openings, details of embedments etc. required for preparation of civil construction drawings and also as referred at relevant sections of Scope, Terminal Points & Exclusions. These documents shall be preceded by appropriate design calculations, static and dynamic analysis as necessary.
4.06.05	Preparation and finalisation of process piping and instrumentation diagrams and schematics, complete in all respects for all systems/packages of the power plant.
4.06.06	Preparation of consolidated schedules and bills of materials, including line numbers, tag numbers, source of supply, service conditions, specifications, materials, types and connections details, quantities for items of the plant including dampers, steam traps, strainers, instrumentations, ducting.
4.06.07	Sizing of all piping and equipment as per the stipulated design criteria; carrying out of flexibility analysis/dynamic analysis as necessary; hangers & support engineering.
4.06.08	Final revision of all documents including preparation and compilation of Instruction Manuals for installation, commissioning, operation and maintenance for all equipment and systems. Refer clause 5.00.00 for the specific requirement in this regard.
4.06.09	Certification and submission of final as-built drawings for all areas.
4.06.10	Preparation and compilation of all drawings, schedules and instructions which may be required at site, whether separately mentioned or not.
4.06.11	All erection and assembly drawings which may be required at site.
4.06.12	For all bought out item packages, the Contractor shall provide complete material / component list along with detail specification, drawings, component part no. etc. during detail engineering stage prior to final approval. Such approved drawing/document shall be made available at site in adequate number prior to commencement of work. Moreover, such document/drawing shall be provided in soft form (CD)
4.06.13	Preparation of necessary documentation, design calculations etc. required for submission to statutory authorities like IBR, Chief Electric Inspector, Factory Inspector etc.

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5.00.00 OPERATING MANUALS AND MAINTENANCE INSTRUCTIONS

5.01.00 The Contractor shall provide at least six (6) months before the time of commissioning and before taking over of the plant and equipment, all necessary maintenance manuals and operating instructions. The instruction manual shall be submitted in the form of one (1) soft copy in CD and 15 hard copies as per distribution schedule (Annexure-1).

5.02.00 The information provided, which shall be contained in loose leaf stiff backed covers, shall include :

- a) A complete inventory of all main items of plant, with identification details.
- b) Service manuals for all plant and equipment giving full descriptions of the main items and auxiliary items such as power packs, hydraulic equipment, actuators, lubricating pumps, etc.
- c) A separate electrical manual covering items such as switchgear, cabling, instrumentation, controls, cabling layouts and wiring diagrams.
- d) A schedule of recommendations for routine maintenance of all electrical and mechanical equipment, recommended inspection point, information on detection, cause and rectifications of troubles & faults.
- e) A lubrication schedule with all necessary drawings diagrams to identify the lubrication points.
- f) Manufacturer's literature.

5.03.00 The instruction manual shall be subject to the approval of Owner.

6.00.00 PLANT HANDBOOK

The Contractor shall submit to the Engineer, a preliminary plant handbook preferably in A-4 size sheets which shall contain the design and performance data of various plant, equipment and systems covering the complete project including single line flow diagrams, within twenty four (24) months from the date of his acceptance of the Letter of Intent. The final plant handbook complete in all respects shall be submitted by the Contractor six (6) months before start-up and commissioning activities. The plant handbook shall be submitted as per distribution schedule.

7.00.00 CONTRACT STAGE DOCUMENT SUBMISSION AND APPROVAL PROCEDURE

7.01.00 Within fifteen (15) days to one month of issue of Letter of Intent (LOI) by the Owner, the Contractor shall furnish a schedule of drawings and design

document to be submitted by him to the Owner/Engineer indicating dates against each document.

The documents shall be divided into two categories : a) for approval and b) for information/further engineering and co-ordination by the Owner.

In preparing this schedule, the Contractor shall allow two (2) weeks from date of receipt for review and comments by the Owner/Engineer for each submission of a document.

This document submission schedule shall require approval by the Owner/Engineer.

7.02.00 All contract documents shall be marked, without fail, with the name of the Owner, the Project, the specification title and number and the unit designation.

All dimensions shall be in metric units.

All notes, markings etc. shall be in English.

7.03.00 Documents/Drawings, submitted during tender stage, shall be revalidated or revised as required and submitted as certified contract document for approval / information of the Owner/Engineer.

7.04.00 Unless specified otherwise, the following categories of documents/drawings would require approval of the Owner/Engineer:

- a) List of sub-vendors (from Owner only)
- b) System scheme and instrumentation diagrams
- c) Design basis justifying selection of equipment & process parameters where not specified in the Contract
- d) Equipment data sheets and general arrangement drawings
- e) Materials of construction
- f) Layout drawings.
- g) Operation logic diagrams.
- h) Typical control circuit.
- i) Drawings of Instrumentation and control.

7.05.00 Unless specified otherwise, the following categories of documents/ drawings would be treated for information/further engineering by the Owner/Engineer. The Contractor shall, however, incorporate all additional information and clarifications in these documents / drawings as and when desired by the Owner/Engineer.

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- a) Equipment foundation drawings.
 - b) Equipment cross-section drawings, product literature etc. which are of proprietary nature.
 - c) Predicted performance curves of equipment.
 - d) Various bills of quantity, schedules etc.
 - e) Piping fabrication drawings, isometrics etc.
 - f) Panel wiring diagrams.
 - g) Instruction/Operation manuals.
 - h) Service manuals and trouble shooting guide for C & I system including field instruments.
 - i) Cable schedule and interconnection chart.
 - j) Drive/feederwise control scheme showing all external interfaces.

In essence, the Contractor is solely responsible for corrections and adequacy of design & engineering for documents under this category.

7.06.00 Upon review, the Owner/Engineer shall put his remarks and one of the following action stamps on the drawing/document:

- a) A - Drawing submitted as approved, proceed with fabrication
- b) B - Drawing approved subject to comments noted, proceed with fabrication, considering our comments. Correct as necessary and resubmit for record.
- c) C - See attached memo.
- d) D - Correct your original drawing incorporating our comments and resubmit for approval.
- e) E - Information furnished is noted.
- f) F - Prints not enclosed

For action stamps in category (c) & (d), documents must be resubmitted for review by the Owner/Engineer. For action stamp in category (b), further review by Owner/Engineer would not be necessary provided the Contractor agrees & incorporates the comments made on the document.

Except for action stamp under category (c) & (d), the Contractor can proceed with manufacturing and other sequential activities for those areas of a drawing/document which do not have any review comment by the Owner/Engineer.

The Owner/Engineer may accord approval in category (c) or (d) in more than one submission of a document till he is satisfied that the intent of the specification has been fully complied with. The Contractor shall be responsible for delay in such cases and no extension of time shall ordinarily be allowed on such grounds. Approval of contract documents by the Owner/Engineer shall not relieve the Contractor of his responsibility for any errors and fulfillment of contract requirements.

The Contractor's work shall be in strict accordance with the finally approved drawings and no deviation shall be permitted without written approval of the Owner/Engineer.

7.07.00 Except key plan/general yard plan, any layout drawing requiring scrutiny shall not be drawn to a scale less than 1:50.

7.08.00 For review by the Consulting Engineer, the Contractor shall furnish soft copies of drawings & documents and three (3) prints of each drawing/document. Two (2) prints of such submission shall also be sent to the Owner. After review, comment/approval will be sent to the Contractor. Upon action under category (a) or (e), the Contractor shall directly distribute the documents to the various offices of the Owner and other agencies in number of copies as specified in the contract document. Such distribution copies shall be marked with the reference and date of the letter by which the Owner/Engineer has accorded his final approval. Penal action shall be taken against the Contractor for any unauthorised revision in the drawings so distributed from the drawings approved by the Owner/Engineer. The contractor shall furnish three (3) CDs of all as built/final drawings for Owner/Consultant site.

7.09.00 In case of contradiction between the stipulations above and those stated elsewhere in the specification, the stipulations herein shall prevail.

7.10.00 For details of documentation for Civil, Structural and Architectural works, VII-A, VII-B and VII-C may be referred.

8.00.00 **TENDER STAGE DOCUMENT SUBMISSION**

8.01.00 The Bidder shall submit along with his bid all documents/drawings as requested in respective specifications. The documents shall include but not be limited to the following :

- a) All Bid proposal sheets duly filled up.
- b) Detailed experience list and financial resources of the prime bidder his collaborators/associates in this bid as well as the sub-vendors proposed.
- c) Scheme drawings indicating scope of supply and service as offered by the Bidder indicating clearly exclusions, if any.
- d) List of terminal points of the package offered together with quality and quantity of various input (i.e. water, air, electricity etc.) as required from the Owner at such interfaces.

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- e) Equipment GA, Layout, Design Calculations, interlock and other write-up, catalogues/literature etc. as required for clear understanding of the bid submitted.
 - f) L-1 network indicating target dates for intermediate milestones and final commissioning of equipment supplied; This network shall be supplemented by a detailed write-up on proposal procedure of project implementation, deployment schedule for Key personnel with their bio-data, schedule of construction machinery etc.
 - g) List of suppliers for all bought out items.

ANNEXURE-1**DISTRIBUTION SCHEDULE**

S. No	Description	TSGENCO								M/S DCPL, KOLKATA			Equipment Vendor	Remarks
		Director Projects	Director Technical	CE/Civil Thermal Projects Hyd.	CE/ TPC-I, Hyd	CE/ O&M/ KTPS	SE/ Civil KTPS	SE/E&M / KTPS	DE Constr. KTPS	Kolkata	HYD	KTPS		
A	Letter Of Intent or Contract Documents	1	1	1	S	1	2	2	1	1	1	1	2	
B	Vendor Drawings													
1.	Preliminary	1	1	1	2	1	1	2	2	12	1	-	S	
2.	Return preliminary with comments	-	-	1	2	1	1	1	1	S	1	-	1	
3.	Final and any revision thereof													
	a. Civil	1	1	6+1T	1	1	6+1T	1	-	2+1T	1	1	S	
	b. E&M	1	1	1	6+1T	1	1	6+1T	1	2+1T	1	1	S	
C.	Design Drawings													
1.	Preliminary													
	a. Civil	1	1	2	1	1	2	1	1	4	1	1	S	
	b. E&M	1	1	1	2	1	1	2	1	4	1	1	S	
2.	Released for construction													
	a. Civil	1	1	2	1	1	6	1	1	1	1	2	S	
	b. E&M	1	1	1	1	2	1	6	1	1	1	2	S	
3.	Return marked 'As built'													
	a. Civil	-	-	1	-	-	1	-	-	1	1	S	1	
	b. E&M	-	-	-	1	-	-	1	1	1	1	S	1	
4.	As built drawings													
	a. Civil	-	-	1+1T	-	2+1T	5+1T	-	1	1+1T	-	1	S	
	b. E&M	-	-	1	2+1T	2+1T	-	5+1T	1+1T	1+1T	-	1	S	

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S. No	Description	TSGENCO								M/S DCPL, KOLKATA			Equipment Vendor	Remarks
		Director Projects	Director Technical	CE/Civil Thermal Projects Hyd.	CE/ TPC-I, Hyd	CE/ O&M/ KTPS	SE/ Civil KTPS	SE/E&M / KTPS	DE Constr. KTPS	Kolkata	HYD	KTPS		
D	Progress Report Monthly													
1.	Equipment vendor	1	1	1	2	1	1	2	1	1	1	1	S	
2.	M/s DCPL, Kolkata	1	1	2	2	1	1	2	1	S	1	1	Nil	
E	Test & Inspection Reports													
1.	Equipment manufacturer													
	a. Civil	1	1	1	2	1	1	1	-	11	1	1	S	
s	b. E&M	1	1	-	2	1	-	1	1	11	1	1	S	
2.	M/s DCPL, Kolkata	1	1	-	2	1	-	1	1	S	-	1	-	
F	Instruction Manuals/Data Books													
1.	Equipment manufacturer													
	a. Civil	1	1	1+1T	1	1	6+1T	1	1	2+1T	1	1	S	
	b. E&M	1	1	-	3+1T	1	-	6+1T	2	3+1T	1	1	S	
2.	M/s DCPL, Kolkata	1	1	-	10+1T	1	-	15+1T	-	S	1	1	Nil	
G	M/s DCPL, Kolkata Criteria	1	1	1	8+1T	1	1	2	1	1	1	1	S	
H	Design Calculations	1	1	1	8+1T	1	1	2	1	1	1	1	S	
I	Final consulting Engineering Report	1	1	1	10	1	1	2	1	S	1	1	Nil	

S – Source, T – Transparency & Soft Copy on CD,

TSGENCO : Telangana State Power Generation Corporation Limited

Director, Projects, Hyd : Director/ Projects, TSGENCO, Vidyut Soudha, Hyderabad – 500 082

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Director, Technical, Hyd	:	Director/ Technical, TSGENCO, Vidyut Soudha, Hyderabad – 500 082
CE/ Civil, Hyd	:	Chief Engineer/Civil, Thermal Projects, TSGENCO, Vidyut Soudha, Hyderabad – 500 082
CE/ TPC-I, Hyd	:	Chief Engineer/TPC, TSGENCO, Vidyut Soudha, Hyderabad – 500 082
CE/ O&M/ KTPS	:	Chief Engineer(O&M), KTPS, Kothagudem, Telangana
SE/Civil, KTPS	:	Superintending Engineer (Civil), KTPS, Kothagudem, Telangana
SE/E&M, KTPS	:	Superintending Engineer (E&M), KTPS, Kothagudem, Telangana
DE/Constr./ KTPS	:	Divisional Enginer/Constrcution, KTPS, Kothagudem, Telangana
M/s DCPL, Kolkata	:	M/s DCPL, Kolkata.
M/s DCPL, Hyd	:	M/s DCPL, Hyderabad.
M/s DCPL, KTPS	:	M/s DCPL, KTPS, Kothagudem, Telangana

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QUALITY ASSURANCE REQUIREMENTS

CONTENT

CLAUSE NO.	DESCRIPTION
1.00.00	QUALITY ASSURANCE PROGRAMME
2.00.00	GENERAL REQUIREMENTS QUALITY ASSURANCE
3.00.00	QUALITY ASSURANCE DOCUMENTS
4.00.00	INSPECTION, TESTING & INSPECTION CERTIFICATES

ATTACHMENTS

ANNEXURE-I	FORMAT OF QUALITY ASSURANCE PROGRAMME
ANNEXURE-II	FIELD WELDING SCHEDULE

QUALITY ASSURANCE REQUIREMENTS

1.00.00 QUALITY ASSURANCE PROGRAMME

1.01.00 To ensure that the equipment and services under the scope of Contract whether manufactured or performed within the Contractor's works or at his Sub-contractor's premises or at the Owner's site or at any other place or work are in accordance with the specifications, the Contractor shall adopt suitable quality assurance programme to control such activities at all points, as necessary. Such programmes shall be outlined by the Contractor and shall be finally accepted by the Owner/Authorised representative after discussions before the award of contract. A quality assurance programme of the Contractor shall generally cover the following :

- a) His organisation structure for the management and implementation of the proposed quality assurance programme.
- b) Documentation control system.
- c) Qualification data for Bidder's key personnel.
- d) The procedure for purchase of materials, parts, components and selection of Sub-contractor's services including vendor analysis, source inspection, incoming raw-material inspection, verification of materials purchased etc.
- e) System for shop manufacturing and site erection control including process controls and fabrication and assembly controls.
- f) Control of non-conforming items and system for corrective actions.
- g) Inspection and test procedure both for manufacture and all site related works.
- h) Control of calibration and testing of measuring and testing equipments.
- i) System for quality audit.
- j) System for indication and appraisal of inspection status.
- k) System for authorising release of manufactured product to the Owner.
- l) System for handling storage and delivery.
- m) System for maintenance of records.

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- n) Furnishing of quality plans for manufacturing and field activities detailing out the specific quality control procedure adopted for controlling the quality characteristics relevant to each item of equipment/component as per format enclosed at Annexure-I to this section for Owners approval
 - o) Internal standards, if referred in the quality plans shall generally be compatible with National / International standards and shall be mentioned in the quality plans. Alternatively bidder shall furnish extracts of the internal standards detailing out acceptance norm for the product / material.

2.00.00 GENERAL REQUIREMENTS - QUALITY ASSURANCE

2.01.00 All materials, components and equipment covered under this specification shall be procured, manufactured, erected, commissioned and tested at all the stages, as per a comprehensive Quality Assurance Programme. An indicative programme of inspection/tests to be carried out by the Contractor for some of the major items is given in the respective technical specification. This is however, not intended to form a comprehensive programme as it is the Contractor's responsibility to draw up and implement such programme duly approved by the Owner/Consultant. The detailed Quality Plans for manufacturing and field activities should be drawn up by the Bidder, separately in the format attached at Annexure-I and will be submitted to Owner/Authorised representative for approval. Schedule of finalisation of such quality plans will be finalised before award.

Contractor shall furnish list of Manufacturing Quality Plans of major equipments indicating proposed inspection categorisation indicating items that will be offered for Owner's inspection etc and the Field Quality Plans

2.02.00 Manufacturing Quality Plan for all the major equipment will detail out their respective important components, their in-process various tests/inspection & final inspection / tests, to be carried out as per the requirements of this specification and standards mentioned therein and quality practices and procedures followed by Contractor's Quality Control organization. The relevant reference documents and standards, acceptance norms, inspection documents raised etc., during all stages of materials procurement, manufacture, assembly and final testing/performance testing are to be comprehensibly documented by Contractor.

Manufacturing Quality Plan for all major equipments/ items will be approved by owner. In these approved quality plans, Owner / Authorised representative shall identify customer hold points (CHP), test / checks which shall be carried out in presence of the Owners Engineer or his authorised representative and beyond which the work shall not proceed without consent of Owner / Authorised representative in writing. Inspection/ Test reports are to be submitted to owner as specified in final approved Manufacturing Quality Plans.

2.03.00 Field Quality Plans / Procedures for all field activities shall be submitted to

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- owner for review / approval. These Quality Plans / procedures will detail out, for all equipment, the quality practices and procedures etc. to be followed by the Contractor's site Quality Control organisation, during various stages of site activities from receipt of materials/ equipment at site.
- 2.04.00 The Bidder shall also furnish copies of the reference documents/plant standards/acceptance norms/tests and inspection procedure etc., as referred in Quality Plans along with Quality Plans. These Quality plans and reference documents/standards etc. will be subject to Owner's approval without which manufacture shall not proceed. These approved documents shall form a part of the contract. In these approved quality plans, Owner/Authorised representative shall identify customer hold points (CHP), test/checks which shall be carried out in presence of the Owners Engineer or his authorised representative and beyond which the work will not proceed without consent of Owner/Authorised representative in writing. All deviations to this specification, approved quality plans and applicable standards must be documented and major deviations in the form of Non Conformity Report shall be referred to Owner/Authorised representative for approval and dispositioning.
- 2.05.00 No material shall be despatched from the manufacturer's works before the same is accepted subsequent to pre-despatch final inspection including verification of records of all previous tests/inspections by Owner's Engineer/ Authorised representative for "CHP" and "W" points marked in quality plans , and duly authorised for despatch by issuance of Material Despatch Clearance Certificate (MDCC). For items which is not under owner's inspection the contractor shall apply for despatch clearance (MDCC) from owner by submitting their internal inspection reports and quality records
- 2.06.00 All materials used or supplied shall be accompanied by valid and approved materials certificates and tests and inspection report. These certificates and reports shall indicate the sheet serial numbers or other such acceptable identification numbers of the material. The material certified shall also have the identification details stamped on it.
- 2.07.00 Castings and forgings used for construction shall be of tested quality. Details of results of chemical analysis, heat treatment record, mechanical property test results shall be furnished.
- 2.08.00 All welding and brazing shall be carried out as per procedure drawn and qualified in accordance with requirements of ASME Section - IX (latest edition) or other International equivalent standard acceptable to the Owner.
- All brazers, welders etc. employed on any part of the contract at Contractor's/ Sub-Contractor's works or at site shall be qualified as per ASME Section-IX (latest edition) or equivalent international standard approved by the Owner. Such qualification tests shall be conducted in presence of Owner / his authorised representative or owner approved Third Party Inspection Agency(TPIA). Previously qualified WPS & PQR shall be acceptable if witnessed by owner's approved TPIA.
- For welding of pressure parts and high pressure piping coming under IBR purview, the requirements of IBR shall also be complied with.

2.09.00	All non-destructive examination (NDT) shall be carried out in accordance with LIST OF STANDARDS FOR REFERENCE as given below in this section. The NDT operator shall be qualified as per SNT-TC-IA (of American Society of non- destructive examination). Results of NDT for the list major equipments / items identified for owner's inspection shall be properly recorded and submitted for review and approval. Other items not covered under owner's inspection, contractor shall review and approve the NDT results and such reports shall be submitted to owner in the final documentation of the items / equipments
2.10.00	All the sub-vendors proposed by the Contractor for procurement of major bought out items including castings, forgings, semi-finished and finished components/equipment list of which shall be drawn up by the Contractor and finalised with the Owner shall be subject to Owner's approval. Quality Plans of the successful vendors shall be discussed, finalised and approved by the Owner/Authorised representative and form part of the Purchase Order between the Contractor and the Vendor.
2.11.00	All the purchase specifications for the major bought-out items, list of which shall be drawn up by the Contractor and finalised with the Owner shall be furnished to the Owner for comments and subsequent approval before orders are placed. Owner reserves the right to carry out quality audit and quality surveillance of the systems and procedures of the Contractor's or their sub-vendor's quality management and control activities. The Contractor shall provide all necessary assistance to enable the Owner carry out such audit and surveillance. Quality audit/approval of the results of tests and inspection will not prejudice the right of the Owner to reject equipment not giving the desired performance after erection and shall not in no way limit the liabilities and responsibilities of the Contractor in earning satisfactory performance of equipment as per specification.
2.12.00	Quality requirements for main equipment shall equally apply for spares and replacement items.
2.13.00	Repair/rectification procedures to be adopted to make any job acceptable shall be subject to the approval of the Owner.
2.14.00	For quality assurance of all civil works refer to the specifications for civil works.
3.00.00	QUALITY ASSURANCE DOCUMENTS
3.01.00	The Contractor shall be required to submit two (2) copies and two (2) sets of microfilms / CDs of the following Quality Assurance documents within three (3) weeks after despatch of the equipment: a) Material mill test reports on components as specified by the specification.

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- b) The inspection plan with verification, inspection plan check points, verification sketches, if used and methods used to verify that the inspection and testing points in the inspection plan were performed satisfactorily.
 - c) Non-destructive examination results /reports including radiography interpretation reports.
 - d) Factory tests results for testing required as per applicable codes and standards referred in the specification.
 - e) Welder identification list listing welder's and welding operator's qualification procedure and welding identification symbols.
 - f) Sketches and drawings used for indicating the method of traceability of the radiographs to the location on the equipment.
 - g) Stress relief time temperature charts.
 - h) Inspection reports duly signed by QA personnel of the Owner and Contractor for the agreed inspection hold points. During the course of inspection, the following will also be recorded :
 - i) When some important repair work is involved to make the job acceptable.
 - ii) The repair work remains part of the accepted product quality.
 - i) Letter of conformity certifying that the requirement is in compliance with finalised specification requirements.

4.00.00 **INSPECTION, TESTING AND INSPECTION CERTIFICATES**

4.01.00 The Owner's Engineer, or his duly authorised representative and/or an outside inspection agency acting on behalf of the Owner shall have access inside the workshops, test labs, establishments at all reasonable times to inspect and examine the materials and workmanship of the works during its manufacture or erection and if part of the works is being manufactured or assembled on other premises or works, the Contractor shall obtain for the Owner's Engineer and for his duly authorised representative permission to inspect as if the works were manufactured or assembled on the Contractor's own premises or works.

4.02.00 The Contractor shall give the Owner's Engineer/ Authorized Inspector twenty one (21) days written notice for "CHP" / "W" points of any material being ready for testing by owner' engineer / Authorized inspector. Such tests shall be to the Contractor's account except for the expenses of the Inspector. The Engineer/ Inspector, unless the witnessing of the tests is virtually waived, will attend such tests within fifteen (15) days of the date on which the equipment is notified as being ready for test/inspection. If owner's Engineer / Authorised Inspector fail to attend the inspection, next mutually convenient date for test shall be agreed with Contractor. Contractor shall, in

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- no case proceed with the test without owner or his authorized inspectors, unless the witnessing is officially waived and advised Contractor to proceed with the test. Contractor shall forthwith forward duly certified completed test report and a product quality certificate in six (6) copies to owner upon completion of such test.
- 4.03.00 The Engineer or Inspector shall within fifteen (15) days from the date of Inspection as defined herein give notice in writing to the Contractor, or any objection to any drawings and all or any equipment and workmanship which is in his opinion not in accordance with the contract / QAP or other approved quality documents. The Contractor shall give due consideration to such objections and shall either make modifications that may be necessary to meet the said objections or shall confirm in writing to the Engineer/Inspector giving reasons therein, that no modifications are necessary to comply with the contract / QAP or other approved quality documents.
- 4.04.00 When the factory tests have been completed at the Contractor's or sub-contractor's works, the Engineer/Inspector shall issue a certificate to this effect fifteen (15) days after completion of tests excluding the test completion date subject to submission of all certified documents related to the test, If the tests are not witnessed by the Engineer/Inspectors, the certificate shall be issued within fifteen (15) days of the receipt of the Contractor's test certificate by the Engineer/Inspector. Failure of the owner's Engineer/Inspector to issue such a certificate shall not prevent the Contractor from proceeding with the works. The completion of these tests, or the issue of the certificates shall not bind the Owner to accept the equipment should it, on further tests after erection be found not to comply with the contract / QAP or other approved quality documents.
- 4.05.00 In all cases where the contract provides for tests whether at the premises or works of the Contractor or any sub-contractor, the Contractor, except where otherwise specified shall provide free of charge such items as labour, materials, electricity, fuel, water, stores, apparatus and instruments as may be reasonably demanded by the owner's Engineer/Inspector or his authorised representatives to carry out effectively such tests on the equipment in accordance with the Contract / QAP or other approved quality documents. Contractor and shall give facilities to the owner's Engineer/ Inspector or to his authorised representative to accomplish testing.
- 4.06.00 To facilitate advance planning of inspection in addition to giving inspection notice as per Clause 4.02.00, the Contractor shall furnish quarterly inspection programme indicating proposed schedule dates of inspection at customer hold point and final inspection stages. Updated quarterly inspection plans will be made for each three consecutive months and shall be furnished before beginning of each calendar month.

LIST OF STANDARDS FOR REFERENCE

- a) International Standards Organisation (ISO).
- b) International Electro-technical Commission (IEC).
- c) American Society of Mechanical Engineers(ASME)
- d) American National Standards Institute (ANSI).
- e) American Society for Testing and Materials (ASTM).
- f) American Institute of Steel Construction (AISC).
- g) American Welding Society (AWS).
- h) Architecture Institute of Japan (AIJ).
- i) National Fire Protection Association (NFPA).
- j) National Electrical Manufacturer's Association (NEMA).
- k) Japanese Electro-technical Committee (JEC).
- l) Institute of Electrical and Electronics Engineers (IEEE).
- m) Federal Occupational Safety and Health Regulations (OSHA).
- n) Instrument Society of America (ISA).
- o) National Electric Code (NEC).
- p) Heat Exchanger Institute (HEI).
- q) Tubular Exchanger Manufacturer's Association (TEMA).
- r) Hydraulic Institute (HIS).
- s) International Electro-Technical Commission Publications.
- t) Power Test Code for Steam Turbines (PTC).
- u) Applicable German Standards (DIN).
- v) Applicable British Standards (BS).
- w) Applicable Japanese Standards (JIS).
- x) Electric Power Research Institute (EPRI).
- y) Standards of Manufacturer's Standardization Society (MSS)

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- z) Bureau of Indian Standards Institution (BIS).
 - aa) Indian Electricity Rules.
 - bb) Indian Boiler Regulations (IBR).
 - cc) Indian Explosives Act.
 - dd) Indian Factories Act.
 - ee) Tariff Advisory Committee (TAC) rules.
 - ff) Emission regulation of Central Pollution Control Board (CPCB).
 - gg) Pollution Control regulations of Dept. of Environment, Govt. of India
 - hh) Central Board of Irrigation and Power (CBIP) Publications

ANNEXURE-I
FORMAT OF QUALITY ASSURANCE PROGRAMME

VENDOR'S LOGO , NAME & ADDRESS		MANUFACTURING QUALITY ASSURANCE PLAN					DOC NO:		XXXXX-CAL-QAP-M-0001														
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CLIENT :							LOCATION :																
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VENDOR :							REFERENCE APPROVED DATA SHEET :																
SUB VENDOR :							REFERENCE APPROVED DRAWING. NO. :																
ABBREVIATIONS : QAP - QUALITY ASSURANCE PLAN, CR - CRITICAL, MA - MAJOR, MI - MINOR SPEC - SPECIFICATION, TC - TEST CERTIFICATES P - PERFORM w - WITNESS V - VERIFY CHP - CUSTOMER HOLD POINT										AGENCY : 1 - DCPL/PROJECT AUTHORITY 2 - SUPPLIER 3 - SUB-SUPPLIER 4 - MANUFACTURER 5 - THIRD PARTY INSPECTION AGENCY					GENERAL REMARKS 1 THE ITEMS WHICH ARE FALLING UNDER ANY STATUTORY AUTHORITY'S (LIKE I.B.R. ETC.) SCOPE SHALL BE SUBJECTED TO THAT STATUTORY AUTHORITY'S INSPECTION CLEARANCE.								
NOTES: 1. EXACT MATERIAL / PROCESS / INSPECTION / TESTS FOLLOWED BY THE MANUFACTURER SHALL BE SPECIFIED 2. EXACT REFERENCE DOCUMENT/ACCEPTANCE STANDARD SHALL BE SPECIFIED 3. IN CASE SPECIFIED ACCEPTANCE STANDARD / NORMS IS OTHER THAN NATIONAL / INTERNATIONAL STANDARDS . STANDARD / COPY OF THE ACCEPTANCE NORMS FOLLOWED BY THE MANUFACTURER SHALL BE SUBMITTED FOR REVIEW RECORD 4 FINAL INSPECTION DOSSIER SHALL BE PREPARED BY MANUFACTURER & SHALL BE ENDORSED BY INSPECTIONION AGENCY																							
Prepared by					Checked by					Approved By													
Revision	R0	R1	R2	R0	R1	R2	R0	R1	R2														
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ANNEXURE-II**FIELD WELDING SCHEDULE**

PROJECT : FWS NO :

CONTRACTOR : REV NO. :

PACKAGE : FIELD WELDING CODE :

SYSTEM : PAGE NO. :

SI No.	Drawing No. for Weld Locations & Identification mark	Description of parts to be welded	Material specification	Dimensions	Process of Welding	Type of Weld	Electrode Filler Specification	WPS No.	Minimum Pre-heat Temperature	Heat Treatment Temperature [Holding Time in secs]	NDT Method Quantum	NDT Specification Number	Acceptance Norm Ref.	Remarks
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The Field Welding Schedule should be submitted for :

- o Pressure Parts
- o Tanks/Vessels
- o Piping
- o Heavy/Important Structural Steel
- o Heat Exchangers
- o Bus Ducts

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REQUIREMENTS OF SPARES, TOOLS & TACKLE, LUBRICANTS/OIL/CONSUMABLES

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CONTENT

CLAUSE NO.	DESCRIPTION
1.00.00	TOOLS AND TACKLE
2.00.00	SPARES
	ATTACHMENT
ANNEXURE-I	MANDATORY SPARE LIST

REQUIREMENTS OF SPARES, TOOLS & TACKLE, LUBRICANTS/OIL/CONSUMABLES

1.00.00 TOOLS & TACKLE

The Contractor shall supply with the equipment one complete set of special tools and tackle as required for the erection, assembly, dismantling & maintenance of the equipment. These special tools will also include special material handling equipment, jigs & fixtures for maintenance and calibration/readjustment, checking & measurement aids etc. A list of such tools & tackle shall be submitted by the Bidder along with the offer. Detailed description of each tools/tackle, its function along with the equipment/part for which it is meant for and the price of each tools/tackle shall also be indicated in the offer. These tools & tackle shall be separately packed and sent to site before the first unit commissioning. The Bidder shall also ensure that these tools are not used for erection purpose.

2.00.00 SPARES

2.01.00 General

The Bidder shall indicate and include in his scope of supply all the necessary start-up, commissioning and recommended spares in addition to mandatory spares as specified elsewhere in the specification. The Owner reserves the right to buy any or all mandatory and recommended spares. The Contractor shall also state for each item of spares both mandatory and recommended, the normal expected service life.

2.01.01 All spares supplied under this contract shall be strictly interchangeable with the parts for which they are intended to replace. The spares shall be treated and packed for long storage under the climatic conditions prevailing at the site, e.g. small items shall be packed in sealed transparent plastic bags with dessicator packs as necessary.

2.01.02 Each spare part shall be clearly marked or labelled on the outside of the packing with the description. When more than one spare part is packed in a single case, a general description of the contents shall be shown on the outside and a detailed list enclosed. All cases, containers and other packages must be suitably marked and numbered for the purposes of identification.

2.01.03 All cases, containers or other packages are liable to be opened for examination as may be considered necessary by the Engineer.

2.01.04 All mandatory spares shall be delivered to site within one to three months prior to the scheduled date of the trial operation of the plant. However, they shall not be despatched before the despatch of the associated main equipment.

-
- 2.01.05 The Bidder shall also guarantee supply of spare parts, which will be made, based on manufacturer's drawings on special order from the Purchaser for 30 years after commissioning of the plant.
- 2.01.06 Warranty period for all kinds of spares shall be six thousand (6000) hours of operation, except normal wear or eighteen (18) months from the date of receipt at site, whichever is earlier. In case of failure or non-conformance to specifications, the Contractor shall replace them free of cost.
- 2.02.00 **Recommended Spares**
- 2.02.01 The Contractor shall provide a list of recommended spares giving unit prices and total prices for 2 years of normal operation of the plant for spares of indigenous origin, and for 5 years of normal operation for spares of non-indigenous origin. This list shall take into consideration the mandatory spares specified elsewhere in the specification and should be a separate list.
- 2.02.02 The price of recommended spares will not be used for the evaluation of bids. The price of these spares shall remain valid for a period as specified elsewhere in the specification from the date of Award of the Contract. Where the recommended spares are the same as mandatory spares, the prices shall be the same. The prices of any recommended spares, which are not common with mandatory spares, shall be subject to review by the Owner, and shall be finalised after mutual discussion.
- 2.03.00 **Start-up Commissioning Spares**
- 2.03.01 Start-up commissioning spares are those spares which may be required during the start-up and commissioning of the equipment/system. All spares used until the plant is handed over to the Owner shall come under this category. Said spares, properly marked, shall be supplied together with the main equipment and shall be used by the Contractor, if needed, during erection & commissioning stage. All such spares which remain unused till issuance of Taking Over Certificate by the Owner, along with an equipment-wise quantitative consumption report shall be returned to the Owner during time of handover. The list of commissioning spares to be brought by the Contractor to ensure smooth commissioning of the plant shall be subject to the Engineer's approval.
- 2.03.02 The Contractor shall submit a complete BBU list inclusive of recommended, mandatory, initial start-up and commissioning spares. Costs of the above spares, which are consumed before the handing-over of the plant, shall be deemed to have been included in the lump sum proposal price of the package, and the Contractor shall have no claim on this account to the Owner.
- 2.04.00 **Mandatory Spare Parts**
- 2.04.01 The Owner considers some of the spares are essential for running the equipment irrespective of whether they are included in the list of recommended spares by the Bidder as mentioned above.

Since the components involved can not be foreseen at the bidding stage, only

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- broad requirements of the Owner in this respect are outlined hereinafter. The bidder shall include his proposal, on the basis of this guideline, an item-wise list of all components and the quantity, unit prices & total price thereof, offered as mandatory spares for each and every equipment. This list shall be separate from the list of recommended spares and shall be used for bid evaluation purposes. Any clarification in this respect may be obtained by the Bidder at the pre-bidding stage.
- 2.04.02 The mandatory spares should be supplied to the Owner at least one month before the trial run. The despatch programme is subject to approval of the Owner/Consultant after award of contract.
- 2.04.03.1 Criteria for selection of Quantity of Mandatory Spares :
- For Mandatory Spares refer ,
- 2.04.04 Purchaser will have the option to procure any or all of the mandatory spares at his discretion.

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CONDENSATE POLISHING SYSTEM

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- 5.20.00 Each Condensate Polisher Mixed Bed shall be provided with resin trap on effluent line. The resin trap in these lines shall be flanged at one end and will be connected at the end of the respective pipeline. The other end shall be open to the drain so that the flow can be seen to check the choking of the trap.
- 5.21.00 All nuts, bolts etc. in submerged and corrosive application shall be of SS-316.
- 5.22.00 Rubbers used for rubber lining of equipment and piping shall be of natural rubber with shore hardness $65 \pm 5^\circ$ in Scale-A.
- 5.23.00 Further specific salient design features of major equipment and accessories have been furnished under Annexure- I to III.
- 5.24.00 In addition to above, required general technical features for Pressure Vessels, Storage Vessels, Piping, Fittings, Valves, Miscellaneous Pumps, Protective Lining, Painting, Mechanical Erection, Testing and Commissioning have been addressed under Sections VI to XIII as attached elsewhere in Volume III-C of this EPC Bid Document.
- 5.25.00 The Condensate Polisher Vessels along with Air Blowers are located indoor at ground floor of the Power House.
- Resin Separation Vessel, Anion Resin Regeneration Vessel, Cation Regeneration Vessel / Mixed Resin Storage Vessel, Resin Hopper, Air Blowers, Acid Measuring Tank, Alkali Measuring Tank and Hot Water Tank are located indoor in the vicinity Power House Area.
- Resin Transfer Pumps cum Regeneration Water Pumps are located outdoor in Demineralized Water System area.
- 6.00.00 OPERATION AND CONTROL PHILOSOPHY**
- 6.01.00 The operation CP System shall be semi-automatic through plant DDCMIS, except addressed otherwise. There shall be provision for remote manual operation also.
- 6.02.00 The CP System, shall be operated for service and resin transfer from concerned Service Area - Equipment Control centre (ECC) to be located indoor in the vicinity of Condensate Polisher Vessels.
- Operation from this ECC can only be undertaken under authorization from Regeneration Area – ECC addressed hereinafter.

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The regeneration of ion-exchange resins of CP System shall be carried out from Regeneration Area - ECC to be located in the vicinity of Power House area.

Remote Terminal Unit (RTU) as an extended node of DDCMIS shall be considered in the vicinity of the CPU regeneration area along with a dedicated work station for control and monitoring of the Regeneration System.

6.03.00 The Control System shall provide safe operation of CP System and provide all necessary protections and interlocks to prevent mal-functions of different equipment/drives and to ensure long term unattended safe and reliable operation.

6.04.00 The remote operation of all pumps, blowers and agitators shall be made through DDCMIS workstation.

Further to above, all drive motors shall have the facility of local Start/Stop. Local starting shall be possible through local / remote selector switch to be located in MCC. Tripping of drive motors shall be permissible by local lockable stop irrespective of local / remote selector switch position.

6.05.00 The salient features of operation of CP SYSTEM in different modes are as follows:

In the AUTO MODE, the state of Service, Resin Transfer or Regeneration shall be initiated by the operator and all subsequent steps in the sequence shall proceed in automatic manner. The system shall be based on sequential operation of various equipment such as valves, pumps, etc.

In the REMOTE MANUAL MODE, the operator has to initiate each step or sequence of regeneration.

6.06.00 The control of the CP System i.e. service and standby status of Polisher Vessels as well as Resin Transfer from Condensate Polisher Mixed Beds to Regeneration Area and vice versa will be achieved through the DDCMIS. DDCMIS shall show the operating mode of each Condensate Polisher Mixed Bed (in service, on standby, resin transfer, rinsing down etc.) the position of all automatic valves, operating parameters (such as flow, conductivity, silica levels, differential pressure etc.) and alarm conditions.
 Condensate Polisher Mixed Bed Operation

Service flow rate for each Condensate Polisher Mixed Bed shall be monitored. 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 transmitter installed between the influent and effluent headers on a high signal will cause an annunciation alarm. By observing the individual vessel flow indications, or conductivity at vessel

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outlet the operator can determine which vessel is contributing most to the pressure drop and is in need of resin cleaning/regeneration.

Conductivity analyser shall monitor the polishing system influent and effluent streams as well as the discharge of each Condensate Polisher Mixed Bed. A high influent conductivity annunciation alarm will alert the System operator that a problem condition such as air or condenser cooling water leakage has occurred. This conductivity analyser shall also provide contacts for an alarm at the DDCMIS. A high conductivity annunciation alarm on outlet of Condensate Polisher Mixed Bed will alert the operator to the need for regeneration of a Condensate Polisher Mixed Bed.

Condensate Polisher Mixed Bed shall be automatically placed in service following manual pushbutton initiation from the control panel. The automatic sequence shall include steps for pressurisation of the Condensate Polisher Mixed Bed, a pre-service rinse and placing in service.

The pre-service rinse shall be time controlled. If the conductivity of the Condensate Polisher Mixed Bed effluent is not acceptable at the end of the pre-service rinse, a rinse overtime alarm shall be sounded and the pre-service rinse continued for a second timed period. If an acceptable Condensate Polisher Mixed Bed effluent is not reached by the end of the second pre-service rinse, a pre-service rinse failure alarm shall be sounded and the vessel shall be automatically returned to standby. If acceptable conductivity at outlet of Condensate Polisher Mixed Bed is attained at the end of the first rinse or during the second rinse, the vessel shall automatically be placed in service. Interlocks shall be provided to prevent placing a vessel into the service mode while resin is being transferred.

The rinse recycle shall be manually initiated full automatic sequence. This sequence shall include a rinse down step using condensate at a suitable rate until effluent quality is acceptable for boiler feed water. The effluent quality shall be determined by conductivity monitoring of the rinse water outlet, which is for recycle. Conductivity parameter shall be interlocked to prevent advancing of the automatic sequence until the rinse down is complete.

Condensate Polisher Mixed Beds shall be automatically removed from service following manual push button initiation from the DDCMIS work station.

Exhaustion of a Condensate Polisher Mixed Bed shall be annunciated by any of the following:

- a) High differential pressure across the polisher battery.
- b) High effluent conductivity from an operating vessel.
- c) High effluent silica from an operating vessel.
- d) Pre-set volume of condensate treated in an operating vessel.

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When the differential pressure across the Condensate Polisher Mixed Bed header reaches the high set point level an alarm shall sound and by pass valve shall be automatically opened by a signal from the control system.

The alarms for a Condensate Polisher Mixed Bed shall be disabled when the Condensate Polisher Mixed Bed is not in service or pre-service rinse.

Resin Transfer Mode

Resin transfer from a Condensate Polisher Mixed Bed to the regeneration vessel shall be automatic from DDCMIS following manual pushbutton initiation from the DDCMIS work station.

Manually initiated automatic sequences shall be provided for transferring resin from a Condensate Polisher Mixed Bed to the remote regeneration facility for physical cleaning and chemical regeneration and for returning fresh resin to that Condensate Polisher Mixed Bed.

The transfer of resin from the Condensate Polisher Mixed Bed shall include isolation of the Condensate Polisher Mixed Bed, hydraulic transfer of the resin to the Regeneration Area.

The return of fresh resin to the empty Condensate Polisher Mixed Bed shall include the hydraulic transfer from the resin separation vessel of the external regeneration system using demineralized water. After receiving fresh resin the Condensate Polisher Mixed Bed will remain in the 'Off' position until returned to service by the operator.

The resin transfer sequence shall be interlocked to prevent resin transfer in any of the following situations:

- a) Unsuccessful completion of a previous chemical regeneration of physical cleaning sequence in the external regeneration system.
- b) The Condensate Polisher Mixed Bed condensate inlet and outlet valves not closed.
- c) High pressure in the polisher Condensate Polisher Mixed Bed.

6.07.00 The control for the external regeneration system shall be from the Operation workstation with DDCMIS RTU located in a separate Control Room at Regeneration Area. This shall clearly show the status of each concerned Condensate Polisher Mixed Bed. This Console will provide a manually initiated automatic sequence for physical cleaning and chemical regeneration of the resins and show the status of the cycle at all times. This shall also provide all controls and operation facilities for the acid and alkali solution preparation and dosing system. The Regeneration Area Operation Console shall also control the sequences of Resin Transfer – i.e. to transfer resin from the Condensate Polisher Mixed Bed to the external regeneration facility and to receive freshly regenerated resin from the regeneration facility– this

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involves depressurisation of the Condensate Polisher Mixed Bed, water sluicing of exhausted resins to the regeneration system, draining the Condensate Polisher Mixed Bed to the condenser hotwell, receiving a water slurry of fresh resin from the regeneration system and finally completely filling the vessel with condensate.

7.00.00 QUALITY CONTROL & SURVEILLANCE

The System / equipment to be supplied under this specification shall have assured quality and workmanship. In the proposal, the Bidder shall submit the Quality Assurance Plan containing quality assurance programme and quality assurance documents for Purchaser's approval. The Bidder shall be bound to conduct all stage inspections on various equipment / material during manufacturing process in accordance with the approved copy of this document. Purchaser shall have the right to carry out Quality Audit and Quality Surveillance by witnessing any or all such tests to be carried out at Bidder's / Sub-Bidder's works as and when desired. The procedure applicable to Bidder's works will also apply to the works of his sub-Bidders. For items coming under the purview of any Statutory Regulation during the course of manufacture, all stage inspections and tests shall be witnessed by an inspecting authority recognized under the statutory regulation. All unpriced copies of Bids of all major bought-out items giving technical details shall be sent to Purchaser for approval prior to placement of orders on sub-vendors.

These audit/surveillance/approvals shall however, do not relieve the manufacturer / sub-vendors of their responsibility of the Quality Assurance of their product and overall guarantee and responsibility shall wholly be confined on the Bidder.

Tests/inspections shall be carried out during and after the completion of manufacture of different components and assembly as applicable in accordance with relevant codes and standards. Test Certificates for all such tests/inspections shall be made available to the Purchaser for approval.

Purchaser or his authorised representative shall have his full access to witness any or all tests/inspections to be carried out at manufacturer's shop. In case, the job is sub-contracted, it will be Bidder's responsibility to make all arrangements so that Purchaser or his authorised representative can attend such tests at Sub-Bidder's premises. Inspection (including interstage inspection) and other tests shall be done as per Approved Quality Plan.

After erection at site, Condensate Polishing System shall be operated for a period of at least two (2) weeks to prove satisfactory, performance and guarantee data.

8.00.00 INSPECTION, TESTING, COMMISSIONING AND PERFORMANCE GUARANTEE TESTS

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The equipment, parts and materials shall be tested and inspected, but not limited to the following

8.01.00 Shop Tests

Shop tests shall include all tests to be carried out at Bidder's works, works of their sub-vendors and at works where materials to be used for fabrication of equipment are manufactured. The tests to be carried out shall include but not be limited to the following:

- a) Composition of all material, castings, forgings, etc.
- b) Hydraulic tests for pressure vessels, pipes, valves, pump casing etc.
- c) Tests to check faults in protective lining and painting.
- d) Static balancing test for agitators, stirrers, paddles etc.
- e) Static and dynamic balancing tests on all impellers.
- f) Performance tests (Head, Capacity and Power) for each of pumps and blowers.
- g) All tests with reference to instrumentations and controls complete with accessories as addressed in Technical Specifications for Instrumentation and Control - ~~Volume -VI of this Bid Document.~~
- h) All tests with reference to electrical equipment and accessories as addressed in Technical Specifications for Electrical Equipment & Accessories - ~~Volume - V of this Bid Document.~~

8.02.00 Tests before Trial Run

Bidder shall carry out tests at site to prove to the Purchaser that individual equipment of all the System complies with the requirements stipulated and is erected in accordance with requirements specified. Before the System is put on trial run, the Bidder will be required to conduct tests to demonstrate to the Purchaser that each individual item is capable of correctly performing the functions for which it has been designed for. These tests may be conducted concurrently with those required under commissioning sequence. Tests required shall in general be as follows:

- a) The tests to be carried out for the fabricated storage vessels shall include:
 - i. During fabrication and before lining:
 - a) Bottom testing for leakage by soap solution, after the bottom and at least the bottom course of the shell plate have been welded.

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- b) Hydraulic shell testing for leakage.
 - c) Fixed roof test for leakage by soap solution.
- ii. After lining:

Water leakage test for storage tank shall be carried out by filling it with water up to the overflow level.

 - b) All piping and valves, after installation, will be tested hydrostatically at one and half times of the maximum attainable pressure in the system to check against leak tightness.
 - c) All valves/isolation gates shall be operated throughout 100% of the travel and these should function without any trouble whatsoever.
 - d) Each of all pumps and blowers shall be run with the specified fluid from shut off condition to valve wide-open condition. Head developed will be checked from the discharge pressure gauge reading. Capacity may be checked from flow indicator where available. Otherwise capacity shall be checked from the volume of fluid handled (determined from level indicator reading of concerned tank) wherever applicable and duration of test.
 - e) Each of pumps and blowers shall be tested at site to run smoothly without undue vibration, flow pulsation, temperature rise in bearing parts, noise etc.
 - f) Each of all the agitators and other rotating/moving devices shall be run at the rated speed with water/chemicals up to the normal water level for a period of twenty four (24) hours. During this period all the components shall function smoothly without any unbalance, vibration, overheating at bearing parts etc.
 - g) All the rubber lining are to be subjected to the following tests as per relevant code:
 - i. Adhesion test
 - ii. Resistance to bleeding
 - iii. Thickness measurement
 - iv. Shore hardness
 - v. High voltage spark test
 - h) Epoxy painting shall be checked by dry type thickness gauge.
 - i) All monorail hoists shall be subjected to full working load during all motions without showing any sign of defect.
 - j) Visual check on all structural components, welding, painting etc.

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- i) All tests with reference to instrumentations and controls complete with accessories as addressed in Technical Specifications for Instrumentation and Control - ~~Volume -VI of this Bid Document.~~
- j) All tests with reference to electrical equipment and accessories as addressed in Technical Specifications for Electrical Equipment & Accessories - ~~Volume -V of this Bid Document.~~

8.03.00

Performance Guarantee Test Procedure

- a) The duration of the test shall not be less than 72 hours on continuous basis. These tests will be carried out within a reasonable period from the date of commissioning of the plant. The tests shall be conducted by the Bidder to prove beyond doubt the guaranteed performance of the plant to the satisfaction of the Purchaser.
- b) The test procedures shall be as per applicable Indian Standards. Where Indian Standard is not available or applicable, the test procedures shall be as per standards from recognized origins. The test procedures shall be furnished for review and approval by Purchaser.
- c) Necessary pumps shall be started and flow shall be established through all the streams. Valves be adjusted so as to have equal and rated distribution of flow through all the streams.
- d) One (1) Condensate Polisher Mixed Bed shall be taken under service. Samples of water will be drawn every hour from the outlet and then tested in the laboratory. The results shall be compared against the required parameters stipulated elsewhere under this specification.
- e) Exhaustion of each Condensate Polisher Mixed Bed shall be indicated by the features addressed under 'Operation and Control Philosophy'. The resins of Condensate Polisher Mixed Bed shall then be backwashed / regenerated at the specified regeneration level. Total amount of chemicals required for regeneration and the duration of chemical injection /regeneration shall be noted against the guaranteed figures.
- f) The regenerated Condensate Polisher Mixed Bed shall be again put into service and tests addressed above will be continued. At the end of run, total amount of water treated will be noted from the flow integrators.
- g) Inlet water analysis is determined by making arithmetic average of all hourly readings of feed water taken during the test.
- h) Based on this inlet water analysis, design exchange capacity of resins and resin volume provided, the capacity of each Condensate Polisher Mixed Bed in terms of total volume of treated water (m³) between two (2) successive regenerations shall be calculated. Resin volume shall not include the buffer and inert layers provided. The calculation shall be

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approved by the Purchaser / Engineer.

- i) Quantity of treated water as determined by tests as in above shall be checked against calculated quantity of treated water during regeneration as in above and must be equal to or more than the calculated amount.
- j) All the above mentioned tests shall be separately done for each of the Condensate Polisher Mixed Beds of the complete Condensate Polishing System.

8.04.00

Performance Guarantee parameters

- a) Each pump shall be guaranteed for capacity, total dynamic head and power consumption.
- b) All blowers shall be guaranteed for head and power consumption.
- c) Condensate Polisher Mixed Beds
 - i) Each Condensate Polisher Mixed Bed will have a rated continuous treated water output capacity of not less than design value. Each Condensate Polisher Mixed Bed Unit shall be regenerated once after every 240 hours of continuous service run.
 - ii) Net output from each of Condensate Polisher Mixed Beds shall be not less than design volume of treated water for the design water analysis as exhibited in Annexure-I. In case water analysis is different from the design values, guaranteed quantity shall be calculated as indicated elsewhere in this Specification and guarantee shall be applicable on this calculated quantity.
 - iii) Chemical consumption of the Condensate Polisher Mixed Bed as indicated by the Bidder shall be guaranteed against the regeneration level employed and resin volume provided without any tolerance.
 - iv) Qualities of treated water from Condensate Polisher Mixed Bed shall be as per treated water analysis as exhibited in Annexure-II.

9.00.00

BID EVALUATION CRITERIA

With reference to Bid Evaluation Criteria, Bidder may please refer to Lead Specification - Volume I of this EPC Bid Document.

10.00.00

PERFORMANCE GUARANTEE TOLERANCE AND PENALTY

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10.01.00 Liquidated Damages (LD) for Additional Power Consumption

With reference to Additional Power Consumption, Bidder may please refer to Lead Specification - Volume II-A of this Bid Document.

10.02.00 Liquidate Damages (LD) for Non Achievement of Specific Performance:

The performance Guarantee parameters for Condensate Polishing System have been indicated elsewhere in this specification.

No negative tolerance in respect flow, head and other performance guarantee parameters are acceptable to the Purchaser. In case, any equipment of Condensate Polishing System is not able to achieve the performance guarantee parameters during the Performance Guarantee Tests, Bidder shall make necessary modifications or replace the Equipment/ Plant or any part within three months period from the date of conducting PG test. If even after rectification, the Equipment/Plant is not able to achieve the guaranteed performance parameters, the Purchaser shall have right to reject the Equipment/Plant. In such case, the Bidder shall pay back the total amount paid to them with reference to the Equipment/Plant (with all taxes and duties as applicable) to the Purchaser.

10.03.00 **LIQUIDATED DAMAGES FOR DELAY IN DELIVERY & COMMISSIONING**

With reference to Liquidated Damages for Delay in Delivery & Commissioning, Bidder may please refer to Conditions of Contract - Volume I of this Bid Document.

11.00.00 **SPARES**

With reference to Spares, Bidder may please refer to Lead Specification - Volume II-A of this Bid Document.

12.00.00 **TOOLS & TACKLES**

With reference to Tools and Tackles, Bidder may please refer to Lead Specification - Volume II-A of this Bid Document.

13.00.00 **DRAWINGS / DOCUMENTS TO BE FURNISHED BY THE BIDDER**

~~The Bidder's formal proposal must be accompanied by the following Documents/Drawings/Information:~~

13.01.00 All the details as addressed under Bid Proposal Sheets under Volume-III of the ~~EPC~~ Bid Document.

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- 13.02.00 Process and Instrumentation Diagram for the complete system.
- 13.03.00 Dimensional General Arrangement Drawing for the complete system.
- 13.04.00 Electrical Load List for the complete system.
- 13.05.00 Schedule of terminal points and their characteristics.
- 13.06.00 Quality assurance plan.
- 13.07.00 Requirement of construction power & water with the required characteristics, quantum etc.
- 13.08.00 Experience list addressing the details complete with the locations where Bidder have supplied and commissioned similar systems for similar application under similar duty conditions as specified under this EPC Bid Document.
- 13.09.00 List of imported items, if any.
- 13.10.00 List of proposed Sub-Vendors.
- 13.11.00 In case Bidder is offering equipment/plant/test procedures as per International Standards not mentioned specifically in the Bid Documents, he should furnish at least three (3) copies of English Version of the same along with the offer, for consideration.
- 13.12.00 All Documents/Drawings/Information as addressed in Technical Specifications for Instrumentation and Control - ~~Volume -VI of this Bid Document.~~
- 13.13.00 All Documents/Drawings/Information as addressed in Technical Specifications for Electrical Equipment & Accessories - ~~Volume -V of this Bid Document.~~
- 13.14.00 All Documents/Drawings/Information as addressed in General Specification and Design Criteria for Civil and Structural Work - ~~Volume VII/A, General Specification and Design Criteria for Architectural Work - Volume -VII/B & Technical Specification for Civil, Structural and Architectural Work - Volume -VII/C of this Bid Document.~~
- 13.15.00 ~~All Documents/Drawings/Information as addressed in Specifications for Ventilation and Air Conditioning System - Volume IIID of this Bid Document.~~
- 14.00.00 DRAWINGS / DOCUMENTS TO BE FURNISHED AFTER AWARD OF CONTRACT**
- The Bidder need to comply with all Documents/Drawings/Information already furnished in their Bid and subsequent correspondences/clarifications if any till the date of issue of notice of award of Contract. Revision of any data must meet the approval of the Purchaser.
- Requirements of Documents/Drawings/Information (not limited to) from the successful Bidder after finalization of contract in respect of individual equipment

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as well as the complete system covered under the specification are furnished below:

Requirements of Documents/Drawings/Information under 'Approval' category

- 14.01.00 Process Design Calculations, Mechanical Design Calculations (Sizing Calculations for each equipment, miscellaneous Hydraulic Calculations, miscellaneous Pressure Drop Calculations, miscellaneous Thickness Calculations, etc).
- 14.02.00 Process and Instrumentation Diagram for the entire system complete with all kinds of details.
- 14.03.00 Dimensional General Arrangement Drawing for the entire system complete with all kinds of applicable details.
- 14.04.00 Dimensional General Arrangement and Cross Sectional Drawing for each of all major equipment and each of all buildings complete with all kinds of applicable details.
- 14.05.00 Indoor and Outdoor Piping Layout with suitable sectional views for the complete system.
- 14.06.00 Procedures for Performance Guarantee Tests.
- 14.07.00 All Documents/Drawings/Information as addressed in Technical Specifications for Instrumentation and Control - ~~Volume - VI of this Bid Document.~~
- 14.08.00 All Documents/Drawings/Information as addressed in Technical Specifications for Electrical Equipment & Accessories - ~~Volume - V of this Bid Document.~~
- 14.09.00 All Documents/Drawings/Information as addressed in General Specification and Design Criteria for Civil and Structural Work - ~~Volume - VII/A, General Specification and Design Criteria for Architectural Work - Volume - VII/B & Technical Specification for Civil, Structural and Architectural Work - Volume - VII/C of this Bid Document.~~
- 14.10.00 ~~All Documents/Drawings/Information as addressed in Specifications for Ventilation and Air Conditioning System - Volume III-D of this Bid Document.~~

Requirements of Documents/Drawings/Information under 'Information' Category

- 14.11.00 Pipe Schedule for the complete system.
- 14.12.00 Valve Schedule for the complete system.
- 14.13.00 Isometric Piping Drawings the complete system.
- 14.14.00 Data Sheets, Dimensional General Arrangement and Cross Sectional Drawing

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for each of pumps, blowers, agitators, valves, isolation gates, monorail hoists, etc.

14.15.00 Following test certificates/test curves/data shall be furnished :

- a) Material test certificates.
- b) Performance tests results and characteristics curves of pumps, fans and electric drive motors.
- c) Hydraulic test results of pressure vessels, pipes, valves, fittings, etc.
- d) Test results to anticorrosive coatings.
- e) Nondestructive test results as applicable.

14.16.00 All Documents/Drawings/Information as addressed in Technical Specifications for Instrumentation and Control - ~~Volume -VI of this Bid Document.~~

14.17.00 All Documents/Drawings/Information as addressed in Technical Specifications for Electrical Equipment & Accessories - ~~Volume -V of this Bid Document.~~

14.18.00 All Documents/Drawings/Information as addressed in General Specification and Design Criteria for Civil and Structural Work - ~~Volume -VII/A, General Specification and Design Criteria for Architectural Work - Volume -VII/B & Technical Specification for Civil, Structural and Architectural Work - Volume -VII/C of this Bid Document.~~

14.19.00 ~~All Documents/Drawings/Information as addressed in Specifications for Ventilation and Air Conditioning System - Volume III-D of this Bid Document.~~

The Bidder shall submit a complete list of documents and drawings along with the category for review/approval by Purchaser.

Before manufacturing of the equipment, the Bidder shall have to take approval of the relevant design calculations/drawings from the Purchaser. Any manufacturing done prior to approval of the of the relevant design calculations/drawing shall be at risk of the Bidder and in case of any discrepancy with reference to approved design calculations/drawings rectification shall be made by the Bidder at their own cost without any violation of delivery schedule.

It is to be noted by the Bidder that approval or release of Documents / Drawings by Purchaser does not include the checking for drafting and other errors, but only review of basic concepts and general principles involved. Approval does not relieve the Bidder from responsibility for correctness of design, details and dimensions.

~~15.00.00 DEVIATION~~

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**TECHNICAL SPECIFICATION
FOR
PRESSURE AND STORAGE VESSELS**

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**TECHNICAL SPECIFICATION
FOR
PRESSURE AND STORAGE VESSELS**

C O N T E N T S

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TECHNICAL SPECIFICATION FOR PRESSURE AND STORAGE VESSELS

1.00.00 INTENT OF SPECIFICATION

This specification covers the design, manufacture, shop testing, shop testing, construction, fabrication, erection, testing, inspection & commissioning of pressure and storage vessels at works & site.

2.00.00 CODES AND STANDARDS

The design, manufacture, shop testing, site fabrication and erection, testing and commissioning of the pressure vessels and atmospheric storage tanks vessels shall conform to the latest revisions of the following standards, in addition to other standards addressed elsewhere in the Bid Specification subject to any modification and requirement, as specified elsewhere:

a)	ASME Section VIII	Rules for Construction of Pressure Vessels
b)	ASTM Standards	Standards published by American Society for Testing and Materials
c)	BS EN 12285-2	Workshop fabricated steel tanks. Horizontal cylindrical single skin and double skin tanks for the aboveground storage of flammable and non-flammable water polluting liquids
d)	IS-803	Code of Practice for Design Fabrication and Erection of Vertical Mild Steel Cylindrical Welded Oil Storage Tanks
e)	IS-816	Code of Practice for Use of Metal Arc Welding for General Construction in Mild Steel
f)	IS-817	Code of Practice for Training and Testing of Metal Arc Welders
g)	IS-822	Code of Procedure for Inspection of Welds
h)	IS-1363 Part 1 to Part 3	Hexagon Head Bolts, Screws and Nuts of Product Grade C
i)	IS-1367 Part 1 to Part 16	Technical Supply Conditions for Threaded Steel Fasteners
j)	IS-2002	Steel Plates for Pressure Vessels for Intermediate

		and High Temperature Service including Boilers
k)	IS-2062	Hot Rolled Medium and High Tensile Structural Steel
l)	IS-2825	Code for Unfired Pressure Vessels
m)	IS-3133	Manhole and Inspection Openings for Chemical Equipment - General Requirements
n)	IS-4049 Part 1 & Part 2	Formed Ends for Tanks and Pressure Vessels
o)	IS-4682 Part 1 to Part 10	Code of Practice for Lining of Vessels and Equipment for Chemical Processes
p)	IS-4864 to IS-4870	Shell Flanges for Vessels and Equipment

3. 00.00 GENERAL DESIGN FEATURES

3. 01.00 Design of all pressure vessels shall conform to IS 2825 or ASME Section VIII Division-I or equivalent code / standard (subject to approval by Purchaser).

3. 02.00 Design of all vertical cylindrical atmospheric storage tanks containing water, acid, alkali and other chemicals shall conform to IS-803.

Supporting frame where required for design of Demineralized Water Storage Tanks shall be in accordance with IS-800. The tank shall be "Non-pressure" fixed roof type with atmospheric vents.

3. 03.00 Design of all horizontal cylindrical atmospheric storage tank containing decationized water, acid, alkali and other chemicals shall conform to BS EN 12285-2.

3. 04.00 Design temperature of all pressure vessels and atmospheric storage tanks shall be 10 deg. C higher than the maximum temperature that any part of the vessel / tank is likely to attain during operation.

3. 05.00 Design pressure shall be the maximum expected pressure to which the vessels may be subjected to plus 5% additional margin. Maximum expected pressure for vessels placed in the discharge line of pumps shall be based on the shut-off head of the pumps plus static head at pumps suction, if any.

3. 06.00 In case, tank is subjected to vacuum under any situation, the same shall be duly considered as one of the criteria for design of the tank.

3. 07.00 Each pressure vessel / atmospheric storage tank without inside rubber lining shall have a corrosion allowance of minimum 2.0 mm.

3. 08.00 Mill tolerance as per applicable code (minimum 0.3 mm) shall be duly considered for each shell as well as dished end.

3. 09.00 Thinning allowance of 2.0 mm (minimum) shall be considered for each dished end.

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3. 10.00 Effective liquid volume for an atmospheric storage tanks tank shall be considered as the liquid volume in between the design highest operating level / design highest level switch set point and design lowest operating level / design lowest level switch set point.
3. 11.00 A liquid volume (corresponding to a minimum of 100 mm shell / liquid height in between design lowest operating level / design lowest level switch set point and top of side mounted outlet nozzle / bottom of tank) below the required effective liquid volume shall be considered & provided for satisfactory functioning of concerned level switch.
3. 12.00 Each atmospheric tank shall have sufficient free board (minimum 300 mm unless specified otherwise) above the design highest level / design highest level switch set point.
3. 13.00 The invert of overflow nozzle shall be kept at least 50 mm or 5 % of total height whichever is higher above the design highest level / design highest level switch set point for each of the atmospheric tanks, except for the Demineralized Water Storage Tanks.
3. 14.00 For Demineralized Water Storage Tanks, the invert of overflow nozzle shall be kept at least 500 mm or 5 % of total shell height whichever is higher above the design highest level / design highest level switch set point.
3. 15.00 A minimum 100 mm shell height shall be provided above the top of overflow nozzle of each atmospheric storage tank.
3. 16.00 Wall thickness of each of atmospheric tanks shall not be less than 6 mm. If higher thickness for any atmospheric storage tank is specified elsewhere in this Specification, the same shall be provided.
3. 17.00 Vessels coming under preview of IBR shall be designed accordingly.
4. 00.00 **MATERIAL OF CONSTRUCTION**
4. 01.00 The pressure vessels shall be designed as Class 3 vessels (as per IS-2825) and fabricated of steel as per IS-2062 / IS-2002 Grade 3 or SA-515 / 516 Grade 60 / 70 In case, the vessels are designed as Class 1 or Class 2 vessels (as per IS-2825), the material of construction shall conform to IS-2002 Grade 3.
4. 02.00 Atmospheric storage tanks shall be fabricated of mild steel as per IS-2062.
4. 03.00 The material of construction for various connections, for all the lined or unlined vessels/tanks shall be same as that of interconnecting piping material suitably lined wherever required. The pipe flanges, manhole/manhole covers, reinforcement pads etc. shall be fabricated out of the same material as that one used for the vessel / tank. However, screwed fittings for instrumentation, sample connection, drain connection of size 25 mm NB and less shall be of stainless steel construction (SS-316).

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5. 00.00	FABRICATION
5. 01.00	All pressure vessels and storage tanks except the large tanks like Demineralised Water Storage Tanks should preferably be fabricated and tested completely at manufacturer's works to ensure better workmanship.
5. 02.00	The plates to be used for fabrication shall preferably have a minimum width of 1500 mm.
5. 03.00	Ends of pressure vessels shall be of dished design and constructed of forging, pressing or spinning as per IS-4049.
5. 04.00	Interior surfaces of all atmospheric storage tanks shall be clear of stiffeners and other structural supports. Tanks shall be reinforced and stiffened externally as required.
5. 05.00	Plates to be used for fabrication of atmospheric vertical storage tanks shall be accurately formed in bending rolls to the diameters called for and cold rolled through plate bending machine by several number of passes to true curvature and joined by welding.
5. 06.00	The atmospheric vertical storage tanks shall have flat bottom.
5. 07.00	Ends of atmospheric horizontal storage tanks shall be of dished design and constructed of forging, pressing or spinning as per IS-4049. Conical or Flat Ends shall not be accepted.
5. 08.00	All welding shall be as per IS-816 or equivalent code (subject to approval by Purchaser). The qualification of the welders should be as specified in IS-817 and welding electrodes shall be as per relevant Codes / Standards.
5. 09.00	Bidder shall state clearly in his proposal the make and type of welding rods necessary for fabrication / construction work.
5. 10.00	Welding sequence shall be adopted in such a way so as to minimize the distortion due to welding shrinkage. The Bidder shall indicate in drawing, the sequence of welding proposed which should meet prior approval of the Purchaser. Welding shall not be carried out when the surface of the parts to be welded are wet from any cause and during periods of rain and high winds unless the welder and work are properly shielded.
5. 11.00	All seams shall be so positioned that they do not pass through connections of vessel / tank. The connections shall be flushed with inner surface of vessel / tank and welded continuous on both sides of the vessel / tank. Sharp inside edges shall be rounded to a minimum 3 mm radius. Inside seam weld shall be ground smooth, suitable for application of corrosion resistant coating / lining.
5. 12.00	All the joints (circumferential / longitudinal) shall be double butt welded with full penetration or single butt welded without backing strip. For joints involving small thickness 6 mm or less, back chipping to metal followed by DP test and re-welding shall be done to have full penetration.
5. 13.00	All internal baffles, wear plates, pipes etc. shall be continuously welded on both sides at all contact points with full fillet welds which shall be free of voids, gaps,

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- craters, high spots, sharp edges, and undercutting. Sharp edges shall be ground to a 3 mm minimum radius.
5. 14.00 All welds on inner surface of vessel / tank shall be free of voids, gaps, craters, pits, high spots, sharp edges, abrupt ridges and valleys or undercut edges. High spots, irregularities and sharp edges shall be removed by grinding.
5. 15.00 Weld splatter shall be removed.
5. 16.00 Inspection of all welds shall be carried out in accordance with IS-822 'Code of Practice for Inspection of Welds.'
6. 00.00 **APPURTENANCES**
6. 01.00 Internals for pressure vessels and atmospheric storage tanks shall be provided as detailed out elsewhere in the specification and as further required.
6. 02.00 All the pressure vessels and atmospheric storage tanks shall be provided with drain connections along with drain valves of suitable size.
6. 03.00 All the pressure vessels and atmospheric storage tanks shall be provided with the vent connections. The design shall be as to offer adequate area for venting. Venting area shall be such that over pressure/vacuum is not created during maximum filling / withdrawal rate. The maximum withdrawal rate for the Demineralized Water Storage Tanks shall be intimated later at detail engineering stage to the Bidder.
6. 04.00 Various instrumentation and the fittings required for the pressure vessels and atmospheric storage tanks shall be provided as elaborated elsewhere in the specification.
6. 05.00 **Manholes / Hand Holes**
- 6.05.01 Manholes shall be provided for all pressure vessels and atmospheric storage tanks to provide easy access into the same. The diameter shall be minimum 500 mm and each manhole will be provided with cover plate, nuts, bolts and gaskets to ensure leak tightness at the test pressure. Manholes shall be davit type for rubber lined vessels.
- 6.05.02 Each of the pressure vessels and horizontal type storage tanks shall be provided with at least one manhole at the top.
- 6.05.03 Each of the vertical type atmospheric storage tanks with diameter 1200 mm or more shall be provided with a manhole on the top. For the Demineralized Water Storage Tanks, manholes shall be provided as per IS-803.
- 6.05.04 Each of the pressure vessels filled with ion exchange resins shall be provided with a handhold of diameter at least 150 mm at a level in the vicinity of bottom of resin bed.
- 6.05.05 The required lining / coating for the inside surface of the manhole / handhold, nozzle and cover plate of the manhole/ handhold shall be same as that of the respective vessel/tank.
6. 06.00 **Nozzle Connections**

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- 6.06.01 Bidder shall furnish all materials required for nozzle connections with reference to system requirements. In addition to these, additional nozzle connections, if required by the Purchaser for the inter-connection with other systems / piping / instruments etc. shall also be provided. Such additional requirements may be intimated to the Bidder later at detail engineering stage and Bidder shall provide the same complete with necessary supports and other accessories without any sort of price implication whatsoever.
- 6.06.02 Nozzle wall thickness shall be as per relevant code for design to be followed for the vessel/tank in questions.
- 6.06.03 All flanged connections should be supplied complete with matching counter flanges, bolts, nuts and gasket materials. The flange design (thickness and drilling etc.) shall match with the interconnected piping flanges.
- 6.06.04 Bolts and nuts to be used externally to the vessels shall be of hexagonal head conforming to IS-1367. However fasteners if any within tanks shall be of SS-316 / SS-304 or Hastalloy-B as per the duty conditions / requirements.
- 6.06.05 Gaskets shall be of full face type.
6. 07.00 Sight glasses shall be provided for the tanks/vessels as specified elsewhere in the specification. The material for sight glass shall be high quality transparent PLEXIGLASS of sufficient thickness to withstand the test pressure. The sight glass shall be provided with suitable gaskets and bolts to ensure leak tightness at the test pressure.
6. 08.00 **Vessels Supports / Lifting Lugs**
- 6.08.01 Adequate supporting arrangements like legs, straps, saddles, skirt boards, pillars etc. for the pressure vessels and atmospheric storage tanks shall be provided to transfer all loads to civil foundation. All foundation bolts, inserts etc. shall also be provided.
- 6.08.02 All vessels shall be provided with lifting lugs, eye bolts etc. for effective handling during erection.
- 6.08.03 All vessels of internal, diameter of 1200 mm or greater shall be provided with minimum four (4) lifting lugs for safe and effective handling during erection. Smaller vessels shall be provided with atleast two (2) lifting lugs.
- 6.08.04 Material of construction for these vessel supports, saddles, lugs shall conform to IS-2062.
6. 09.00 **Special Accessories for Tanks**
- 6.09.01 Each of all the tanks shall be provided with over flow connection designed for the filling rate of the respective tank.
- 6.09.02 Water Seal shall be provided for the overflow line of Demineralized Water Storage Tanks. Vent line of Demineralized Water Storage Tanks shall be provided with Carbon-Di-Oxide Absorber / Breather of proven design to prevent contamination from atmospheric air. Carbon-Di-Oxide Absorber / Breather shall preferably be located at finished floor / pavement level.

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- 6.09.03 The vent and overflow lines of Acid Bulk Storage / Day / Measuring Tanks shall be provided with fume absorber using suitable packing material, such as pall rings / raschig rings.
- 6.09.04 The vent and overflow lines of Alkali Bulk Storage / Preparation / Day / Measuring Tanks shall be provided with Carbon-Di-Oxide Absorber / Breather as addressed under clause no. 6.05.02 above.
- 6.09.05 Conservation Vent Valve shall provided on each of Demineralized Water Storage Tanks to ensure minimum contact with air. The valve should normally be closed. With vacuum or pressure to the extent of 65mm water gauge into the tank, the valve shall open to relieve the vacuum or pressure.

Material of construction should be as follows:

Body & valve disc	-	Die cast aluminium.
Spindle	-	Steel
Spring	-	Phosphor Bronze
Seal	-	Rubber

7.00.00 **ERECTION**

- 7.01.00 Each of all pressure vessels and atmospheric storage tanks should be directly placed on the civil foundation when supplied in fully fabricated form.
- 7.02.00 All fabricated part, before assembly, shall be transported by the Bidder to installation at site. All preliminary work and fabrication in part or full shall be done at the Bidder's fabrication yard or shop.
- 7.03.00 All material before final installation over the foundation at the respective locality shall be inspected and faired as necessary to ensure that any damage received during transportation is corrected before erection to the satisfaction of the Purchaser. Particular attention shall be given towards removal of buckles and other form of distortion in shell and bottom plates of vertical atmospheric storage tanks. Irregularities and dirt which would prevent metal to metal contact at the jointing faces shall be removed.
- 7.04.00 The method of holding the plates in position during welding and all devices used for this purpose should be approved by the Purchaser. All lap joints shall be held in close contact during welding and the surface in contact shall be thoroughly cleaned before assembly.
- 7.05.00 Holes in plate work to assist in erection should be avoided as far as possible. The location of the holes shall be indicated in the fabrication drawing. The method of filling holes shall be approved by the Purchaser. Lugs attached by welding to the tank and required only for the purpose of erection shall be removed and any projections of weld metal shall be chipped and grounded flush with the plate surface.
- 7.06.00 In the construction of the shell, every care shall be taken to minimize distortion or lack of circularity due to welding or for any other reason.

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- 7.07.00 Tanks shall be safeguarded against damage due to wind or any other external causes by providing suitable steel cable guys until completion.
- 7.08.00 All materials used by the Bidder such as electrodes, gaskets, bolts and nuts, paints and any other appurtenance shall be conforming to relevant Indian Standard Code of Practice or equivalent (subject to approval by the Purchaser). Manufacturer's test certificate for guaranteed performance shall have to be provided when called for.
- 7.09.00 The finished bottom plate of vertical atmospheric tanks shall be crowned from the outer periphery to the centre with a slope of 1:36. Sufficient number of plugged holes shall be provided in bottom plate of the tanks for bottom testing.
8. 00.00 **PROTECTIVE LINING AND PAINTING**
8. 01.00 Inside surfaces of all pressure vessels and atmospheric storage tanks shall be protected by anticorrosive paints or rubber lining as required / specified. External surfaces of all pressure vessels and atmospheric storage tanks shall be protected by anti corrosive painting.
8. 02.00 The supply and application of Protective Lining and Painting with reference to pressure vessels and atmospheric storage tanks need to be as per **Sub Section: M7 – Technical Specification for Protective Lining and Painting**, attached herewith.
9. 00.00 **TESTS AND INSPECTION**
9. 01.00 All pressure vessels shall be hydraulically tested at 1.5 times design pressure or 2 times the maximum working pressure whichever is higher, for a period not less than one (1) hour.
9. 02.00 All atmospheric storage tanks shall be tested for leak tightness by filling up with water up to the highest level for a period not less than 8 hours.
9. 03.00 Full rubber lining is to be tested as per IS-4682 Part I for the following tests:
- (a) Adhesion tests
 - (b) Tests to check resistance to bleeding
 - (c) Measurement of lining thickness
 - (d) Shore hardness test
 - (e) Spark test at high voltages 5 KV / mm of thickness with a gap of 8 mm between the probe and lining.
9. 04.00 Thickness of painting shall be checked with dry type thickness gauge.
9. 05.00 Vessels as per IBR shall be tested accordingly.
9. 06.00 DP test after back gauging and on complete welds on atmospheric tanks and pressure vessels need to be carried out.
9. 07.00 All non-destructive tests shall be carried out as per the applicable design code / standard for all pressure vessels and atmospheric tanks.

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| 9. 08.00 | Butt welds if any on the dished ends shall be radio graphed after dishing and shall be stress relieved. |
| 9. 09.00 | All dished ends for pressure vessels shall be stress relieved after dishing. |
| 9. 10.00 | All weld procedure and welder qualification certificates shall be verified. |
| 9. 11.00 | All painting on vessels and tanks shall be checked for the thickness as per the specification mentioned elsewhere. |
| 9. 12.00 | All materials to be used for the pressure vessels and atmospheric tanks and accessories should be of tested quality and test certificates shall be made available to the Purchaser. |

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**TECHNICAL SPECIFICATION
FOR
PIPING, FITTINGS AND VALVES**

373942/2021/PS-PEM-MAX

C O N T E N T S

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**TECHNICAL SPECIFICATION
FOR
PIPING, FITTINGS & VALVES**

1.00.00 INTENT OF SPECIFICATION

This specification covers the design, manufacturing, inspection, shop testing, erection, testing and commissioning at site of all the piping, fittings, valves and all other accessories as specified and as further required.

2. 00.00 SCOPE

The items & materials to be supplied shall include but not be limited to the following:

- 2. 01.00 Pipes, bends, elbows, tees, branches laterals, crosses, reducing unions, couplings, cap, expansion joints, flanges, blank flanges, saddles, shoes, sampling connections etc. necessary for making a reliable piping system.
- 2. 02.00 Gaskets, ring joint, backing rings, jointing material etc. as required.
- 2. 03.00 Instrument tapping connection, stub and thermowells.
- 2. 04.00 Supply and machining work of flanges, pipe spools and matching pipes to connect flow measuring orifice nozzles etc., pressure accumulators as necessary.
- 2. 05.00 Valves and Isolation Gates, to start/stop and control / regulate flow.
- 2. 06.00 Strainers.
- 2. 07.00 Anchor blocks (for buried / over ground piping), support brackets, clamps, support trestles, hangers, vibration dampener etc. for the piping under the scope of contract.
- 2. 08.00 Bolts, nuts, fasteners as required for interconnecting piping, valves and fitting as well as for terminal points.
- 2. 09.00 Steel for pipe supports and embedded steel. Also pipe supports and necessary embedment required to be embedded in concrete for underground / above ground pipes.
- 2. 10.00 Painting, anti-corrosive coatings, etc. inside and outside of pipes as necessary and as specified.
- 2. 11.00 All embedded parts required for all tanks/water retaining structures made of RCC including puddle pipes shall be supplied by the Bidder.

3. 00.00

CODE & STANDARDS

The design, manufacture, fabrication shop testing & inspection, erection, testing and commissioning of piping fittings and valves shall conform to the latest revisions of the following Indian / International codes / standards and other applicable statutory codes / ordinances, rules, regulations as well as safety codes, in addition to other codes / standards if any as addressed elsewhere in the Tender Specification.

Other National / International Standards may also be considered acceptable (subject to specific approval by Purchaser) with reference to any specific situation / requirement provided they are recognized to be equivalent or superior to the Standards as stipulated in the Tender Specification.

ANSI	-	B 16.5	:	Steel pipe flanges and flanged fittings.
ANSI	-	B 16.9	:	Wrought steel Butt welding fittings
ANSI	-	B 16.11	:	Forged steel socket welding and screwed fittings
ANSI	-	B 16.21	:	Non Metallic Gaskets for Pipe Flanges
ANSI	-	B 16.25	:	Butt welding ends
ANSI	-	B 16.28	:	Wrought Steel Butt Welding short radius elbows and returns
ANSI	-	B 31.1	:	Power Piping code.
ANSI	-	B 36.10	:	Welded & seamless wrought steel pipe
ANSI	-	B 36.19	:	Stainless steel pipe
API	-	5L	:	Specification for Line Pipe
ASME	-	Section II	:	Ferrous Materials Specification
ASTM	-	A 53	:	Seamless carbon steel.
ASTM	-	A 106	:	Grade C Seamless carbon steel pipe.
ASTM	-	F441 / F441M - 09	:	Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80
ASTM	-	F439 - 11	:	Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80

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AWWA	-	C-203	:	Coal tar protective coatings and linings for steel water pipe lines - Enamel and Tape - Hot Applied
AWWA	-	C-208	:	Dimensions for Steel Water pipe fittings
AWWA	-	C-504	:	Standard for butterfly valve.
BS	-	1868	:	Specification for steel check valves (flanged and butt-welding ends) for the petroleum, petrochemical and allied industries
BS	-	5158	:	Specification for cast iron plug valves
BS	-	5353	:	Specification for steel plug valves
BS EN	-	593	:	Industrial valves. Metallic butterfly valves
BS EN	-	1796	:	Plastics piping systems for water supply with or without pressure. Glass-reinforced thermosetting plastics (GRP) based on unsaturated polyester resin (UP)
BS EN	-	13397	:	Industrial valves. Diaphragm valves made of metallic materials
BS EN	-	13789	:	Industrial valves. Cast iron globe valves
BS EN	-	14364	:	Plastics piping systems for drainage and sewerage with or without pressure. Glass-reinforced thermosetting plastics (GRP) based on unsaturated polyester resin (UP). Specifications for pipes, fittings and joints
BS EN ISO	-	16138	:	Industrial valves. Diaphragm valves of thermoplastics materials
DIN	-	16966	:	Glass fibre reinforced polyester resin (UP-GRP) pipe fittings and joint assemblies - Requirements for and testing of bushes, flanges, and flanged and laminated joints
IS	-	210	:	Grey Iron Castings
IS	-	318	:	Leaded Tin Bronze Ingots and Castings
IS	-	458	:	Precast Concrete Pipes (with and without reinforcement).
IS	-	554	:	Pipe Threads where Pressure Tight-Joints are made on the Threads – Dimensions, Tolerances and Designation.

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IS	-	778	:	Copper Alloy Gate, Globe and Check Valves for Waterworks Purposes.
IS	-	783	:	Code of Practice for Laying of Concrete Pipes.
IS	-	1239 Part 1	:	Steel Tubes, Tubulars and other Wrought Steel Fittings - Specification Part 1 Steel Tubes
IS	-	1239 Part 2	:	Specification Steel Tubes, Tubulars and other Steel Fittings Part 2 Steel Sockets Tubular and other Steel Pipe Fittings
IS	-	1363	:	Hexagon Head Bolts, Screws and Nuts of Product Grade C.
IS	-	1364	:	Hexagon Head Bolts, Screws and Nuts of Product Grades A and B.
IS	-	1367	:	Technical Supply Conditions for Threaded Steel Fasteners.
IS	-	1536	:	Indian Standard for Centrifugally Cast (Spun) Iron Pressure Pipes for Water, Gas and Sewage.
IS	-	1537	:	Vertically Cast Iron Pressure Pipes for Water Gas and Sewage.
IS	-	1538	:	Cast Iron Fittings for Pressure Pipes for Water, Gas and Sewage.
IS	-	1703	:	Water Fittings - Copper Alloy Float Valves (Horizontal Plunger type)
IS	-	1879	:	Malleable Cast Iron Fittings
IS	-	2016	:	Plain washers
IS	-	2062	:	Hot Rolled Low, Medium and High Tensile Structural Steel.
IS	-	2629	:	Recommended practice for Hot dip galvanising of iron and steel
IS	-	2633	:	Method for testing uniformity of coating on zinc coated articles.
IS	-	2379	:	Colour Code for Identification of Pipe Lines.

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IS	-	2685	:	Code of Practice for Selection, Installation and Maintenance of Sluice Valves.
IS	-	2712	:	Gaskets and Packings- Compressed Asbestos Fibre Jointing.
IS	-	2825	:	Code for Unfired Pressure Vessels.
IS	-	3006	:	Chemically Resistant Glazed Stoneware Pipes and Fittings.
IS	-	3042	:	Single Faced Sluice Gates (200 to 1200 mm size).
IS	-	3114	:	Code of Practice for Laying of Cast Iron Pipes.
IS	-	3589	:	Steel Pipes for Water and Sewage (168.3 to 2540 mm Outside Diameter).
IS	-	4038	:	Foot Valves for Waterworks Purposes.
IS	-	4682 (Part I)	:	Code of practice for lining of vessels and equipment for chemical - rubber lining.
IS	-	4736	:	Hot-dip Zinc Coatings on Mild Steel Tubes.
IS	-	4984	:	High Density Polyethylene Pipes for Potable Water Supplies.
IS :	-	4985	:	Unplasticized PVC Pipes for Potable Water Supplies.
IS :	-	5312	:	Swing Check Type Reflux (non-return) Valves for Water Works Purpose.
IS :	-	5822	:	Code of practice for laying of electrically welded steel pipes for Water supply.
IS :	-	8062	:	Code of practice for cathodic protection (Part-II) of steel structure
IS :	-	10221	:	Code of practice for coating and wrapping of underground mild steel pipes
IS :	-	14846	:	Sluice Valve for Water Works Purposes (50 to 1200 mm Size).

4. 00.00 DESIGN, MANUFACTURE, FABRICATION AND ERECTION

4.01.00 The piping system, fittings and accessories supplied shall conform to high standards of engineering, design, workmanship and be capable of performing in continuous commercial operation in a manner acceptable to Purchaser.

4.02.00 All the piping systems, fittings and accessories supplied under this package shall be designed to operate without replacement and with normal maintenance for a plant service life of 25 years and shall withstand the operating parameter fluctuations and cycle variations which can be normally expected during this period.

4.03.00 Material of construction for pipes under different services shall be as below:

Service	Recommended Material of Construction
River Water	Carbon Steel
Clarified Water	Carbon Steel
Filtered Water	Carbon Steel (inside rubber lined)
Degassed Water	Carbon Steel (inside rubber lined)
Demineralised Water	Carbon Steel (inside rubber lined)
Service Air	Galvanized Steel
Instrument Air	Stainless Steel (schedule 40)
Potable Water	Galvanized Steel
Chlorine (liquid under pressure)	Seamless Carbon Steel (schedule 80)
Chlorine (dry gaseous under pressure)	Seamless Carbon Steel (schedule 80)
Chlorine under vacuum	CPVC (schedule 80)
Chlorine in water	CPVC (schedule 80) / Carbon Steel (inside rubber lined)
Sodium Hydroxide Solution	CPVC (schedule 80) / Carbon Steel (inside rubber lined)
Alum Solution	CPVC (schedule 80) / Carbon Steel (inside rubber lined)

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Service	Recommended Material of Construction
Lime Solution	Galvanized Steel
Polyelectrolyte Solution	CPVC (schedule 80) / Carbon Steel (inside rubber lined)
Hydrochloric Acid (concentrated)	Carbon Steel (inside rubber lined)
Hydrochloric Acid (dilute)	Carbon Steel (inside rubber lined)
Sodium Hydroxide (concentrated)	Carbon Steel (inside rubber lined)
Sodium Hydroxide (dilute)	Carbon Steel (inside rubber lined)
Sulfuric Acid Solution (concentrated)	Carbon Steel
Sulfuric Acid Solution (dilute)	Carbon Steel (inside rubber lined)
Scale Inhibitor Solution	Stainless Steel (schedule 40) / CPVC (schedule 80)
Corrosion Inhibitor Solution	Stainless Steel (schedule 40) / CPVC (schedule 80)
Biocide Solution	Stainless Steel (schedule 40) / CPVC (schedule 80)
Filter Backwash Wastewater	Carbon Steel
Ammonia Solution	Seamless Stainless Steel (304 grade)
Hydrazine Solution	Seamless Stainless Steel (304 grade)
Oxygen Line	Aluminum
Crude Condensate	Carbon Steel (inside rubber lined)
Treated Condensate	Carbon Steel (inside rubber lined)
Demineralized Water with ion exchange resins	Stainless Steel (304 grade)
Non Oily Sludge	Cast Iron (underground) Carbon Steel (overground)
Neutralized Wastewater	Carbon Steel (inside rubber lined)

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Cooling Tower Blowdown	Carbon Steel
Boiler Blowdown	Carbon Steel
Crude Oily Wastewater	Seamless Carbon Steel
Treated Oily Wastewater	Seamless Carbon Steel
Rainfall Runoff	Carbon Steel
Equalized Wastewater	Carbon Steel
Oily Sludge	Seamless Carbon Steel

The portion of pipe lines at the downstream of isolation valves, conveying flushing water shall be of the material & type same as those of the pipelines which are being flushed.

4.04.00 Material & Dimensional Standards for Piping and Fittings

4.04.01 The welded Carbon Steel Pipes shall conform to the following codes / standards:

Pipes	Material Code / Standard	Dimension Code / Standard
50 mm NB and below	Mild Steel, ERW, IS-1239 Part-1 / ASTM-A 53 Grade B (Welded), Type-E, Schedule 80.	IS-1239 Part-1. Plain ends for Socket Welding.
65 mm to 150 mm NB	Mild Steel, ERW, IS-1239 Part-1 / ASTM-A 53 Grade B (Welded), Type-E, Schedule 40.	IS-1239 Part-1. Bevelled ends for Butt Welding.
200 mm to 450 mm NB	Mild Steel, ERW, IS-3589 Grade Fe 410 / ASTM-A 53 Grade B (Welded), Type-E, Schedule 40.	IS-3589. Bevelled ends for Butt Welding.
500 mm NB and above	Rolled and Butt Welded from IS-2062 Grade A plates or SA-285 Grade C or Equivalent (subject to approval by Purchaser). / Spiral Welded pipes.	IS-3589. Bevelled ends for Butt Welding.

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Elbows (R=1.5 D)	Material Code / Standard	Dimension Code / Standard
50 mm NB and below	Forged carbon steel from ASME-SA 105 / Carbon Steel to IS-1239 Part-2 (Heavy grade).	SW ends to ANSI-B 16.11 (3000#) / IS-1239 Part-2.
65 mm to 150 mm NB	ASME-SA 234 Grade WPB / Carbon Steel to IS-1239 Part-2 (Heavy grade).	BW ends to ANSI-B 16.9 / IS-1239 Part-2.
200 mm to 350 mm NB	ASME SA-234 Grade WPB	BW ends to ANSI-B 16.9 / IS-1239 Part-2.
Mitre Bends (R=1.5 D)	Material Code / Standard	Dimension Code / Standard
400 mm NB and above	Fabricated from parent pipe.	ANSI-B 31.1 / AWWA-C 208. 90° - 3 cut, 4 piece constructions. 45° - 2 cut, 3 piece constructions.
Tees	Material Code / Standard	Dimension Code / Standard
50 mm NB & below	Forged Carbon Steel to ASME-SA 105 / ASME-SA 234 Grade WPB / Carbon Steel to IS-1239 Part-2 (Heavy grade).	SW ends to ANSI-B 16.11 (3000#) / IS-1239 Part-2.
65 mm to 150 mm NB	ASME-SA 234 Grade WPB / Carbon Steel IS-1239 Part-2 (Heavy grade).	BW ends to ANSI-B 16.9 / IS-1239 Part-2.
200 mm NB and above	ASME-SA 234 Grade WPB / Fabricated from parent pipe.(set in / set on type).	ANSI-B 16.9
Reducers	Material Code / Standard	Dimension Code / Standard
50 mm NB & below	Forged carbon steel to ASME-SA 105 / ASME-SA 234 Grade WPB / Carbon Steel to IS-1239 Part-2 (Heavy grade).	SW ends to ANSI-B 16.11 (3000#) / IS-1239 Part-2.
65 mm to 150 mm NB	ASME-SA 234 Grade WPB / Carbon Steel to IS-1239 Part-2 (Heavy grade).	BW ends to ANSI-B 16.9 / IS-1239 Part-2.

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200 mm NB and above	ASME-SA 234 Grade WPB / Fabricated from parent pipe.(set in / set on type)	ANSI-B 16.9
Slip On Flanges / Blind Flanges	Material Code / Standard	Dimension Code / Standard
All sizes	IS-226 / IS-2062 Grade A / ASME-SA 105 / ASTM-A 216 Grade WCB. Flanges shall be either machined or forged from plate / casting.	Dimensions / Drilling as per ANSI-B 16.5, Pressure rating 150# / 300# or otherwise as applicable, generally Flat face.
Bolts & Nuts	Material Code / Standard	Dimension Code / Standard
All sizes	IS -1367 Cl 4.6 for bolts IS-1367 Cl 4 for nuts	IS -1367
Gaskets	Material Code / Standard	Dimension Code / Standard
All sizes	3 mm thick wire reinforced rubber. Material shall contain no asbestos.	ANSI-B 16.21.

- 4.04.02 Seamless Carbon Steel Pipe shall conform to ASTM-A 106 Grade C (Schedule 80) / ASTM-A 53 / API 5L. Fittings shall conform to applicable codes / standards and be in conformity with the code / standard for the parent pipe.
- 4.04.03 Galvanized Steel Pipes and Fittings shall conform to the clause 4.02.01 above and be galvanized to IS-4736. Ends of all fittings will however be screwed as per IS-554. Mitre Bends shall not be used. Pipe joints shall be screwed for lower size and flanged for higher size. No hot work on G.I. pipes shall be done. Flanges shall be screwed and hot dipped galvanized.
- 4.04.04 Pipes and Fittings which shall be rubber lined, need to conform the clause 4.02.01 above. The inside surfaces of the items shall be completely deburred and made suitable for lining. The items will be inside rubber lined with 3 mm thick (minimum) natural rubber in two layers as per IS-4682. Flanges shall be flat face as per ANSI-B 16.5 and full face rubber lined. Pipe to Pipe joint will be flanged only. For small size fittings, SS-316 fittings shall be used if rubber lined carbon steel fittings are not available.
- 4.04.05 Stainless Steel Pipe shall conform to ASTM-A 312 of specified grade (Schedule 40) with dimensions as per ANSI-B 16.39. Fittings shall conform to applicable codes / standards and be in conformity with the code / standard for the parent pipe. Mitre Bends shall not be used. Elbows / Tees / Reducers shall be of Forged Stainless Steel (ASME-SA 182) with SW ends to ANSI-B 16.11 (3000#).

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- 4.04.06 Cast Iron pipes shall conform to IS-1536. Fittings shall conform to applicable codes / standards and be in conformity with the code / standard for the parent pipe.
- 4.04.07 PVC Pipes shall conform to IS-4984 Class 4. Fittings shall conform to applicable codes / standards and be in conformity with the code / standard for the parent pipe.
- 4.04.08 High density Polyethylene Pipes shall conform to IS-4984 Class 5. Fittings shall conform to applicable codes / standards and be in conformity with the code / standard for the parent pipe.
- 4.04.09 CPVC pipe (Schedule 80) shall be produced from compounds which conform to and are specified in ASTM-D 1784. CPVC Pipe shall be manufactured in strict compliance with ASTM-F 441. Pressure-Rated CPVC Pipe shall be manufactured in strict compliance with ASTM-F 442. All CPVC piping shall be manufactured from NSF approved compounds and NSF Listed for potable water use. CPVC Fittings (Schedule 80) shall be as per ASTM-F 437 and F 439.
- 4.04.10 Pipe lines carrying water, chemicals, air etc. shall be sized generally based on the following ranges of velocities. However pipe size if any for any particular service is addressed in the Tender Drawings / Data Sheets, the selected size for the applicable service shall not be less than the specified size.

Pipe Size	Velocity in m/sec		
	Below 50 mm	50 mm - 150 mm	200 mm & above
Pump Suction for Water		1.2 - 1.5	1.2 - 1.8
Pump Discharge for Water	1.2 - 1.8	1.8 - 2.4	2.1 - 2.5
Header		1.5 - 2.4	2.1 - 2.4
Compressed air below 2 Kg/cm ² (g)	15 - 20	20 - 30	25 - 35
Compressed air 2 Kg/cm ² & above	20 - 30	25 - 40	35 - 45
Suction to compressor/ Blowers		7 - 8	
Pump Suction for Chemical Solution	1.0 - 1.2	1.1 - 1.3	
Pump Discharge for Chemical Solution	1.2 - 1.4	1.3 - 1.5	

- 4.05.00 Pipe line under gravity flow shall be restricted to a flow velocity of 1 m/sec generally. Channels under gravity flow shall be sized for a maximum flow velocity of 0.6 m/sec.

- 4.06.00 The following "C" Value shall be used in WILLIAM & HAZEN formula for calculating the friction loss in piping and fittings.

i)	Carbon Steel Pipe	:	100
ii)	C.I Pipe	:	100
iii)	Carbon Steel Pipe (inside rubber lined)	:	120
iv)	PVC / HDPE / GRP / CPVC pipes	:	140

For calculating the pump head, atleast 10% margin shall be taken over the pipe friction losses.

- 4.07.00 Piping Layout

- 4.07.01 Piping shall be grouped together as far as practicable and routed to present a neat appearance and orientation. All piping shall generally be installed perpendicular or parallel to the major equipment, building structure and floor. Pipe routing shall be such as to provide sufficient clearance for removal and maintenance of equipment, easy access to valves, instruments and other accessories. The piping shall not encroach on the withdrawal space of other equipment. Piping shall be routed to avoid interferences with other pipes, hangers, structures, equipment electrical trays, HVAC ducts etc. Convenient supporting points, adequate flexibility for thermal expansion and neat appearance shall be considered in piping layout work.

- 4.07.02 Provision shall be made while preparing piping layout to accommodate all system accessories such as valves/ expansion bellows/instrument stubs/instruments/ specialties as per P&ID.

- 4.07.03 All local instruments on the pipeline shall be located such that the reading can be observed without inconvenience.

- 4.07.04 Overhead indoor piping shall have a vertical clearance of minimum 3.0 m above finished floor level of working areas / walkways. Overhead outdoor piping shall have a vertical clearance of minimum 4.0 m above finished ground level and minimum 7.5 m above finished road level unless addressed otherwise elsewhere in this specification. When several pipe lines are laid parallel, flanged joints must be staggered. Welded and flanged joints should as far as possible located at one third span from supports. If the support is situated right under the welded joints this joint must be reinforced with a strap. Flanged and welded joints must be avoided in the middle of the span. Valves should be located in such a manner so as to ensure their convenient operation from the floor or the nearest platform.

- 4.07.05 In specific cases (subject to instruction by Purchaser for any site specific reason), pipes may be routed overground on RCC pedestals with bottom of pipes minimum 300 mm above finished ground level.

- 4.07.06 Pipe, when specifically addressed, shall be laid in trenches or buried. All buried pipes in general shall be laid with the top of the pipe 1.2 m to 1.5 m below the finished ground level unless mentioned otherwise. Full length of buried piping shall be provided with 100 mm thick sand bed.

- 4.07.07 Openings provided to accommodate pipelines must be closed with bricks and mortar with 10 mm to 12 mm clearance between brick work and pipe. The clear space must

be filled with felt or approved filling compound. The details of wall sealing arrangement shall be approved by Purchaser.

4.07.08 Drains shall be provided at low points and at pockets in piping such that complete drainage of system is possible. Vent connections shall be provided at high points where air or gas pockets may occur. Vent for use during hydrostatic test shall be plugged after the completion of the test. Vents shall not be less than 15 mm size. Plugs / cocks required for vent/drain system shall form part of the piping system and shall be supplied by Bidder as per finalized flow diagram. All vent valves & drain valves shall be arranged with easy reach of operation. All pipelines shall be given proper slope towards the drain points.

4.07.09 To facilitate dismantling of piping at the valves and equipment, break up flange/unions shall be provided. The location shall be decided as per the system requirement during detailed engineering.

4.08.00 Line Joints

Line Joints shall be envisaged as follows:

CS and SS pipes	:	Welded (socket welded for 50 mm NB & below & butt welded for 65 mm NB and above)
Galvanized Pipes	:	Screwed
Rubberlined Pipes	:	Flanged

4.08.01 Welded joints

For making welded joints (socket weld or butt weld) the welding shall be performed by manual shielded metal arc process. Any welder employed for carrying out welding shall be qualified as per ASME-Section IX for the type of joints to be welded. Jointing by butt weld or socket weld shall depend upon the respective piping material specification.

For Stainless Steel piping atleast the root run shall be welded with Tungsten Inert Gas (TIG).

Butt welding edge preparation shall be done as per ANSI-B 16.25.

All welding electrodes and welding rods including special ones, if any shall be furnished by the Bidder.

4.08.02 Screwed joints

Threading of pipes shall be carried out after bending, heat treatment etc. If not possible, threading may be done prior to these operations but proper care should be taken to protect them from damage. Threads shall be to ANSI-B 2.1 (taper) NPT / IS 554, unless specified otherwise.

Teflon tapes shall be used to seal screwed joints and it shall be applied to the male threads only. Threaded parts shall be wiped clean of oil or grease (with appropriate

solvent if necessary) and dried before applying the sealant. Pipe ends shall be reamed or filed out to size of bore and all chips shall be removed. Screwed flanges shall be attached by screwing the pipe through the flange and the pipe as well as the flange shall be refaced accurately.

4.08.03 Flanged joints

All flanges and flange drilling shall be to ANSI-B 16.5 of applicable pressure/temperature class. However in case of interface with the pipe of Purchaser, the flange/interconnection details shall be designed to match the applicable interface piping and concerned details.

When weld neck or socket weld flanges are used, their bore must be made the same as that of the pipe being welded to. Socket welded or threaded flanges may be used, with the appropriate piping system for connection of pipe to the flanged equipment.

Drilling of flanges on piping must match with the drilling of flanges on the valves / equipments to which the piping is to be connected.

While fitting the mating flanges, care shall be taken to properly align the pipes and to check the flanges to trueness so that the faces of the flanges can be pulled up together without producing any stress on the adjacent pipes and equipment flanges.

Flanges shall be generally Slip-On / Blind Flat Face type. The packing ring or gasket of the flanged joint shall be of full face type. Flanged joints shall not be buried.

4.08.04 With reference to maintenance for carbon steel pipes, three piece socket welded unions for sizes 50 mm NB and below shall be used. For higher sizes, flanged joints shall be used.

4.09.00 Fabrication of Pipes

4.09.01 General Requirements

The Bidder shall prepare necessary fabrication drawings based on approved piping layouts.

Flanges and their contact surfaces shall be concentric with the pipe axis and shall be accurately machined and drilled true to template.

Where welded pipe and fittings are used, the longitudinal weld seams of adjoining sections shall be staggered by 90 degree.

Prefabrication shall be carried out in the fabrication shop to ensure quality of work and to minimize work on the field.

Where fabricated reducers have been specified, they shall be fabricated from parent pipes by the 'cut and shut' method.

All bends, tees and reducers shall be fabricated as per the latest edition of power piping code, ANSI-B 31.1 or approved equivalent. Reinforcement wherever required, shall be provided.

Only shop fabricated mitre bends or mitre fittings shall be acceptable. Mitre bends will not be accepted for steel pipes of 350 NB and below. For sizes 400 mm NB and above, the mitre bends shall conform to BS-534.

For easy handling & removal of equipment, valves etc. and for maintenance purpose, break up flanges shall be provided for 65 mm NB and above. For flanged joints of 50 mm NB and below, suitable type of compression flexible coupling shall be provided.

4.09.02 Rolled and Welded /Spiral Welded Pipes

Pipes of larger diameter shall be fabricated from steel plates conforming to IS-2062 by rolling and welding or spiral welded pipes shall be used.

Where pipe lengths need to be erected before the circumferential joints is welded, the pipe ends at these joints shall be beveled so that the top half is welded mostly from outside and the bottom half mostly from inside of pipe.

Beveled (single V / double V) ends shall be provided for butt welding as per Welding Procedure Specification.

4.09.03 Fabrication of flanges for large diameter pipes (sizes 600 mm NB and above)

Flanges fabricated from plates shall conform to AWWA-C 207 / BS-4504 / ANSI-B 16.47.

All welds in fabricated flanges shall be subjected to 10% radiographic examination.

Flanges shall be flat faced machined to 10 microns surface finish. Back face of the flanges shall also be machined to 25 microns surface finish.

Inspection holes shall be provided at suitable locations for pipes 800 mm NB and above as required for periodic observations and inspection purposes.

4.09.04 Rubber Lined Pipes

All rubber lined pipes shall be seamless or bead removed ERW pipes. Inside surface of the pipes shall be completely cleaned and made suitable for lining.

All rubber lined pipes shall have flanged joints. Pipes shall be welded with flanges before rubber lining.

For rubber lined pipe, natural rubber lining should be applied in two (2) layers on the inside surface of pipes, giving a total thickness not less than 3 mm. Surface hardness of rubber lining shall be 65 ± 5 Shore A class.

4.09.05 Welding

Welding shall be carried out by manual shielded metal arc and Tungsten Inert Gas

Welding process. Electrodes used shall be of Purchaser approved make. Electrodes shall be kept dry and electrode containers shall be protected against moisture. Electrodes that show sign of deterioration or damage shall not be used. Automatic or semiautomatic welding shall be done with the specific approval of Purchaser.

The Bidder shall submit procedures for welding, stress relieving, dye penetrant testing radiography etc. for prior approval of the Purchaser.

Weld shall not be made in pipe bends.

4.10.00 Supports for Overground Pipe

4.10.01 Complete supporting system for the pipe line shall be designed, fabricated and supplied by the Bidder. Inside the building, the overhead portion of the pipe line may be supported from the building structures. No support shall be taken from the brick wall. Outdoor pipes shall run on steel trestles wherever required. All the steel structure for the pipe rack and the supporting posts/trestles along with all necessary hangers, clamps, connecting steel, fixing bolts, nuts etc. shall be supplied and erected by the Bidder.

4.10.02 Hangers and supports shall be capable of carrying the sum of all concurrently acting loads. They shall be designed to provide the required supporting effects and allow pipe line movements as necessary. All guides, anchors, braces, dampener, expansion joint and structural steel to be attached to the building/structure, trenches etc. shall be provided. Type of hangers and components for all piping shall be selected and approval obtained from the Purchaser.

4.10.03 The supports shall meet the general guidelines indicated in the following code / standards:

MSS-SP 58	:	Pipe hangers & supports - Materials, design and manufacture.
MSS-SP 69	:	Pipe hangers & supports Selection and application.
ANSI-B 31.1	:	Power Piping Codes

4.10.04 Bidder shall locate, design, fabricate, supply and erect all supports, restraints and anchors required for supporting of over ground portion of piping under this contract

4.10.05 Support drawings for piping shall be got approved from the Purchaser. BOM for each support shall also be submitted.

4.10.06 All material for supports shall be of tested quality.

4.10.07 All structural steel required for supports shall be provided by the Bidder at no extra cost to the Purchaser.

4.10.08 All pipe supporting element, guides, sliding support, beams, channel section, attachment to supports, beam clamps etc. shall be provided by the Bidder.

4.10.09 Support locations will be shown in the layout drawing to be submitted by the Bidder.

4.10.10 Fabrication, supply and installation of brackets, pipe shoes, saddles etc. shall be

-
- included in the scope of Bidder and the same shall be carried out as per approved drawings.
- 4.10.11 If an outdoor saddle support is assumed to permit sliding movement of piping over the support, consideration shall be given in selection of supporting material at the interface so that no rust formation takes place and the actual sliding movement is feasible in practice.
- 4.10.12 All pipe supports shall be designed to fully sustain the pipe in normal operating position, allow free and ample expansion or contraction except where anchored and prevent excessive stress.
- 4.10.13 Sway braces, cushioned clamps or other vibration control equipment shall be used in order to prevent unwanted movements of the piping due to vibration, shock or other causes. These shall be of such design as to protect piping against these movements regardless of direction.
- 4.10.14 The supports shall be so interspaced as to minimize sagging of the pipes and to keep them within permissible limits where pipes are full with the conveying media.
- 4.10.15 All piping supports shall be designed to avoid interference with other piping hangers, electrical conduits equipment and structures etc.
- 4.10.16 Saddles, supports etc. shall be capable of carrying the sum of all concurrent acting loads and shall be fabricated from plates/pipes sections conforming to SA 53 / IS-2062 or equivalent. They shall be designed to provide the requirement of supporting effects and allow pipe line movements as necessary. The structural work shall be as per IS-800 / BS-4360.
- 4.10.17 The maximum spans of the supports of straight lengths shall not exceed the recommended values indicated in ANSI-B 31.1. The spans shall be suitably reduced considering the following:
- a) Point loads due to valves and specialties, branch lines etc.
 - b) Pipe bends
 - c) Structural Steel beams.
 - d) Facilities for maintenance of flanged joints.
 - e) Minimum loads on equipment.
- 4.10.18 All vertical lines shall be properly supported on the vertical run and additionally provided with adequate number of lateral-restraints where the length of vertical run exceeds 5M.
- 4.10.19 At all sliding surfaces of restraints and supports Bidder shall provide a teflon lining to minimize sliding friction.
- 4.10.20 Pipe clamps shall have a minimum thickness of 5 mm for indoor piping and 6 mm for outdoor piping.
- 4.11.00 Erection

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- 4.11.01 The Bidder shall coordinate the erection of the piping system as required with the erection schedule of other concerned systems. The sequence of work shall be carefully planned to minimize interference with other groups working in the same area. The actual sequence to be followed shall be to the approval of Purchaser who may at any time, direct the Bidder to reschedule his work as per the status of work site
- 4.11.02 Prior to making interface connections with equipment / system supplied by others, the Bidder shall obtain the approval of the concerned authority.
- 4.11.03 All workmanship shall be accomplished using accepted methods and procedures of the highest recognized fabrication and erection code / standards. Workmanship not conforming to the intent of this specification shall be liable to rejection by the Purchaser at any time, during the progress of work. The Bidder shall correct the workmanship immediately at no extra cost to the Purchaser.
- 4.11.04 The Bidder shall make all interface joints of the piping system, covered under this specification at the connecting points with equipment/piping supplied by others.
- 4.11.05 It is the responsibility of the Bidder to ensure correct orientation of all valves, instrument stubs etc. in line with final piping drawings.
- 4.11.06 The Bidder shall utilize the existing structures if any, to support the piping as far as practicable. All auxiliary steels required shall be supplied by the Bidder.
- 4.11.07 Before performing any welding, all corrosion products, dust, grease and other foreign material shall be cleaned from the surfaces to be joined.
- 4.11.08 Piping on both sides of the joint shall be adequately supported during all welding. Temporary supports, if used shall be so designed that no stress due to pipe weight comes on the joints during the joining.
- 4.11.09 All pipes shall be located and laid in accordance with the approved layout drawings. No deviation will be allowed unless written consent is issued by Purchaser in specific case(s).
- 4.11.10 Before laying the pipes, the coordinates and levels of the pipes shall be checked by the Bidder. Any discrepancies between the execution and approved drawings shall be brought to the notice of the Purchaser and corrections shall be carried out as per his instructions.
- 4.11.11 During erection of piping, the Bidder shall provide proper number and size of bolts and nuts as per drawings and specification. The Bidder shall provide approved quality of grease mixed with graphite powder thoroughly on all the bolts, nuts and washers immediately after erection and when the flange joints are dismantled for flushing, testing and alignment of equipment etc. to prevent rusting of nuts, bolts and gaskets. The grease and graphite powder shall be supplied by the Bidder
- 4.12.00 **Cleaning and Flushing**
- The exterior and interior surface of all piping shall be thoroughly cleaned of all sand, mill scale, grease, oils, dirt and other foreign materials. After cleaning, the interior surfaces of all piping shall be thoroughly blown dry and protected with a completely

water soluble preventive coating.

Flange faces shall be coated with an easily removable rust preventive coating.

Machined surface shall be coated with rust preventive paint. The paint shall be consumable in the welding process.

4.13.00 Pipes and Fittings if any, coming under purview of IBR, should meet its requirements and getting the approval from IBR in respect of the same shall be under the scope of the Bidder.

4.14.00 Valves & Isolation Gates

Valves will be used to start/stop or control flow.

All valves, shall be suitable for service conditions i.e. flow, temperature and pressure under which they are required. The valves shall be of standard pressure rating as per the applicable code/ standard. The pressure rating of diaphragm valves shall be selected considering the maximum expected operating differential pressure. Sample valves will be used in sample collection lines.

Gates will be primarily used for isolation of flow in open channels although these should be capable of throttling the flow too.

For location and type of Valves / Isolation Gates, Bidder need to refer to the P&I drawings enclosed with this specification.

4.14.01 Sluice / Gate Valves (for river water / clarified water / filtered water / similar application)

Sluice / Gate valve shall conform to IS-14846 PN1.6 minimum. Stem, seat ring and wedge facing ring shall be of stainless steel construction. Other parts shall be as per IS-14846. Valves shall be of outside screw and rising stem type. Ends will be flanged and compatible with ANSI-B 16.5 Cl. 150 (minimum) piping flanges.

Sluice / Gate valves for sizes 50 mm NB and below shall conform to IS-778 Class-2 / ANSI-B 16.34 straight, rising stem; with outside screw.

Sluice / Gate valves shall be provided with the following accessories in addition to the standard items.

- a) Hand wheel
- b) Gear Reduction Unit Operator for valves 250 mm NB and above.
- c) Bypass valve for valve of sizes 300 mm NB and above.
- d) Draining / Flushing arrangement wherever required.
- e) Arrow indicating flow direction.
- f) Position indicator.

Sluice / Gate Valves shall be provided with back seating bush to facilitate gland renewal during full open condition.

For lower sizes, the gate valves will be screwed bonnet with outside screw rising stem as per IS-778. The material of construction will be gun metal body, with brass stem and trim. Ends will be screwed to ANSI-B 2.1.

Gate valve on galvanized iron pipe shall be gun metal construction as per IS-778 Class 2. Ends will be screwed to ANSI-B 2.1.

4.14.02 Butterfly Valves (for river water / clarified water / filtered water / similar application)

Butterfly valves shall be of double flanged or lugged wafer type of low leakage rate conforming to AWWA-C 504 class 150 (min.) or BS-5155 PN 10 / class 150 (minimum)

The various components of butterfly valves shall be of the following:

i)	Body	:	Cast Iron – ASTM-A 48 Cl.40; BS-1452 Grade220 SG Iron – BS-2789. Cast Iron IS-210 Grade FG 260 Cast Steel – ASTM-A 216 Grade WCB; BS- 1504 or Equivalent grade (subject to approval by Purchaser).
ii)	Disc	:	Cast Iron – ASTM-A 48 Cl.40; BS-1452 Grade220 SG Iron – BS-2789. Cast Iron IS-210 Grade FG 260 Cast Steel – ASTM-A 216 Grade WCB; BS-1504 or Equivalent grade (subject to approval by Purchaser).
iii)	Shaft	:	ASTM-A 296 Grade CF 8M / AISI 316; AISI-420; BS-970 Grade 316; BS-970 Grade 420 S45.
iv)	Seat rings	:	Nitrile rubber, EPDM (Ethylene propylene rubber), Hypalon.

Butterfly valves shall be fitted with sleeve type bearing such as PTFE. Valves of size 350 mm NB and above shall be provided with one or two thrust bearings to hold the disc securely in the centre of valve seat without hydraulic or external axial shaft loads. Sleeve and other bearings fitted into the valves body shall be of self lubricated materials that do not have any effect on the fluid handled and other components of the valves.

All the butterfly valves shall be provided with Hand wheel or lever/wrench operated as per the requirements.

The use of lever operators shall be limited to valves requiring a maximum of 90 degree stem rotation from full open to full closed position. For lever/wrench operated valves, means shall be provided for positively holding the disc in not less than three intermediate positions

For larger sizes i.e. 150 mm NB and above, hand wheel shall be provided.

Manually operated valves shall be provided with reduction gear unit for valves of size 250 mm NB and above. Valve provided with motorised or pneumatic actuator shall be provided with a hand wheel for manual operation.

All the valves shall be equipped with adjustable mechanical stop-limiting devices to prevent over travel of the valve disc in the open and closed positions. The valve operators (Handwheel or Gear reduction unit or Motor actuator etc.) shall be designed as per applicable International Standard.

All the butterfly valves shall be provided with an indicator to show the position of the disc.

Ends will be flanged and compatible with ANSI-B 16.5 Cl. 150 (minimum) piping flanges.

4.14.03 Butterfly Valves (for decationized water / deanionized water / demineralized water / desalinated water / similar application)

The butterfly valves shall conform to the requirements addressed under Cl. No. 4.14.02 above along with the requirements delineated below:

- a) Body shall be lined (minimum 3 mm) with natural rubber, ebonite, polypropylene or PVDF.
- b) Disc shall be either lined with PVDF, polypropylene, or natural rubber or shall conform to ASME-SA 479 Grade 316.

4.14.04 Ball Valves (for river water / clarified water / filtered water / similar application)

Ball valves may be used for sizes 40 mm NB and below. Ball valves shall conform to the following technical specifications:

a)	Design Standard	BS:5351
b)	Type	Screwed / Welded / Flanged ends; Full Bore: Split Body & Seat supported construction
c)	Material of Construction	
	Body	Carbon Steel to ASME-216 WCB / Cast Iron to IS-210 Grade 220 or better.
	Ball	Stainless steel ASME-SA 479 Grade 316 or 410.
	Seat ring	PTFE
	Stem	Stainless steel ASME-SA 479 Grade 304 or 316 or 410.
	Seats	Nitrile rubber; PTFE

- d) Valves shall be designed to be directly operable by a wrench / hand lever.

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- e) Suitable stops shall be provided for both the fully open & close condition.
- f) All the valves shall be provided with an indicator for showing the position of the ball port.
- g) Ends will be flanged and compatible with ANSI-B 16.5 Cl. 150 (minimum) piping flanges

4.14.05 Globe Valves (for river water / clarified water / filtered water / similar application)

Globe valves shall conform to the following technical specifications:

For sizes 50 mm NB and below

- i) Design Standard : IS-778 Class-2 / BS-1873
- ii) Type : Straight, rising stem, with outside screw.
- iii) Material of Construction

i)	Body, Bonnet, Stuffing Box & seat rings	Leaded Tin Bronze con forming IS-318 Grade 2
ii)	Stem	Stainless Steel, AISI-316
iii)	Disc	IS-318 Grade 2/AISI-316

Note: However, valves in the flushing water lines shall be of type and material specified for the chemicals which are being flushed by the line.

For sizes above 50 mm NB

- i) Design Standard : BS-13789 PN 10 (minimum).
- ii) Type : Double Flanged or wafer body, outside screw and rising stem type.
- iii) Material of construction

a)	Body	: Cast iron: IS-210 Grade FG260 / BS-1452 Grade14.
b)	Stem	: Stainless steel AISI-410 / 13% chrome steel.
c)	Disc	: Cast iron IS-210 Grade 260 / BS-1452 Grade 14.

d)	Packing	:	PTFE
e)	Seat & seat rings	:	13% chromium steel
f)	Gland & gland nut	:	AISI-420
g)	Hand wheel	:	Cast Iron or Malleable Iron

- iv) Back seat shall be provided on the stem or on the disc.
- v) Renewable disc assembly shall consist of disc holder, disc, disc guide, check nut and disc retaining nut with washer.
- vi) Disc of globe valve may be provided with renewable rubber seating ring.
- vii) Handwheels shall be marked with the word. OPEN or SHUT with arrow to indicate direction of opening or closing.

Ends will be flanged and compatible with ANSI-B 16.5 Cl. 150 (minimum) piping flanges

Globe valve on galvanized iron pipe shall be gun metal construction as per IS-778 class 2. Ends will be screwed to ANSI-B 2.1.

Note: However, valves in the flushing water lines shall be of type and material specified for the chemicals which is being flushed by the line.

4.14.06 Diaphragm Valves (for river water / clarified water / filtered water / similar application)

Metallic Unlined Diaphragm valves (manual / auto as specified elsewhere in this specification) may be used for isolation purposes.

The Metallic Unlined Diaphragm valves shall conform to the requirements addressed under Cl. No. 4.14.07 below except the requirements with reference to lining for body and integral flanges.

4.14.07 Diaphragm Valves (for decationized water / deanionized water / demineralized water / desalinated water / dilute and concentrated acidic solution / dilute and concentrated alkaline solution / similar application)

Metallic Diaphragm valves (manual / auto as specified elsewhere in this specification) may be used for isolation purposes.

The metallic diaphragm valves shall conform to the following requirements.

- a) Design Standard : BS EN-13397 or Equivalent (subject to approval by Purchaser) of required

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rating/class. (minimum rating of valves should be PN 10).

- b) Type : Flanged and lined body ends, sealed bonnet, weir pattern, tight shut off type.
- c) **Material of Construction**
- Body/Bonnet : Cast Iron IS-210 Grade FG.260 or Equivalent (subject to approval by Purchaser).
- Cast steel ASTM-A 216 Grade WCB.
- Body lining : Soft Natural rubber - 3 mm thick as per IS-4682 (hardness 85-90 on shore A), Ebonite polypropylene, PVDF.
- Diaphragm : Reinforced rubber, Hypalon
- Handwheel : Cast Iron
- Compressor : Stainless Steel
- Stem & Bush : Stainless Steel
- d) Ends will be flanged and compatible with ANSI-B 16.5 Cl. 150 (min.) piping flanges, full face rubber lined and shall be cast / integral with the body.
- e) Handwheels shall be marked with the direction of closure.
- f) Valves shall be provided with a position indicator to show the open and closed condition.
- h) Valves provided with pneumatic actuators shall be provided with a handwheel for manual operation. The valves operators shall be designed as per applicable International Standard.
- i) The testing of valves will be as per BS EN-13397 and rubber lining will be tested as per IS-4682.

Note: For valves which may come in contact with concentrated acid/ alkali, the material of construction of diaphragm shall be as follows:

Diaphragm shall be of reinforced Teflon, EPDM for acid services and reinforced Neoprene / Hypalon for alkali services.

Use of Nonmetallic Diaphragm Valves for any specific / critical application shall be subject to approval by Purchaser and shall conform to the requirements of BS EN ISO 16138 - Industrial valves. Diaphragm valves of thermoplastics materials.

4.14.08 Plug Valves (for lime solution / sludge / similar application)

The plug valves shall conform to the following requirements.

a)	Design Standard	BS-5158 or Equivalent (subject to approval by Purchaser)
b)	Type	Flanged and non lubricated, regular pattern, plug valves.
c)	Material of Construction	
	Body	Cast Iron IS-210 Grade FG 260 or Equivalent (subject to approval by Purchaser)
	Plug	Stainless Steel AISI-316
	Body Sleeve or Seat	PTFE
	Seat	PTFE
	Gland	AISI-304 / AISI-316
	Cover	Cast Steel ASTM-A 216 Grade WCB
	Gland Nut	AISI-304 / AISI-316

- d) Valves shall be operated by permanently fitted wrench or Hand lever. Wrench shall be mounted so that they are parallel to the valve bore axis when the valve is in fully open condition.
- e) All valves shall be provided with an indicator for the position of the plug part.
- f) Suitable stops shall be provided for the fully open and fully closed positions of the valve.
- g) Valves of size of 250 mm NB and above shall be provided with a suitable reduction gear unit.
- h) Ends will be flanged and compatible with AISI-16.5 Cl. 150 (minimum) piping flanges.

4.14.09 Non Return or Check Valve (for river water / clarified water / filtered water / similar application)

Non return valves shall be of swing check (reflux) type or dual plate type.

The valves shall conform to the following specifications.

- i) Design Standard : IS-5312, BS-1868, BS-5153, API-594 / API-60 or equivalent (subject to approval by Purchaser)
- ii) Type : Swing check Type and Flanged ends.
- iii) Material of Construction:

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a)	Body & Cover Hinge Disk/Door	Cast iron IS-210 Grade FG 260 / Cast Iron BS-1452 Grade 220 or equivalent (subject to approval by Purchaser)
b)	Hinge Pin and Door / Disc Pin	Cast steel ASTM-A 216 Grade WCB High tensile Brass IS-320 HT 2 or BS-2872 equivalent (subject to approval by Purchaser)
c)	Disc facing ring	Stainless steel
d)	Body Seat ring	Stainless steel
e)	Bearing bushes	Leaded Tin Bronze IS-318 Grade 2
f)	Bolts	Carbon Steel

Ends will be flanged and compatible with ANSI-B 16.5 Cl. 150 (minimum) piping flanges. .

Body shall be permanently marked with an "arrow" inscription indicating the direction of motion of the fluid for all the check valves.

For sizes 50 mm NB and below, check valves shall be gun metal body swing type as per IS-778. Ends will be screwed type to ANSI-B 2.1.

4.14.10

Non Return Valve (for decationized water / deanionized water / demineralized water / desalinated water / dilute and concentrated acidic solution / dilute and concentrated alkaline solution / similar application)

The valves shall conform to Cl. No. 4.09.00 above along with the following requirements:

- a) The body, cover & Disc shall be lined with natural Rubber, PTFE or Viton. The Hinge, Hinge Pin & Disc Pin shall be coated with PVDF, or suitable elastomer. The bearing bushes shall be PTFE or Equivalent (subject to approval by Purchaser) material (subject to approval by Purchaser). Bolting shall be of stainless steel. In the absence of lining/coating, the complete valve shall be of stainless steel construction (AISI-316).
- b) For only acid services Non- Return valves shall be of lined construction & Flap type.
- c) For alkali services, the complete valve shall be stainless steel construction (AISI-316) or of lined construction as specified above.

4.14.11

Valves for Sampling / Instrument Isolation Service

Each sampling valve / instrument isolation valve shall be full bore ball type.

Ball valves shall conform to the requirements stipulated under Cl.4.04.00 above. However, Body material shall be Stainless Steel (AISI-316).

4.14.12 Valves for Air Service

For Air services globe valves or Ball valves may be used for sizes 50 mm NB and below.

For sizes higher than 50 mm NB, either Butterfly valve or Ball valves shall be used.

Globe valves shall generally conform to Cl. 4.05. 00 above.

Ball valves shall conform to the requirements stipulated in Cl.4.04.00 above. However, Body material shall be leaded Tin Bronze (IS-318 Grade2) or stainless steel (AISI-304 / 316).

Butterfly valves shall conform to the Cl.4.03.05 to 4.03.09 of this section. However, the body & Disc shall be either cast iron lined with elastomer such as PVDF or PTFE or stainless steel construction (AISI-304 / 316).

4.14.13 Safety / Relief Valves

The safety valves / relief valves at the downstream of positive displacement type metering pumps shall be of the standard type manufactured by the pump manufacturer and the material of construction shall suit to the fluid handled.

4.14.14 Valves for Resin Transfer Line

In resin transfer line two way eccentric plug valve shall be used. The valves, shall have type 316 stainless steel body and bearings, resilient faced plug and flanged ends.

4.14.15 Isolation Gates

Design standard for gates shall be IS-3042 or Equivalent (subject to approval by Purchaser).

The gates shall be rectangular or square sluice, rising spindle type conforming to class-1 of IS-3042.

Material of Construction

i.	Frame and Door	Cast Iron IS-210 Grade 20
ii.	Spindles, bolts & nuts	M.S. to IS-2062
iii.	Face & seat rings	Gun metal (as per IS-3042).

All the parts of gates shall be applied with the coats of heavy duty bitumastic paint.

Each of the gates shall be provided with handwheel, and a position indicator.

The gates for DM plant drains shall be rubber lined to a minimum thickness of 4.5 mm.

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4.15.00

Strainers

4.15.01

Basket Strainers

- a) Basket strainers of simplex design shall have the following materials of construction for raw/clarified/filtered water application.

i.	Body	Fabricated mild steel : IS-2062 (Tested quality)
ii.	Strainers	Wire shall be stainless steel (AISI:316 18 BWG 30 mesh suitably reinforced. Reinforcement material shall also be of stainless steel construction.
iii.	Drain Plug / Nuts	Gun metal

- b) Inside and outside of basket body shall be protected with one coat of high build zinc phosphate primer and three coats of Chlorinated rubber paint to a total thickness of 200 microns.
- c) Suitable Vent and drain valves shall be provided for the strainers.
- d) Screen (strainer) flow area shall be at least four times pipe sectional area. Flow area in any portion of Basket strainer assembly shall not be less than the pipe cross sectional area.
- e) Pressure drop in clean condition shall not be more than 1.0 mwc at full flow.
- f) Basket Strainer shall be provided with lifting lugs and suitable mounting arrangement.
- g) For DM water service, body shall be rubber lined to minimum 4.5 mm thickness (soft rubber of shore Hardness $65 \pm 5^\circ\text{A}$).

4.15.02

Y-Type Strainer

- a) Y-Type strainer for water application shall be constructed of following materials:

i.	Body	Cast Iron IS-210 Grade FG 260
ii.	Strainers	Wires of stainless steel AISI-316, 18 BWG 30 mesh suitably reinforced. Reinforcement material shall also be of stainless steel construction.
iii.	Drain Plug / Nuts	Gun metal (threaded construction)

- b) Y-Type strainers shall also conform to Cl. 4.15.01 (b), (c), (d), (e) and (f).
- c) Body of the Y-type strainers of alkali, and demineralised water shall be of Cast Iron (IS-210 Grade FG 260) and lined with soft or hard rubber to a thickness of 3 mm.

- d) For acid services, apart from the rubber lined body material, the screen material, shall be Polypropylene or HDPE wire cloth of suitable mesh and thickness.

4.16.00 Resin Traps

The resin traps for the Ion exchange vessels shall be provided for the collection of Ion exchange resin shall conform to the following:

- 4.16.01 The body shall be of mild steel (IS-2062) and lined internally with rubber (Hard/Soft rubber), Saran or polypropylene. The internals (rod and screen) for all resin traps shall be of AISI-316 construction. All screen components shall be welded at each intersection of wire and support rod for good strength, Resin traps screen opening shall not exceed 120 percent of the associated process vessel under drain/backwash collection header nozzle screen opening and shall be suitably selected to retain even the minimum size of the resin selected for the process.

- 4.16.02 The resin traps shall be provided with a draining arrangement with a valve for collection of trapped resins. Resin trap body shall have lifting lug for easy handling during maintenance/erection.

4.17.00 General Requirements for Valves, Gates, Strainers and Resin traps

- 4.17.01 All the items shall be suitable for service conditions i.e. flow, temperature and pressure to which they may be subjected to.

- 4.17.02 All the items shall be of proven design for the duty conditions and the Bidder or manufacturer shall have sufficient experience in using the above equipment in water treatment application in the plants supplied earlier by them.

- 4.17.03 In case Purchaser desires, the experience list/feedback from the users shall be made available to Purchaser for any or all the equipments during the detailed engineering phase.

- 4.17.04 Valves will be used to start/stop or control flow. Gates will be primarily used for isolation of flow in open channels although these should be capable of throttling the flow too. Sample valves will be used in sample collection lines.

- 4.17.05 All valves shall be suitable for service conditions i.e. flow, temperature and pressure under which they are required. All the valves shall be of standard pressure rating of the applicable design code / standard. Non standard pressure rating shall not be accepted. The pressure and temperature rating of the valve shall not be less than the maximum expected pressure and temperature plus 5% additional margin of the system in which valves are proposed to be installed.

- 4.17.06 Valves pressure classes, sizes, types, body materials, and end preparation shall generally be as described herein, unless mentioned otherwise elsewhere in Bid Specification. All valves shall conform to the requirements of the governing codes, and the requirements specified.

- 4.17.07 Valves (including safety, relief and control valves) body materials shall be compatible with the piping with which they are used. If the body material is not of the same type as the material of the connecting pipe work, the valves shall be fitted with suitable welding nozzles to avoid dissimilar butt welds at site.

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- 4.17.08 Each modulating control valve shall be provided with isolation valves. Manual bypass valve shall be provided for each modulating control valve to achieve safe and reliable manual operation.
- 4.17.09 All the actuators of the valves shall be designed to handle the maximum expected pressure differential across the valves and to overcome friction forces and unbalance forces due to the flow through valve.
- 4.17.10 Valve bodies and bonnets shall be designed to support the valve operators (handwheel, gear, or motor) with the valve in any position without external support.
- 4.17.11 Valve ends and size limitations are as follows:
- a) 50mm NB and smaller valves - Class 800 minimum with socket weld ends. (For instruments connections/ isolation valves screwed ends may be acceptable)
 - b) 65mm NB and larger size valves - Class 150 minimum (butt-weld ends or flanged or wafer style).
 - c) Flanged steel butterfly valves - 750mm and larger size; pressure class per AWWA / BS-5155.
- 4.17.12 Gate, globe and angle valves shall be outside stem and yoke construction.
- 4.17.13 Valves sizes 65 mm NB and larger shall have a non-rising handwheel.
- 4.17.14 All the actuator operated valves shall be fitted with handwheel for manual operation. The pneumatic actuators shall be selected based on the available air pressure and operating air pressure (maximum and minimum). The supporting calculations for selection of actuators shall be furnished for Purchaser's approval before finalization of all the actuators.
- 4.17.15 Valves coming under the purview of IBR if any shall meet its requirements and the approval of the same shall be obtained by the Bidder.
- 4.17.16 Sizes of the valves shall be same as that of the interconnected pipe sizes except for the control valves.
- 4.17.17 The various items shall be installed such so that they are easily approachable for the operating and maintenance personnel. All valves shall be accessible without chain pulls, as far as possible. Generally Valves shall be located about 1.2 meter to 1.5 meter from the operating platform and also they shall not be located below the ground level such as beneath the trenches etc. In such cases, extended spindle shall be provided with chain operating from operating floor. Valves which are installed below the ground floor shall be provided with a floor mounted pedestal at the top of the operating floor. Valves which are installed below the ground floor shall be provided with a floor mounted pedestal at the top of the operating floor. The position indicator for such valves shall be also provided along with the stand.
- 4.17.18 All valves shall be provided with hand wheels. Wherever necessary, chain operator shall be provided so that the valve may be operated from the ground floor.
- 4.17.19 All valves shall be provided with cast heat marks on casting of Body and Bonnet.

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- 4.17.20 Whenever screwed valves will be installed in a pipe line, it will always be followed by screwed three piece union of same material as that of pipe.
- 4.17.21 Short pieces used for welding of different pipe fittings and valves shall not be less than 80 mm in length.
- 4.17.22 However valves which are provided (in the buried pipe line) with a valves chamber shall have manual operator/Handwheel inside the valve chamber. The valve chamber shall be provided with built in ladders/staircases and sufficient operating space within the chamber shall also be provided for easy operation of such valves.
- 4.17.23 All the valves, strainers, resin traps etc. shall be provided with external painting as that of the interconnected piping as specified in Clause 3.03.14 above. However, surfaces such as Stainless Steel, aluminium, copper, brass, bronze and other non-ferrous materials shall not be painted. No paint or filter shall be applied until all repairs, hydrostatic tests and final shop inspections are completed, but shall be applied prior to shipment.
- 4.18.00 Rubber Expansion Joint
- 4.18.01 The inner cover (i.e. the tube) and also the outer cover shall be made up of natural or synthetic rubber of adequate thickness. The carcass between the tube and the cover shall be made up of high quality cotton and rayon cord having suitable number of plies and impregnated with rubber or synthetic compounds. Moreover, to ensure adequate strength, reinforcements consisting of metal rings embedded in the carcass, shall be provided.
- 4.18.02 In all cases, the expansion joints shall be integral flanges at both ends complete with split retaining rings.
- 4.18.03 Each of the expansion joint shall be provided with adequate number of limit rod assemblies which shall be tightened after erection of the entire suction branch of the pumps, in order to avoid transmittal of undue pressure thrust on to the pump foundation. Each of these limit rod assemblies shall consist of a long bolt and two connecting plates which are, in turn securely bolted to opposite flanges. Each plate is to be drilled with three holes, two for bolting to the flange, the third for passage of the stretcher belt. Rubber washers backed with metal washer shall be placed under the head of the bolt and under the nut.
- 4.19.00 Protective Lining and Painting
- The supply and application of Protective Lining and Painting with reference to Piping, Fittings and Valves need to be as per **Sub Section: Section-XIII of V.III-C- Technical Specification for Protective Lining and Painting**, attached herewith.
- 5.00.00 **TESTS AND INSPECTION**
- 5.01.00 Tests & Inspection for Pipes and Fittings
- 5.01.01 Shop Tests
- Shop test shall include all tests to be carried out at supplier's work, works of sub

suppliers and at works where raw materials supplied for manufacture of equipment are produced. The supplier shall carryout a comprehensive inspection and testing program during manufacture at works. Necessary Manufacturing and Field Quality Plans shall be prepared by supplier and submitted for approval by Purchaser for all checks conducted on raw materials, fabrication etc.

Calibrated instruments required for measuring / testing of pipes shall be arranged by manufacturer at their works during inspection.

Purchaser shall be given full access to all tests. The manufacturer shall inform Purchaser of the testing well in advance so that Purchaser at own option may witness the test.

All the test certificates and reports shall be submitted to Purchaser for approval.

All the mechanical and chemical tests including optional tests if any as per the applicable codes / standards shall be carried out and the test certificates for the same shall be submitted for approval by Purchaser. Material Certificate shall be furnished for each grade / lot of pipes. All material test certificates shall carry material specification, size, class, length, chemical composition, physical properties and heat number or other acceptable reference to enable correlation of the certificate with the pipe. IBR / CCE / TAC approval certificates / any other statutory approval certificates as required shall be furnished.

Welding procedure and welder performance qualifications shall be carried out. Mechanical and chemical tests shall be carried out as per code. Spot radiography check shall be carried out for all butt welds. D.P.T shall be carried out for all root run welds. Segmented flanges exceeding 30 mm thickness shall be stress relieved. Tensile test, eddy current test, bend test, flattening test and dimensional checks as per applicable code shall be carried out.

All rubber lining is to be subjected to the following tests as per IS-4682 Part I:

- a) Adhesion test.
- b) Tests to check resistance to bleeding.
- c) Measurement of thickness of lining.
- d) Shore hardness test.
- e) Spark test at High voltage 5 KV / mm of thickness.

Galvanizing shall be carried out as per IS-4736 / IS-2629 and tested as per IS-2633 / BS- 729. The test shall include weight of coating, uniformity of thickness and adhesion test.

All pipes and fittings shall be subjected to hydraulic tests as per applicable code / standard. When rubber lined, hydraulic tests shall be carried out before and after rubber lining.

Buried pipes where wrapping and coating is done, material for wrapping and coating shall be tested as per applicable code. Procedure for wrapping and coating and its testing shall be submitted for approval by Purchaser. Entire wrapping and coating shall be checked for thickness and Holiday test. Peel test shall be done to ensure

proper bonding of coating to surface.

5.01.02 Site Test

Hydraulic tests of the piping system at 1.5 times the design pressure or twice the working pressure whichever is higher shall be carried out for a period of minimum 30 minutes. However, if the Code / standard of supplied piping specifies more stringer requirements than the above criteria, then the hydraulic tests shall be conducted as per the applicable piping code / standard.

Pneumatic tests shall be carried out for all pressure piping that shall not be subjected to water filling.

The Bidder shall make all temporary closures/connections as required for hydro-static/pneumatic testing and clean/remove the same after successful completion of the test.

The procedure for hydro test and pneumatic test shall be submitted by the Bidder for review and approval by Purchaser.

All tests as indicated in FQP approved by Purchaser shall also be carried out.

5.02.00 Tests & Inspection for Valves / Gates / Strainers

5.02.01 Shop Tests

Chemical composition of all material, castings, forgings, etc. shall be tested for various components of the valves, gates, strainers and test certificates shall be submitted for approval by Purchaser.

Mechanical tests including optional tests if any shall be performed as per the applicable code / standard and the test certificates for the same shall be submitted for approval by Purchaser. The performance requirements of the valves shall also be tested as per the applicable code / standard.

Elastomer wherever coated or lined for the valves shall be tested for the corrosion resistance against the medium for which those are selected as per applicable code / standard and the test certificates shall be furnished for approval by Purchaser.

Rubber lining on Valves / Gates / Strainers / Resin Traps shall be checked in accordance with IS-4682 Part I including Spark Testing at high voltage (5 KV/mm of thickness).

All the valves shall be hydraulically tested for the body, seat, back seat and all valves shall be pneumatically tested for seat as per the applicable code / standard to which these are designed irrespective of the working pressure for which valves are selected.

Wherever specifically required, pressure drop across each type and each size of the valve at various flows shall be conducted, and test reports shall be submitted for approval by Purchaser. Type test report for this test (if already carried out by the manufacturer) may be submitted to fulfill this requirement.

Gates shall be tested against leakage and strength as required in the code / standard.

Strainer shall be hydraulically tested its strength and the pressure drop across the strainer assembly shall be verified at design flow for clean condition.

5.02.02 Site Tests

All valves, gates, resin traps, strainers and other fittings after erection at site shall be tested to hydraulic test pressure of two times the operating pressure or 1.5 times the maximum allowable pressure whichever is higher for a period of 120 minutes.

All valves / gates (Manual / Automatic) shall be operated throughout 100% of the travel manually and as well as from control panel and these should function without any trouble whatsoever.

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**TECHNICAL SPECIFICATION
FOR
HORIZONTAL CENTRIFUGAL PUMPS**

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**TECHNICAL SPECIFICATION
FOR
HORIZONTAL CENTRIFUGAL PUMPS**

C O N T E N T S

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3.00.00	DESIGN AND CONSTRUCTION	1
4.00.00	TESTING	4

TECHNICAL SPECIFICATION FOR HORIZONTAL CENTRIFUGAL PUMPS

1.00.00 INTENT OF SPECIFICATION

The specification covers the design, performance, manufacturing, shop testing, erection, testing and commissioning at site, of the horizontal centrifugal pumps.

2.00.00 CODES AND STANDARDS

2.01.00 The design, manufacture and performance of the horizontal centrifugal pumps shall conform to the latest revisions of the following codes and Indian standards, in addition to other stipulations and standards mentioned elsewhere in the specification :

- a) IS-1520 : Horizontal centrifugal pumps for clear cold fresh water.
- b) IS-5120 : Technical requirement rotodynamic special purpose pumps.
- c) IS-5639 : Pumps handling chemicals and corrosive liquids.
- d) IS-5659 : Pumps for process water.
- e) Standards of Hydraulic Institute, U.S.A.

2.02.00 The material of construction for the various components of the pumps shall conform to the applicable standards like "American Society of Testing & Materials (ASTM)" and Indian Standards.

3.00.00 DESIGN AND CONSTRUCTION

3.01.00 Pumps shall be of horizontal/vertical split casing with speed preferably be limited to 1500 RPM. Design and construction of various components of the pumps shall conform to the following general specifications. For material of construction of the components, data sheets in Appendix-I of SECTION-III may be referred to.

3.01.01 Casing

The casing shall be structurally sound to provide housing for the pump assembly and shall be designed hydraulically to minimize radial loads at part load operations.

3.01.02 Impeller

The impeller shall be as per the proven design of the manufacturer. It shall be keyed to the shaft and locked in position. The rotor assembly shall be statically and dynamically balanced and designed with critical speed substantially above the operating speed.

3.01.03 Impeller/Casing Wearing Rings

Replaceable type wearing rings shall be provided at suitable locations for each pump. The rings shall be so fitted as to prevent turning while the pump is in operation.

3.01.04 Shaft

The shaft shall be adequately sized to withstand all stress from rotor weight and hydraulic loads etc. The shaft shall be ground and polished to final dimensions.

3.01.05 Shaft Sleeves

Pump shafts shall be protected by renewable type shaft sleeves which shall extend well beyond the pump glands. The sleeves shall be highly polished and shall be securely fastened to the shaft to prevent any loosening.

3.01.06 Bearings

Heavy duty bearings, adequately designed for the type of service specified and for long and trouble-free operations, shall be furnished. The design shall be such that the bearing lubricating oil does not contaminate the liquid being pumped.

3.01.07 Thrust Bearings

Adequately designed thrust bearings to absorb pump thrust or other unbalanced force, if any, shall be provided.

3.01.08 Lubrication system shall be designed in such a way that in case of total power failure, there will not be any damage while coasting down to stop.

3.01.09 Stuffing Boxes

Stuffing boxes of packed ring construction or of mechanical seal type as desired in the Data Sheet - Appendix-II attached with this specification shall be provided. The necessary piping, valves, fitting etc. for the gland sealing connection shall be provided. For mechanical seals, the mating surfaces shall be suitably hard faced to ensure long life.

3.01.10 Pump Shaft-Motor Shaft Coupling

The pump shaft and motor shaft shall be connected with a suitably designed flexible coupling of approved design preferably with a spacer to facilitate dismantling of the

pump without disturbing the motor. Necessary coupling guards for the coupling shall also be furnished.

3.01.11 **Base Plate**

A common base plate for mounting the pump and the corresponding driver motor shall be furnished. The base plate shall be of fabricated steel and of rigid construction, properly ribbed as required. Driplip with drain tap suitable for type of service specified shall be furnished.

3.01.12 **Drain, Vent and Priming Connections**

Each pump shall be provided with a casing drain, vent and priming connection at suitable locations.

3.01.13 **Drive Motor and Its Control**

Please refer Electrical Specification enclosed herewith this specification.

3.01.14 **Anchor Bolts, Sleeves, Inserts, Lifting Lugs, Eye Bolt, etc.**

All anchor bolts, foundation plates, sleeves, nuts, inserts etc. to be embedded in concrete for the equipment are to be supplied. The length of the foundation bolts shall be liberally sized to reach below the reinforcement level.

Each equipment shall be provided with suitable lifting lugs, eye bolts etc. to facilitate maintenance.

3.02.00 Consistent with good operating characteristics and high efficiency, each pump shall have a continuously rising head capacity characteristics curve without any zone of instability. Power flow characteristic shall preferably be non-overloading type beyond rated duty point. The characteristic curves of each set of pumps shall match each other for equal sharing in case of parallel operation. The pump motor set shall be designed in such a way that there is no damage due to reverse flow through the pump which may occur due to any mal-operation of the system.

3.03.00 The pumps shall be suitably designed also for smooth and trouble free continuous solo operation in the event of trip out of the remaining pumps running in parallel.

3.04.00 The pumps shall be designed to have best efficiency at the rated duty point. The pumps shall be suitable for continuous operation within a wide range above and below the rated duty point. Such range of operation within which category of pumps can satisfactorily operate on continuous basis, shall be clearly indicated.

3.05.00 Drive motors for each category of pumps shall be suitable for use on 415V $\pm 10\%$, 30 , 50 Hz $\pm 5\%$ and neutral grounded system. Drive motors shall have 15% spare margin over the maximum power requirement of the pump within the range of operation.

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4.00.00	TESTING
4.01.00	Testing and Inspection at Manufacturer's Works
4.01.01	All tests required shall be conducted to ensure that the equipment furnished shall conform to the requirements of this specification and in compliance with requirements of the applicable codes. The particulars of the proposed tests and the procedures for the tests shall be submitted for approval before conducting the tests.
4.01.02	The representatives of Purchaser shall be given full access to all tests. Prior to pump performance tests, the manufacturer shall inform the Purchaser allowing adequate time so that if the Purchaser desires, his representatives can witness the test.
4.01.03	All materials and casting used for the equipment shall be of tested quality. The test certificates shall be made available to Purchaser.
4.01.04	The pump casing shall be hydraulically tested at 200% of pump rated head or at 150% of shut-off head, whichever is higher. The test pressure shall be maintained for at least half an hour.
4.01.05	The pump rotating parts shall be subjected to static and dynamic balancing tests.
4.01.06	All pumps shall be tested at the shop for capacity, head efficiency and brake horse power and cavitation. The tests are to be done according to the requirement of the "Hydraulic Institute" of USA, ASME Power Test Code PTC-8.2 (latest edition) and Indian Standards as applicable.
4.01.07	The pump accessories e.g. the thrust bearing, the motor pump shaft coupling etc. will be subjected to tests as per Manufacturer's standard.
4.01.08	The combined vibration of pump and motor should be restricted to the limits specified by Hydraulic Institute Standards, USA, when the pump is in operation at any load singly or in parallel.
4.01.09	Tests on motors shall be conducted as per electrical specification enclosed herewith this specification.
4.01.10	The reports and certificates of all the above mentioned tests to ensure satisfactory operation of the system shall be submitted to the Purchaser before despatch.
4.01.11	Cast heat marks are to be provided on castings for casing and impeller.
4.02.00	Tests at Site After erection at site, pumps under different services shall be operated to prove satisfactory performance as individual equipment as well as a system.

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**TECHNICAL SPECIFICATION
FOR
VERTICAL CENTRIFUGAL PUMPS**

DEVELOPMENT CONSULTANTS
(e-PCT-TS-K-02-2014-15 -V-IIIC-Sec-X.doc)

V.III-C/S-X: 1

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TECHNICAL SPECIFICATION
FOR
VERTICAL CENTRIFUGAL PUMPS

C O N T E N T S

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4.00.00	TESTING	4

TECHNICAL SPECIFICATION FOR VERTICAL CENTRIFUGAL PUMPS

1.00.00 INTENT OF SPECIFICATION

The specification covers the design, performance, manufacturing, shop testing, erection, testing and commissioning at site, of the vertical centrifugal pumps.

2.00.00 CODES AND STANDARDS

2.01.00 The design, manufacture and performance of the vertical centrifugal pumps shall conform to the latest revisions of the following codes and Indian Standards in addition to other stipulations and standards mentioned elsewhere in the specification :

- a) IS-1710 : Vertical turbine pumps for clear, cold, fresh water.
- b) IS-5120 : Technical requirement for rotodynamic special purpose pumps.
- c) IS-5639 : Pumps handling chemicals and corrosive liquids.
- d) IS-5659 : Pumps for process water.
- e) Standards of Hydraulic Institute, USA.

2.02.00 The material of construction for the various components of the pumps shall conform to the applicable standards like "American Society of Testing & Materials (ASTM)" and Indian Standards.

3.00.00 DESIGN AND CONSTRUCTION

DEVELOPMENT CONSULTANTS

(e-PCT-TS-K-02-2014-15 -V-IIIC-Sec-X.doc)

V.III-C/S-X: 1

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3.01.00 Pump Type

The pumps shall be vertical wet pit type with open shaft or enclosed shaft construction depending on the type of liquid to be pumped. Material of construction shall be as per the data sheets in Appendix-II. The pump speed shall preferably be limited to 1500 RPM.

3.02.00 Discharge Head Assembly

The pump shall have fabricated discharge head disposed above the ground. The head shall be capable of supporting the pump and motor on the foundation; expansion joint shall be provided immediately at the pump discharge; but no thrust block shall be provided for the unbalanced hydraulic thrust thus developed. The anchor bolts and pump fixing arrangement shall be suitably designed to take up the back thrust due to the expansion joint.

The head shall contain a packed type stuffing box to prevent any leakage.

A water stinger may be fitted to the top shaft to protect the motor from water spray.

3.03.00 Bowl

In addition to housing the impellers properly, the bowls shall provide a smooth path to water passage and shall be hydraulically designed to minimise radial thrust.

3.04.00 Impeller

The impeller shall be closed or open as per standard design of the manufacturer. All rotating parts including the impeller shall be statically and dynamically balanced. The critical speed of all the rotating parts shall be substantially above the design speed.

3.05.00 Pump Shaft and Motor Shaft Coupling

The pump shaft shall be connected to motor shaft by a heavy duty flexible coupling.

3.06.00 Column Pipe and Shaft

DEVELOPMENT CONSULTANTS

(e-PCT-TS-K-02-2014-15 -V-IIIC-Sec-X.doc)

V.III-C/S-X: 2

The line shaft and the shaft enclosing tube shall be made in convenient sections and shall be joined securely by union couplings. The column pipe shall also be made in sections and shall be joined by flanged coupling. In case of flanged joint gaskets shall be provided at each connection.

For sludge handling, vertical cantilever pump with no submerged bearing shall be provided.

3.07.00 Shaft Sleeves

Replaceable shaft sleeves shall be furnished. The shaft sleeve shall be securely locked to shaft to prevent loosening while in operation.

3.08.00 The necessary supporting frame, base-plates, sole-plates, mounting-plates, etc. as required shall be supplied under this specification, alongwith anchor bolts, foundation bolts, pipe sleeves etc.

3.09.00 Thrust Bearings

Thrust bearing of adequate design shall be furnished for taking the pump weight as well as maximum hydraulic thrust. The bearing may be lubricated by grease or oil. The design should be such that the bearing lubricating oil does not contaminate the liquid being pumped. Cooling of thrust bearing, if necessary, shall be done by liquid tapped from the discharge of the pump itself. The thrust bearing shall be designed on the basis of 20,000 working hours minimum for the load corresponding to the duty point.

3.10.00 Line Shaft and Bowl Bearing

Adequate number of properly designed bearings shall be furnished to prevent undue vibration.

3.11.00 Lubrication system shall be designed in such a way that in case of total power failure, there will not be any damage while coasting down to stop.

3.12.00 Shaft Enclosing Tube

For sludge/turbid/dirty water/chemical services, the pump shaft shall be of enclosed tube construction. For the lubrication of shaft necessary clarified/filtered water required shall be arranged. Necessary piping, valves, fittings, booster pumps etc. as required shall be included in scope.

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- 3.13.00 **Suction Bell**
- The pump shall be complete with adequately dimensioned suction bell to guide and streamline intake fluid.
- 3.14.00 **Adjustment of Impeller**
- The pump shaft shall have suitable arrangement for vertical adjustment of impeller position from an accessible point.
- 3.15.00 **Pump Characteristics**
- Head capacity curve should be rising upto the shut-off head condition. Power versus capacity curve shall be non-overloading type beyond rated duty point.
- The characteristic curves of each set of pumps shall match each other for equal load sharing in case of parallel operation. The pump shall however, be also designed for smooth and trouble-free continuous solo operation in the event of trip-out of the remaining pumps running in parallel.
- 3.16.00 The pumps shall be designed for reverse flow through them. The drive motor shall be capable of bringing the pump to its rated speed in the normal direction from the point of maximum possible reverse speed when power to the drive is restored.
- 3.17.00 The pumps shall be designed to have best efficiency at the rated duty point.
- The pumps shall be suitable for continuous operation within a wide range above and below the rated duty point. Such range of operation within which the pumps can satisfactorily operate on continuous basis, shall be clearly indicated.
- 3.18.00 Drive motors for the pumps shall be suitable for use on $415V \pm 10\%$, 3 $\emptyset$, 50 Hz, $\pm 5\%$ and neutral grounded system. Drive motors shall have 15% spare margin over the maximum power requirement of the pump within its range of operation.
- 4.00.00 **TESTING**
- 4.01.00 **Testing and Inspection at Manufacturer's works**

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| 4.01.01 | All tests required shall be conducted to ensure that the equipment furnished conforms to the requirements of this specification and is in compliance with requirements of the applicable codes. The particulars of the proposed tests and the procedures for the tests shall be submitted to Purchaser for approval before conducting the tests. |
| 4.01.02 | The representatives of Purchaser shall be given full access to all tests. Prior to pump performance tests, the manufacturer shall inform the Purchaser allowing adequate time so that if the Purchaser so desires, his representative can witness the test. |
| 4.01.03 | All materials and casting used for the equipment shall be of tested quality. The test certificates shall be made available to the Purchaser. |
| 4.01.04 | The pump casing shall be hydraulically tested at 200% of pump rated head or at 150% of shut-off head, whichever is higher. The test pressure shall be maintained for at least half an hour. |
| 4.01.05 | The pump rotating parts shall be subjected to static and dynamic balancing. |
| 4.01.06 | All pumps shall be tested at the shop for capacity, head, efficiency, brake horse power and cavitation. The tests are to be done according to the requirements of the Hydraulic Institute of USA, ASME Power Test Code, Indian Standards, as applicable. |
| 4.01.07 | The pump accessories e.g. the thrust bearing, the motor pump shaft coupling etc. will be subjected to tests as per manufacturer's standards. |
| 4.01.08 | The combined vibration of pump and motor should be restricted within limits specified by Hydraulic Institute Standards, USA when the pump is in operation at any load singly or in parallel. |
| 4.01.09 | Tests on motors shall be conducted as per electrical specification enclosed with this specification. |
| 4.01.10 | Test reports and certificates of the above mentioned tests to ensure satisfactory operation of the system shall be submitted to the Purchaser before despatch. |
| 4.01.11 | Cast heat marks shall be provided on castings for casing and impeller. |
| 4.02.00 | Test at Site |

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After erection at site, pumps under different services shall be operated to prove satisfactory performance as individual equipment as well as a system.

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**TECHNICAL SPECIFICATION
FOR
POSITIVE DISPLACEMENT PUMPS**

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**TECHNICAL SPECIFICATION
FOR
POSITIVE DISPLACEMENT PUMPS**

C O N T E N T S

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TECHNICAL SPECIFICATION FOR POSITIVE DISPLACEMENT PUMPS

1.00.00 INTENT OF SPECIFICATION

This specification covers the design, performance, manufacturing, shop testing, erection, testing & commissioning at site, of the positive displacement pumps.

2.00.00 GENERAL DESIGN FEATURES

This specification provides guideline for design, manufacturing and testing of positive displacement pumps with variable capacity to inject chemicals, generally used in the treatment of water in metered amounts.

2.01.00 Pumps shall be simplex/duplex type, positive displacement hydraulically operated diaphragm design, driven by squirrel cage induction motor through suitable speed reduction unit.

2.02.00 The stroke shall be continuously adjustable to give a capacity variation 0-100% range, while the pump is running or stopped. Adjustment of capacity shall be done automatically, wherever required, by pneumatic stroke positioner in proportion to a 0.2 - 1.0 Kg/Sq.Cm air signal or manually. For automatic pumps, in addition to the automatic control, manual control facility shall also be provided. Manual control facility shall be of micrometric adjusting type.

2.03.00 Capacity variation may be effected by changing eccentricity of the driving crank or by suitable hydraulic circuit. Pump accuracy shall be industry standard, $\pm 1\%$ of capacity setting.

2.04.00 Pumps shall be provided with an integral relief valve, spring operated, to release pressure when delivery line blockage occurs.

2.05.00 Crank case shall be constructed of high quality cast iron, which will also house the gear box and guides for cross head.

2.06.00 Material of construction should be as follows :

◆ Crank case	Cast iron.
◆ Pump head	Polypropylene.
◆ Valve and valve housing	Polypropylene.
◆ Wheel	Cast iron to a 48.